# THE EFFECT OF MIDDLE SCHOOL TEACHERS' MATHEMATICS TEACHING SELF-EFFICACY BELIEFS ON THEIR STUDENTS' ATTITUDES TOWARD MATHEMATICS

By

BETSY SHIELA SHOWALTER

Bachelor of Arts
University of Oklahoma
Norman, Oklahoma
1976

Master of Arts
University of Oklahoma
Norman, Oklahoma
1978

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Thesis approved

Dr. Patricia Lamphere-Jordan
Thesis Advisor

Dr. Margaret M. Scott

Dr. Dennis Bertholf

Dr. Caroline Beller

Dr. Gordon A. Emslie
Dean of the Graduate College

# PREFACE

This study was conducted in order to learn more than is currently available about the teacher-student connection in middle school mathematics education. The goals of mathematics education are to develop students' appreciation of mathematics, facilitate students' growth as problem solvers, reduce students' fear and potential avoidance behavior toward mathematics, and increase students' desire to do mathematics. Learning more about the teacher-student connection in order to create one that works toward advancing these goals is of paramount importance. Both quantitative and qualitative methods were used in analyzing data from surveys, questionnaires, observations, and interviews.

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# TABLE OF CONTENTS


Chapter Page

I. INTRODUCTION TO THE STUDY ....... 1

Foundation of the Study ....... 4
Significance of the Study ....... 6
Statement of the Problem ....... 8
Research Questions ....... 10
Purpose and Method ....... 10
Assumption ....... 12
Limitation ....... 12
Conclusion ....... 12

II. REVIEW OF THE LITERATURE ....... 14

Teaching Self-Efficacy Beliefs ....... 14
Elementary Teachers and the Reform Movement ....... 17
Uncharted Waters of Middle School Teachers ....... 21
Middle School Students ....... 22
Student Dispositions Toward Mathematics ....... 23
Students' Mathematics Course-Taking Intentions ....... 30
Conclusion ....... 32

III. METHOD ....... 34

Mixed Methods Design ....... 36
Implementation ....... 38
Participants ....... 39
Data Collection ....... 39
Qualitative Measures ....... 40
Quantitative Instruments ....... 41
Evidence of Reliability and Validity ....... 44
Procedure ....... 46
Data Analysis ....... 48
Trustworthiness ....... 49
Summary ....... 50

IV. RESULTS ........................................................................................................52

Mathematics Teaching Self-Efficacy Beliefs ....................................................53
Research Question I ..........................................................................................65
MTEBI ..........................................................................................65
Interviews with Teachers ..........................................................66
Classroom Observations ..........................................................86
Student Attitudes Toward Mathematics.............................................101
Fennema-Sherman Mathematics Attitude Scales ................................102
Student Questionnaire ..........................................................105
Mathematical Disposition ..........................................................115
Student Interviews ..........................................................116
Research Question II..........................................................................................119
Qualitative Results ..........................................................121
Research Question III ..........................................................................................126
Qualitative Results ..........................................................127
Statistical Observations..........................................................130
Conclusion ..........................................................................................132

V. SUMMARY, IMPLICATIONS, RECOMMENDATIONS, CONCLUSION ....135

Introduction ..........................................................................................136
Research Question I Summary and Conclusions ............................................138
Research Question II Summary and Conclusions............................................142
Research Question III Summary and Conclusions ..........................................143
Implications for Mathematics Education ..........................................................145
Implications for Teacher Preparation and Teacher Retention……… ..............146
Suggestions for Future Research…………………………………… ..............150
Unexpected Results..........................................................................................155
Limitations ..........................................................................................157
Ongoing Interest……………………………………………………...............159
Conclusion ..........................................................................................164

REFERENCES………………………………………………………… .............167

APPENDICES………………………………………………………… .............178

APPENDIX A – INTERNAL REVIEW BOARD APPROVAL FORM .........179
APPENDIX B – MTEBI IN-SERVICE SECONDARY .................................181
APPENDIX C – TEACHER QUESTIONNAIRE ........................................184
APPENDIX D – TEACHER INTERVIEW PROTOCOL .............................187
APPENDIX E – F-S MAS (three scales)………………………….................189
APPENDIX F – STUDENT QUESTIONNAIRE…………………… ............193
APPENDIX G – STUDENT INTERVIEW PROTOCOL…………... ............195
APPENDIX H – MTEBI RESULTS……………………………… ............197
APPENDIX I – F-S MAS RESULTS……………………………...............200

## LIST OF TABLES


Table Page

I. Reliability Analysis: MTEBI ....................................................................45

II. Reliability Analysis: F-S MAS ..................................................................46

III. Minimums, Maximums, Means, Standard Deviations: MTEBI ............................54

IV. School Demographic Data ........................................................................56

V. Demographics of In-service Teacher Participants ...............................................57

VI. Demographics of Student Sample .........................................................64

VII. Minimums, Maximums, Means, Standard Deviations: F-S MAS .....................104

VIII. Comparison of Means: Traditional vs. Inquiry-Based Curriculum ...................114

IX. MTEBI Scores and F-S MAS Means ................................................................131

X. Pearson Correlation Coefficients for F-S MAS Scale Pairs ...............................132

# CHAPTER 1

## INTRODUCTION TO THE STUDY

### Perceptions of Mathematics

Mathematics. Do you like it or not? Are you good at it or not? Do you want to study it or not? Most responses to these questions would be either positive or negative; there is seldom neutrality toward mathematics. "Mathematics is a discipline that enjoys a peculiar property: everybody has some mental image of it" (Fulvia Furinghetti, as cited in Picker & Berry, 2001, p. 206). While many consider mathematics to be a subject that is studied only in school, the classroom is not its only arena. Mathematics' influence pervades all of human activity. There are literary references. Some are sublime, as in Virginia Woolf's (1927) observation in her novel, To the Lighthouse, "It was love, . . . distilled and filtered; love that never attempted to clutch its object; but, like the love which *mathematicians bear their symbols*, or poets their phrases, was meant to be *spread over the world and become part of the human gain* (emphasis added by the author)" (p. 47). While others, if not ridiculous, are at least more humorous, as in Scieszka's (1995) book for children, Math Curse. The child in this book is told by his teacher, Ms. Fibonacci, "You know, you can think of almost everything as a math problem" (p. 2). Problems begin first thing in the morning:

I look in my closet, and the problems get worse: I have 1 white shirt, 3 blue shirts, 3 striped shirts, and that 1 ugly plaid shirt my Uncle Zeno sent me.

1) How many shirts is that all together?

2) How many shirts would I have if I threw away that awful plaid shirt?

3) When will Uncle Zeno quit sending me such ugly shirts? (p. 4)

This young student even finds that English is a math problem: If mail + box = mailbox:

1) Does lipstick – stick = lip?

2) Does tunafish + tunafish = fournafish? (p. 13)

Mathematics' image suffers at the hands of creative artists, like singer and songwriter, Jimmy Buffet:

If necessity is the mother of invention
Then I'd like to kill the guy who invented this.
The numbers come together in some kind of a third dimension
A regular algebraic bliss . . .
Geometry, trigonometry and if that don't tax your brain
There are numbers too big to be named.
Numerical precision is a science with a mission
And I think it's gonna drive me insane.

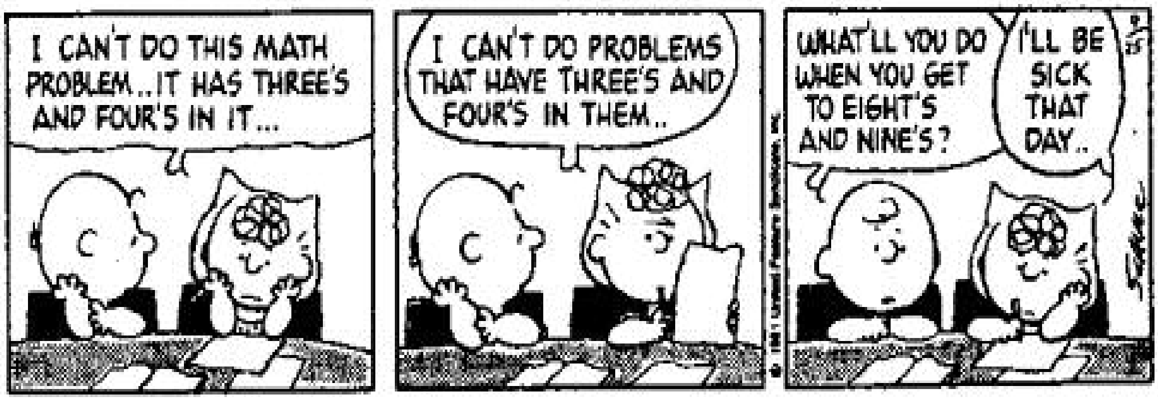
(*Math Suks* (sic) by Buffet, Guth, & Mayer, 1999)

One can even find poetic references to mathematics and those who study it:

*Having perceived the connexions, they seek*
*the proof, the clean revelation in its*
*simplest form, never doubting that somewhere*
*waiting in the chaos is the unique*
*elegance, the precise, airy structure,*
*defined, swift-lined, and indestructible* (Morrison, 1981, p. 23).

Charles Schultz and other graphic artists often use the mathematics classroom to strike a common chord among members of a diverse readership:

**PEANUTS** By Charles M. Schulz




"Peanuts" reprinted by permission of United Features Syndicate, Inc.

When this author informally asked teachers for their perceptions of mathematics, their responses were varied: "Systematic way to solve problems," "Just a problem to be solved or worked out. There is an answer to find," "The simpler the better," "A process," "Procedural," "Computation, statistics, and other operations that quantify data," and "Critical thinking."

Gibson (1994) found that students could effectively use metaphors to explain the feelings that mathematics evokes: "Math is most like an earthquake. If an earthquake was to hit, even just a tremor, it could knock down and ruin a lot of things. Just like in math, if you make one error in a problem, even a small one, it can ruin or tear down all of your work." "For me, math is like an endless jigsaw puzzle, with all the pieces the same color." "To me, math is like a used car that you can get for a good price; sometimes it runs smoothly, but on certain days things go wrong. It's frustrating, like a car can be, when it won't go right. . . . With math, things don't always work out right. I don't know how many times I've screamed and pulled my hair out trying to 'fix' a math problem, but when I finally figure it out, I feel fantastic, like I've accomplished something. Sometimes you break down, in a car or during a math problem, but if you work with it, you'll get to where you're going!" (pp. 8-9).

## Foundation of the Study

### *Student Attitudes Toward Mathematics*

Attitudes toward mathematics are engendered by perceptions, whether those perceptions are expressed lightheartedly or seriously, as in the above examples, and mathematics educators are concerned with fostering positive student perceptions of and positive attitudes toward mathematics. Kempa and McGough (1977) outlined mathematics attitudes as being one's perception of the difficulty of learning mathematics, one's enjoyment and liking of mathematical activities, and one's views on the usefulness of mathematics. Implicit attitudes toward mathematics become explicitly expressed as what the National Council of Teachers of Mathematics (NCTM) terms a "mathematical disposition" in its *Curriculum and Evaluation Standards for School Mathematics* (1989). Mathematical disposition "refers not simply to attitudes but to a tendency to think and act in positive (or negative) ways" (p. 233). Mathematical disposition includes (1) interest and curiosity, (2) perseverance, (3) confidence, (4) flexibility, and (5) valuing the application of mathematics. A positive disposition is manifested in a number of ways, such as higher achievement levels (Butty, 2001), but perhaps even more significantly as a continued interest in mathematics on the part of the student (Steinback & Gwizdala, 1995), which then could be exhibited as the student's participation in non-required mathematics courses (Lantz & Smith, 1981). Ameliorating the subjective student attitudes toward mathematics is an attainable goal for intervention, according to Lantz and Smith.

*Teacher Efficacy Beliefs*

Bandura (1997) termed the belief that one has as to the effect that personal actions or efforts have on the attainment of goals or the accomplishment of objectives as one's efficacy beliefs or one's perception of self-efficacy. This sense of self-efficacy influences "the courses of action people choose to pursue, how much effort they put forth in given endeavors, how long they will persevere in the face of obstacles and failures, their resilience to adversity, whether their thought patterns are self-hindering or self-aiding, how much stress and depression they experience in coping with taxing environmental demands, and the level of accomplishments they realize" (p. 3). Ashton and Webb (1986) focused the self-efficacy construct on teachers by defining teachers' sense of self-efficacy as a situation-specific expectancy that they can effect or bring about student learning. Like Bandura (1997), Ashton and Webb recognized that these beliefs affect a teacher's choice of classroom activities, the amount of effort the teacher is willing to expend, and his or her persistence in the face of difficulties. A teacher with a low sense of self-efficacy will be preoccupied with perceived inadequacies and imagine them to be more pronounced than they are while a teacher with a high sense of self-efficacy will tend to maintain high expectations and choose challenging activities even when faced with difficulties.

Ashton and Webb (1986) separated the construct of teaching self-efficacy into two dimensions: (1) sense of teaching efficacy – the belief as to whether teaching can influence student learning despite external factors and (2) sense of personal teaching efficacy – an individual's assessment of his or her own teaching competence. In other words, if a teacher has a low sense of teaching efficacy, h/she will feel that no teacher can affect student achievement, regardless of intentions. Responsibility for learning or blame for lack of learning is placed upon the student and external factors. A teacher who has a high sense of personal teaching efficacy will feel, if not totally responsible for lack of student achievement, at least a shared responsibility with students.

## Significance of the Study

### *Student Attitudes Toward Mathematics*

A student's mathematical behavior is an outgrowth of his or her attitude toward mathematics. Ryan and Pintrich (1997) found that a student with a positive attitude with regard to competence in mathematics was more likely to seek "adaptive help" in class. When a student requests adaptive help, such as clarification of a problem, hints, or examples of similar problems, s/he is showing a desire to independently solve a problem as opposed to when s/he requests more passive help in which s/he just wants to see the solution to the problem in question. In examining students' metaphors for mathematics, Gibson (1994) found that students whose metaphors indicated a positive attitude toward mathematics more readily drew upon their own resources than their classmates.

Teachers are encouraged to allow students to take a more active role in their mathematical learning (NCTM, 2000). However, Franke and Carey (1997), in their work with first graders, and Kloosterman and Stage (1992), in their work with secondary and college students, found that when students held onto the attitude that mathematics was a set of rules and procedures, only some of them were able to learn. Also, these students were reluctant to examine strategies and engage fully in problem-solving tasks. In other words, the students were less willing to take risks and to accept that it was all right to be wrong (Brown, 1992). Of more far-reaching significance, the negative disposition of students toward mathematics may be felt in the long-term by a decreased enrollment of students in advanced mathematics courses, not only in high school but also at institutions of higher education. The National Research Council (NRC), in its 1989 document, *Everybody Counts*, reported that for each year between ninth grade and graduate school, about half of students leave the area of mathematics for other fields of study, which could result, warned Picker and Berry (2000), in a continued shortage of mathematicians and mathematics educators. The NRC lamented "Mathematical illiteracy is both a personal loss and a national debt" (p. 18).

### *Teacher Efficacy Beliefs*

In its *Principles and Standards for School Mathematics* (2000) the NCTM recommends that mathematics educators should move from teaching mathematics as a set of facts and fixed procedures toward facilitating students' efforts to construct meaning and understanding from prior knowledge and experience. The teacher's role then changes from one of being the captain who sets the course and is the giver of knowledge and instruction to one of being a crew member with his or her students. According to the NCTM's recommendations, through reasoning, discourse, representation, and questioning, students should set the course of their learning. Smith (1996) found that a teacher's efficacy beliefs could influence his or her readiness to adopt the reform recommendations. According to Ashton and Webb (1986), a teacher with a low self-efficacy, who relies on authority that comes by virtue of his or her position as the leader of the class, tends to be distrustful of students and feels threatened when the roles of teacher and student are blurred. In contrast, a teacher who has a high self-efficacy and relies on an earned sense of authority, will make the students the center of the learning environment, will treat them with respect, and will provide appropriate tasks that will enhance their learning.

Vinson, Haynes, Brasher, Sloan, and Gresham (1997) defined math anxiety as a feeling of uneasiness when asked to perform mathematical calculations, a lack of confidence in a problem-solving situation, a low motivation to do mathematics, and a strong dislike of mathematics. By experiencing a lower level of math anxiety a student may be willing to taking more advanced mathematics classes, which would be the ultimate success of mathematics education. Newstead (1998) found that students who were exposed to alternative teaching practices as recommended by the NCTM responded with less overall mathematics anxiety than those exposed to the traditional approach. As stated above, a teacher's sense of his or her efficacy determines whether s/he will adopt reform recommendations. Therefore, it is worthwhile to study the relationship between a teacher's mathematics self-efficacy and his or hers students' attitudes toward mathematics.

## Statement of the Problem

There is significant research on teacher efficacy and there is equally accessible research on student attitudes toward mathematics. Brown (1992) found evidence that a teacher's image or perception of mathematics influences his or her students' perceptions of mathematics. Teacher beliefs about how mathematics should be taught and how those beliefs translate into choices for classroom instruction may influence their students' definition of what is or is not mathematics, according to Kouba and McDonald (1991). Brown and Gray (1992) found that students' attitudes toward problem-solving would reflect the level of confidence that their teacher felt about problem-solving. If a teacher has a strong sense of mathematics self-efficacy, his or her students will show a higher achievement in mathematics (Ashton, 1986; Tracz & Gibson, 1986).

There is little research that explores whether there is a relationship between a teacher's mathematics self-efficacy beliefs and his or her students' attitudes toward mathematics and their resulting mathematics disposition. The existence of such a relationship would be significant because it would illustrate another facet of the impact that a teacher's beliefs can exert on students. The goals of mathematics education are to develop students' appreciation of mathematics, facilitate students' growth as problem solvers, increase students' desire to do mathematics, and reduce students' fear and potential avoidance behavior toward mathematics. Learning more about the teacher-student connection in order to create one that works toward advancing these goals is of paramount importance.

Gusky (1981) found that elementary teachers had a stronger sense of personal teaching efficacy and accepted more responsibility for success or lack of success with students than did secondary teachers. Midgley, Feldlaufer, and Eccles (1989) reinforced the importance of self-efficacy beliefs when they found that "the beliefs of students who had low-efficacy teachers became more negative as the school years progressed, whereas the beliefs of students who had high-efficacy teachers became more positive or showed less negative change from the beginning to the end of the school years" (p. 254). These results could have implications for those who design professional development experiences for classroom teachers.

The participants in the research into self-efficacy beliefs often have been pre-service teachers rather than in-service teachers. Presumably this is because, as Wenner (2001) found, the self-efficacy beliefs of in-service teachers, in particular science and mathematics teachers, tend to be higher than those of pre-service teaches, and therefore pre-service teachers should be the targeted population for intervention. However, as cited earlier, as reform recommendations are made by professional organizations, it is precisely in-service teachers on whose shoulders lies the burden to adopt new strategies or adapt often ingrained practices to reflect the suggested goals. While established efficacy beliefs are difficult to change, Tschannen-Moran, Hoy, and Hoy (1990) affirmed the need to give attention to teachers' efficacy beliefs across the span of their careers.

## Research Questions

The questions that this study addressed were:

1) What is the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics?
2) What is the relationship between a student's disposition toward mathematics and his or her choosing to continue to study mathematics?
3) What influences middle school students' desire to continue studying mathematics?

## Purpose and Method

The purpose of this study was to examine the relationship between mathematics teaching efficacy beliefs and disposition of students toward mathematics. The method of this two-phase, sequential, mixed methods study was to gather statistical, quantitative results from a sample of middle school mathematics teachers and then follow up with a selected sample of their students to explore the results in more depth. In the quantitative phase, analysis of  teachers' responses to a mathematics teacher self-efficacy beliefs survey served to identify a sample of teachers whose mathematics teaching self-efficacy beliefs were at the high/low extremes. The students whose teachers fell within this sample responded to a mathematics attitudes survey and analysis of these responses served to identify those students whose attitudes were at the positive/negative extremes.

In the second phase, qualitative data was used to (1) examine teachers' mathematics teaching beliefs and classroom instruction, (2) examine the relationship between teacher practice and student attitudes, and (3) determine what prompts students' decisions to continue in the study of mathematics.

In the past decade a shift has taken place in the philosophical debate surrounding the choice of methodology in research design. The question no longer asks qualitative or quantitative but rather where on a continuum between the two does research practice lie that will allow the researcher to address his or her question(s) (Creswell, 2003). Creswell offers two strong reasons that support combining methods in a single study:

1) Mixing methods will neutralize the biases that are inherent in any single method.
2) Results from one method can indicate the direction of another method.

This study followed what Creswell called sequential procedures in which the survey results from the teachers guided the selection of the sample of students who were chosen to participate in the second stage of the study, which included data from both quantitative and qualitative sources. The combination of survey responses and responses to open-ended questions allowed the researcher to have a fuller understanding of the dynamic relationship between teacher and student and analysis of the data from these sources was used to determine which students would be chosen for interviews. Quantitative data in the form of Likert-type surveys was collected in order to determine levels of teachers' efficacy beliefs and the attitudes toward mathematics of their students. Using the survey results as a means of selecting respondents, qualitative data in the form of responses to open-ended questions and interview responses was collected from a smaller sample of the students. These responses allowed the researcher to gain a fuller understanding of not only the students' attitudes toward mathematics, but also how these attitudes might reflect their teachers' efficacy beliefs and how these attitudes might influence the students' intentions to take non-required mathematics classes. The information gained from the interviews were used in conjunction with observations of classroom instruction to fill in details that allowed the researcher to make sense of the interaction between teacher and student.

## Assumption

The researcher assumed that each teacher and student in this study would be truthful in his or her responses to survey items, open-ended questions, and interview questions.

## Limitations

Initially, this study was confined to middle school mathematics teachers in four districts that were within a seventy-five-mile radius of the researcher's home base. From this initial sample of teachers a smaller purposive sample of their students was included in the second phase. These samples of both geographic convenience and purposive nature preclude the possibility of generalization. The findings from this study, while adding to the current research, are not generalizable to all middle school mathematics teachers and their students. Also, with respect to the inherently subjective nature of qualitative research, the findings are subject to interpretations other than those of the researcher.

## Conclusion

This dissertation is organized according to a five-chapter format. This first chapter has presented the foundation, significance, and statement of the problem that was the focus of the study. Additionally, this chapter has included the purpose of the study and a brief statement of the method of the study, the research questions that were addressed, the assumptions of the study, and the limitations of the study. Previous research is examined in the form of a literature review in Chapter II and this examination holds up the lens through which the researcher viewed, analyzed, and interpreted the data. The methodology of the study with regard to participants, design, instruments, and collection of data is outlined in Chapter III. The results of the study are reported in Chapter IV. In Chapter V, the researcher summarizes the findings of the study, makes conclusions based upon interpretations of the data, suggests areas for further research, and offers implications for mathematics education and teacher education and retention.

# CHAPTER II

## REVIEW OF THE LITERATURE

Chapter II presents an overview of research surrounding teachers' self-efficacy beliefs, including specific attention to the self-efficacy beliefs of middle school mathematics teachers. This chapter also addresses students' dispositions toward mathematics and students' intentions to take non-required mathematics courses. This literature review is the lens through which the researcher viewed the collected data and sets the framework upon which the researcher built analysis and interpretation of the data.

### Teaching Self-Efficacy Beliefs

Once an individual defines a task to be accomplished or a problem to be solved, s/he internally processes the parameters of the task or problem, evaluates the available resources, and devises a strategy by which the resources can be applied. How does one know or recognize the problems with which s/he is dealing? According to Nespor (1987), this is the point at which *belief systems* become important determinants of task or problem definition. The structure of a belief system relies upon several features. One's belief system is built upon certain propositions and assumptions regarding tangible or intangible entities. There are often alternative realities or ideals that influence the belief system. Affective components, e.g., feelings, moods, and subjective evaluations, may have more bearing upon the formation of the belief system than cognitive knowledge. Information that is used to form one's belief system is likely stored as episodes from one's previous experiences. "Belief systems can be described as loosely-bounded systems with highly variable and uncertain linkages to events, situations, and knowledge systems. There are no clear logical rules for determining the relevance of beliefs to real-world events and situations" (p. 321).

Looking at a specific type of belief system, that of self-efficacy, Bandura (1977, 1997) attempted to account for specific choices individuals make when faced with the tasks required for goal attainment, beginning with the choice to even attempt to make changes in one's situation. One's belief in his or her ability to influence the outcome of a situation or effect change drives not only the choice of activities, but also the amount of effort that is expended in the pursuit of the goal, the willingness to persevere in the face of obstacles or temporary setbacks, how much stress and/or depression is experienced when demand is greatest, and what accomplishments ultimately will result from the effort. Although successes and failures can act to raise or lower self-efficacy respectively, once an elevated sense of self-efficacy is established, the potential impact of a failure is lessened.

Self-efficacy beliefs link knowledge with action. These beliefs can be task and situation specific, meaning that the intensity of the beliefs and the perceived difficulty of the task at hand will vary according to the task or situation. Self-efficacy beliefs may or may not generalize across a range of similar activities or domains or to other domains or settings. The knowledge that contributes to the development of one's self-efficacy beliefs comes from the outcomes of actual or lived experiences and observed experiences, including the physical and emotional responses to those experiences, and communication with others. Efficacy expectations, the belief that one is capable of executing the necessary behavior to affect outcomes, and outcome expectations, the belief that the behavior will in fact have the desired effect, form Bandura's (1997) self-efficacy construct.

Beginning with Bandura's (1977) idea that self-efficacy beliefs can be domain specific, Ashton and Webb (1986) apply self-efficacy theory to the domain of teaching. These teaching efficacy beliefs, paralleling Bandura's (1977) general efficacy theory, affect what activities the teacher chooses to use in the classroom, the amount of effort expended in the implementation of planned strategies, and his or her persistence when faced with difficult situations. A teacher who has a low sense of teaching efficacy may focus on perceived inadequacies and avoid planning activities that s/he believes exceeds his or her capabilities. A teacher with a higher sense of teaching efficacy might plan activities that challenge both teacher and student.

Ashton and Webb (1986) observed high school basic skills teachers and described classroom behavior according to whether the teacher showed low or high teaching self-efficacy beliefs. Those teachers with a low sense of teaching self-efficacy did not spend much time engaged in learning activities with their students, relying instead on seatwork to keep students "busy." These teachers were distrustful of students, felt their competency threatened by students who had difficulty learning, and tended to lower their expectations for and require less of students whom they perceived as being "slow." The teachers focused on discipline issues and guarded their position of "teacher" as the primary source of their authority. Teachers who had a high sense of teaching self-efficacy tended to make the student the center of attention and expected them to behave and stay on task. Although assignments were given for students to work on in class, teachers remained actively involved with students by monitoring individual student progress and offering encouragement. These teachers often redirected student questions back to the student by asking, "What do you think?" or "Try it and find out" (p. 137). This placing of responsibility for active learning on the student was a marked difference between the pedagogies of the teachers with a high sense of teaching self-efficacy and the teachers with a low sense of teaching self-efficacy. Those teachers with low teaching self-efficacy saw their role as one of imparting facts and answers to students who were passive learners and when their students were unsuccessful, these teachers felt a personal helplessness and were at a loss as to how to help their students learn.

### *Mathematics Teaching Efficacy Beliefs of Elementary Teachers and the Reform Movement*

The current reform recommendations from the NCTM (2000) shift the focus of mathematics education from teaching mathematics as a static system of facts and algorithms to teaching mathematics as a dynamic complex of ideas that is "continually enriched through conjecture, exploration, analysis, and proof" (p. 5). Battista (1999), reflecting on the intent of the then fifteen year-old reform movement in mathematics education, suggested that mathematics instruction should be centered around problem-solving and that students should be encouraged to generate their own mathematical knowledge. By reflecting on this constructed knowledge, students begin to make the transition from reliance upon concrete models to being able to work within the sophisticated realm of mathematical symbols. Unfortunately, Battista acknowledged, the current state of mathematics education was such that "although virtually all students enter school mathematically healthy and enjoying mathematics as they solve problems in ways that make sense to them, most exit school apprehensive and unsure about doing all but the most trivial mathematical tasks" (p. 426).

The question is, why, despite the recommendations of the NCTM and the National Research Council (1989), do teachers continue to teach mathematics as an exercise of mimicry rather than a dance of creativity? Lee, Meadows, and Lee (2003) suggested that teachers' pedagogical content knowledge in mathematics determined their classroom practice. Pedagogical content knowledge is comprised of both content knowledge (is this "knowledge" conceptual or merely procedural?) and pedagogical knowledge (understanding what children already know in mathematics, understanding children's mathematics problem-solving process, and understanding the organization of mathematics environments). The authors drew the analogy of the need for both types of knowledge in the mathematics classroom to the situation in which even though a person may know how to get to the grocery store, s/he may not be able to give directions to others. While knowledge may arguably be the primary determinant of a teacher's ability to implement the recommendations of the reform movement, Nespor (1987) contended that "teachers' beliefs play a major role in defining teaching tasks and organizing the knowledge and information relevant to those tasks" (p. 324).

In a study with 25 pre-service elementary teachers, Benbow (1995) found that pre-existing beliefs about mathematics teaching and learning played a pivotal role in guiding the pre-service teachers as they planned and implemented their mathematics lessons. Smith (1996) pointed out that many teachers' pre-existing beliefs were grounded in their prior experiences as students of mathematics education. They were students of the "teaching by telling" pedagogy, that is, they were taught that mathematics was a set of facts and accompanying procedures and that the teacher simply had to tell the students everything they needed to know in order for learning to take place. Teaching by telling is safe, predictable, and manageable. These teachers' sense of mathematics teaching self-efficacy is based upon their being able to organize the information into tidy packages that their students will take in and be able to reproduce on a test. Teachers feel efficacious when their students perform prescribed tasks of reciting facts and carrying out step-by-step procedures. Guillaume and Kirtman (2005) asked 144 pre-service teachers to write their mathematics autobiographies, in which they traced their histories as both knowers and learners of mathematics. Most of the participants had learned mathematics as only a school subject; few reported that it had been taught as having any relevance outside of school. Secondly, participants learned that mathematics was procedural and algorithmic, with few reporting any conceptual understanding of why a particular algorithm was used or any problem-solving opportunities in which they could apply their understanding. The consequence of writing and sharing these autobiographies was that the pre-service teachers reflected on their past experiences, positive and negative, and developed notions of what good mathematical education practice would look like. Their collaborative work resulted in six central themes for effective mathematics instruction:

- Good teachers believe in their students and convey that conviction.
- Good teachers drive their instruction by their goal of student learning.
- Good teachers teach for conceptual understanding.
- Good teachers use methods that are interesting and engaging to students.
- Good teachers create settings in which students feel safe to take risks.
- Good teacher show the connections between mathematics and other facets of life.

According to Smith (1996), a teacher's teaching self-efficacy exerts a strong influence on his or her decisions for classroom practice and consequently on his or her students' learning. Roberts, Henson, Tharp, and Moreno (2000) cited a study by Riggs and Jesunathadas (1993) that found that teachers with high personal teaching self-efficacy were likely to spend longer on concept development in class, incorporating cooperative learning among students. In this scenario, students have the freedom to explore concepts and construct knowledge, thereby exercising more control over the learning environment. Teachers with lower teaching self-efficacy beliefs tended to rely on a surface knowledge of facts and procedures and were more tied to the textbook, using a lecture format with students remaining as individual learners (Riggs, 1995, cited by Roberts, et al, 2000). Furthermore, the teachers who had lower teaching self-efficacy beliefs also tended to have a pessimistic view of their students' abilities to learn and relied on rigid classroom control and extrinsic rewards for motivation (Woolfolk & Hoy, 1990). Self-efficacy beliefs that are based upon exercising control over student acquisition of facts could be shaken by the unpredictability of student interactions. Smith (1996) concludes that teachers must reconceptualize what efficacy is so that efficacy beliefs promote classroom practice that will align with reform principles.

Pre-service teachers, primarily elementary teachers, have historically been the target population for self-efficacy beliefs intervention and they respond to a variety of efforts on the part of teacher preparation programs with an increase in their personal teaching self-efficacy (Wingfield, Nath, Freeman, & Cohen, 2000; Benbow, 1995; Benbow, 1993; Woolfolk & Hoy, 1990; Utley& Moseley, 2003; Vinson, 1995). As a result of these intervention efforts on the behalf of elementary teachers, Midgley, Feldlaufer, & Eccles (1989) found that elementary teachers felt more efficacious in the classroom than their secondary counterparts. Furthermore, these researchers found that elementary teachers perceived that they were more responsible for their students' successes or failures than did secondary teachers. Some attention has also been given to in-service teachers (Woolfolk & Hoy, 2000; Wenner, 2001). Woolfolk and Hoy's (2000) research focused on teachers' self-efficacy beliefs as they progressed from student teaching through the first year of teaching. They found that efficacy beliefs rose during teacher preparation, but fell during the first year of teaching. Wenner (2001) conducted a five-year study that included both elementary pre-service teachers and elementary in-service teachers who had one to ten years' experience. He found that pre-service teachers reported more confidence in their ability to explain mathematics concepts, they were more receptive to student questions and they believed they would continue to find better ways to teach in the future, and contrary to Woolfolk and Hoy (2000), the teachers' experience tended to contribute to an increase in teaching self-efficacy. Thus there seems to be no predictable relationship between self-efficacy beliefs and a teacher's teaching experience.

### *The Uncharted Waters of Middle School Teachers*

Middle school mathematics teachers may be trained through elementary education preparation programs or they may be trained through secondary mathematics education programs. While much research has investigated the mathematics teaching efficacy beliefs of both pre-service and in-service elementary teachers, Molina (2004) cited Askey's (1999) observation that middle school teachers frequently experience a journey through a no man's land in their preparation for teaching. "The material they (middle school teachers) will be teaching is not taught in detail to either prospective elementary teachers or to prospective high school teachers; there are no courses specifically for middle school teachers" (p. 20). Only 7% of U. S. middle school mathematics teachers have taken courses in all of the areas recommended by the NCTM standards (National Science Board, 1998) and many U. S. middle school mathematics teachers are teaching out of field due to budget considerations or under emergency certification, according to

Huffman, Thomas, and Lawrenz (2003), citing results from the National Commission on Teaching and America's Future (1999). Close to home, in Oklahoma, middle school teachers are required to have only a subject area endorsement in order to be able to teach mathematics in the middle school (edweek.com, 2003).

The mathematics teaching self-efficacy beliefs of these middle school teachers, according to Hackett and Betz (1982) may be the strongest indicator of conceptual understanding and may explain avoidance of mathematics, even more so than math anxiety. Molina (2004) found that middle school mathematics teachers experienced mathematics education as facts and procedures and were often unclear about the concepts behind the procedures. The feeling that they are not adequately prepared to teach the mathematics they must teach may adversely, in turn, affect middle school teachers' teaching self-efficacy. There is little research that examines the mathematics teaching self-efficacy of in-service middle school teachers.

## Middle School Students

Beane (1993) emphasized the need for special attention to middle school students. These early adolescents are beginning to experience an awareness of the social world and their place in it and are less willing to accept structure and predictability. Notably, they themselves are less predictable: "Early adolescents respond in varying ways from enthusiastic engagement to outright resistance" (p.13). Their awareness of the social world sparks concerns about social issues and it is at this time that they begin to explore their interests to find out what options they might have for the future. This is an opportunity for middle school teachers to engage the curiosity of early adolescents. The NCTM (2000) recognizes this opportunity as well: "During this time, many students will solidify conceptions about themselves as learners of mathematics--about their competence, their attitude, and their interest and motivation" (p. 211). Beane (1993) also addressed mathematics by noting that while mathematical skills are "helpful in many ways as we find, analyze, and solve problem situations . . . . they are not seen as isolated or self-justified skills, but rather as functional skills, developed and used in the context of important themes under consideration" (p. 74). Both Beane and the NCTM remarked on the diversity of students at this level. Differences in intellectual development, emotional maturity, and sensitivity to peer-group perceptions challenge the middle school mathematics teacher to create a learning environment that nurtures the learning of mathematics for everyone.

### *Student Dispositions Toward Mathematics*

The importance of a student's disposition toward mathematics cannot be underestimated. The NCTM (1989) reported that a positive disposition toward mathematics is a strong influencer of one's becoming quantitatively literate. Wilkins and Ma (2003) break down quantitative literacy into five components: "(a) a functional knowledge of mathematical content, (b) an ability to reason mathematically, (c) a recognition of the societal impact and utility of mathematics, (d) an understanding of the nature and historical development of mathematics, and (e) a positive disposition toward mathematics" (p. 52). Focusing on the affective components, the last three of the five, Wilkins and Ma examined data from the Longitudinal Study of American Youth (Miller, Kimmel, Hoffer, & Nelson, 2000) in order to isolate the variables that affect student attitudes toward mathematics throughout secondary school. They discovered that as students progress through secondary school, they become less positive toward mathematics and their opinion as to the social importance of mathematics declines, regardless of their achievement levels. However, Wilkins and Ma also found that if there was a mitigating factor to this downward trend it was the combined effect of teachers, parents, and peers. Of significance to this study, while the researchers did not find a strong relationship between middle school mathematics curriculum and student affect, "the perceived encouragement from teachers consistently predicted positive status and slower decline in student attitude toward mathematics and was the only significant predictor of change in attitude during the middle school years" (p. 60).

Almost half of the students in an academically competitive college cited the influence of a particular high school teacher and his or her instruction as the impetus for their decision to major in mathematics (Gavin, 1996). However, Jones, Brown, Hanley, and McNamara (2000) citing a study by Su (1992) stated that it is students' reaction and performance in response to a teacher's instruction that is the most powerful indicator of that teacher's effectiveness of being a teacher. There seems to be a symbiotic relationship between teaching practice and student disposition toward mathematics.

Fleener, Depree, and Craven (1997), in a study with seventh and eighth graders, targeted the recognition of the importance of mathematics and the perception that success in mathematics is possible. These researchers believed that the affective components were key to students' feeling empowered as they studied mathematics. According to the National Council of Teachers of Mathematics (1989), mathematical empowerment is the ability to "explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve non-routine problems" (p. 5). When asked to characterize a typical mathematics classroom in response to six cartoons depicting different mathematics classroom environments, the students made observations such as "all the students are gathered around the teacher," "everyone is seated and quiet and paying attention," "the teacher is taking the kids step-by-step," "the teacher has control of her class and it is pretty boring," "students are not having any part in the classroom," "most teachers just stand up and talk and don't let the students try," "the students are listening, probably not understanding it, trying to figure out what is going on" (p. 42). Despite the efforts on the part of the NCTM to foster mathematics teaching in which the students are equal partners with their teachers in the learning process, it seems that the students in this study were still experiencing mathematics instruction as the teacher's being the "sage on the stage" and the researchers found that most of the students were comfortable with that situation.

In a search for a connection between student perceptions and student achievement in mathematics, Young (2000) conducted a two-year study involving year eight, nine, ten, eleven, and twelve students in both urban and rural schools in Western Australia. Students responded to the Academic Self-Concept instrument (perception of academic ability and potential to be successful in school) and a multiple-choice mathematics and science test. An example of items on the Academic Self-Concept is "If I work really hard I could be one of the best students in my school year." While the researchers found statistically insignificant gender and socioeconomic differences in achievement, they did report that achievement differences appeared at the classroom level and at the student level. Student factors included prior achievement and self-concept and classroom factors included classroom cohesiveness and perception of academic ability of peers. Although the researchers did not specifically address the effect of teacher factors on student achievement, they did suggest that because of the strong relationship between classroom environment and achievement, future research should analyze teacher effect on achievement.

Brahier (1995) worked with eighth graders enrolled in a first-year algebra course as he focused on the affective dispositions of *interest* (the desire to pursue an object because of the potential for personal growth), *perseverance* (the willingness to continue to work on a difficult or trying task until completion), *confidence (self-efficacy)* (one's perception of his or her capability to plan and execute the strategies necessary to achieve a goal), and *flexibility* (willingness to try alternative methods when solving a problem after an initial try has failed). Most (80%) of the students cited extrinsic reasons, e.g. high school preparation or being forced to take the course, for taking algebra. "They appeared much more interested in impressing the teachers and earning high grades than learning for the sake of learning" (p. 6). Brahier found that students and their parents viewed the value of algebra as being a prerequisite for other classes and saw only future algebra teachers as the only individuals who needed an algebra course. The students experienced little problem-posing of the type that would pique curiosity and trigger the perception of the worth of studying algebra. Rather they experienced the traditional classroom routine of checking homework, presenting examples of new work, and using class time to work on the day's assignment. The author concluded that it was this teacher-directed experience that accounted for the negative dispositions of students toward algebra and its study. As cited earlier, Smith (1996) found that a teacher's teaching self-efficacy strongly influenced his or her classroom practice and a low teaching self-efficacy predisposed a teacher to adhere to the traditional classroom model described in the Brahier (1995) study.

Picker and Berry (2001) learned from mathematicians that it was during middle school that they realized that mathematics was more than just a school subject, that it could be a gateway to career opportunities, both within education and other areas.

However when Picker and Berry (2000, 2001) asked seventh graders to draw their images of a mathematician at work and respond to statements aimed at determining their attitudes toward mathematicians and mathematics, they found that students seemed to find little use for mathematics unless one was planning to teach. The researchers suggested that teachers play a major role in nurturing the development of students' perceptions of mathematics' possibilities for a career choice or as an avocation. Teachers themselves, through their classroom practice or because of their own lack of knowledge about, or their own stereotyped images of, mathematicians and the value of mathematics, may unconsciously be undermining the goal of burnishing the image of mathematics as being pivotal to students' overall literacy as touted by professional organizations such as the NCTM.

In its *Principles and Standards for School Mathematics*, the NCTM (2000) stated, "Problem-solving means engaging in a task for which the solution method is not known in advance. Students should have frequent opportunities to formulate, grapple with, and solve complex problems that require a significant amount of effort and should then be encouraged to reflect on their thinking" (p. 52). The teaching self-efficacy beliefs that teachers model through their own problem-solving behavior have significant influence upon their students, according to Schunk (1995). When students perceive that their teacher is confident and capable, they may be more motivated to attempt to take ownership of their learning and be willing to adopt more risk taking behavior in their problem-solving. Schunk's conclusion followed his reporting on a study conducted by Zimmerman and Ringle (1981) in which students watched a model work to solve a problem for varying lengths of time and listened as the model verbalized statements that indicated varying degrees of confidence or pessimism. After each viewing, the children were presented with a puzzle to solve themselves. The researchers found that children who had observed a low-persistence model who expressed confidence, i.e. exhibited strong self-efficacy, showed an increase in their own self-efficacy while students who observed a model who was persistent but who made pessimistic remarks, i.e. exhibited a weak self-efficacy, showed a lowering of their own self-efficacy. In turn, Pajares (1996) found that a student's mathematics self-efficacy was a stronger predictor of his or her mathematics problem-solving behavior than self-concept, perceived usefulness, or prior experience, giving further support to the importance of a teacher's mathematics teaching self-efficacy.

Clarke (1985) used the framework of "mathematical behavior" to encompass ability, understanding, performance, self-concept, conception of mathematics, individual student classroom practices, and practices of the learning environment. The sample for his three-year study was comprised of ten students as they progressed from grade 6 through grade 8. From this sample, Clarke chose two on whom to focus the final study. The purpose of his research was to see what effect secondary schooling and secondary mathematics had on these students as they moved from elementary school (grade 6) to secondary school (grades 7 and 8). Both students viewed themselves as competent in mathematics at the beginning of the study however; they reported that they did not like mathematics.

The teachers of the students in this study kept detailed diaries in which they recorded details about lesson content, methods of instruction, and class and individual behavior for every lesson they taught. Clarke described the lessons in the seventh grade mathematics classes as "unduly mundane" (p. 238), meaning they followed the traditional pattern of discussion, notes, examples, and problems. Following grade 7 mathematics one student continued to perform adequately, while the other showed lower performance. Neither student expressed a positive attitude toward mathematics at the end of grade 7, however, both students commented that the grade 8 class was more interesting, i.e. the usefulness of mathematics was apparent, there were more "fun" activities in class, and the second student regained some of his previous confidence and competency. Following extensive interviews with the two children, Clarke offered two observations:

1) The opinions held by the learning community, which includes the teacher, influenced the child's behavior more so than any attributes the child may have had, such as "ability."

2) The students' positive responses to their grade 8 mathematics experience were attributed to the teacher in that grade rather than to the subject. In other words, teacher action corrected the negative trend in their mathematical behavior.

Clarke viewed his study as contributing to the base of information for those in the mathematics education community who are concerned with increasing the likelihood of a student's continued successful participation in mathematics.

Midgley, Feldlaufer, and Eccles (1989) looked at the specific relationship between students' beliefs about mathematics and their teachers' sense of efficacy. As in the previously reported study, the researchers selected a sample of students who were transitioning from sixth grade in elementary school to seventh grade in secondary school. Of interest to the researcher of this study is Midgley, et al's hypothesis that "students who have teachers with a higher sense of efficacy in either the last year of elementary school or the first year of junior high school will have more positive self- and math-related beliefs than will students who have teachers with a lower sense of efficacy" (p. 248). The authors cited studies by Fuller and Izu (1986) and by Guskey (1981), who found that not only do elementary teachers feel more efficacious than secondary teachers, but that elementary teachers accepted greater responsibility for any perceived lack of success with their students than did secondary teachers. A previous study by Midgley, et al (1988, cited by Midgely, et al, 1989) found that the teachers whom students had in junior high had significantly lower efficacy beliefs than did the elementary teachers of the same students. This result provided the foundation for the study that is being reported here. The researchers found that not only did students who had teachers with higher teaching self-efficacy beliefs feel that they were performing better in math and that they would continue to do well in the future, but they also believed that mathematics was less difficult than did those students whose teachers had lower teaching self-efficacy beliefs. Furthermore, this impact was more pronounced in lower-achieving students than in higher achieving students. Hence this relationship has implications for current education mandates that target low achieving students.

*Students' Mathematics Course-Taking Intentions*

One indicator of a student's disposition toward mathematics is his or her decision to take non-required mathematics courses. Students must have the desire to go beyond the minimum requirements for high school graduation if they are to become the future mathematicians and mathematics teachers. Lantz and Smith (1981) conducted a study involving students who were enrolled either in the last semester of required mathematics or in the first semester of non-required mathematics. The researchers surveyed students who were enrolled in their last semester of required mathematics as to their intentions to enroll in non-required mathematics. The researchers followed up this initial survey by finding out how many of the students actually enrolled in an optional mathematics class. While there was no significant gender difference in actual enrollment in optional mathematics (61.1% of males versus 59.9% of females) or in acting consistently with intentions to enroll (25.5% of males and 27.0% of females changed their minds), the researchers did find that factors in the affective domain, such as a liking for mathematics and confidence in mathematical ability, as well as the perception of the utilitarian value of mathematics, did correlate with mathematics participation. The authors observed that these subjective factors could show positive gains as a result of intervention by those who occupy significant roles in the student's life, such as parents, peers, and teachers.

Thorndike-Christ (1991) surveyed middle school and high school students and Meece, Wigfield, and Eccles (1990) surveyed seventh, eighth, and ninth grade students, to determine their attitudes toward mathematics and their plans to enroll in future mathematics courses. Again, there was no significant difference between genders with regard to course-taking plans, however Thorndike-Christ (1991) found that all attitude variables, particularly confidence in learning mathematics and affectance motivation, an indicator of how much fun mathematics was for the student, were significantly positively correlated to mathematics course-taking plans. Mathematics efficacy beliefs and value of mathematics perceptions played key roles in students' mathematics enrollment plans, according to Meece, Wigfield, and Eccles (1990). Both studies concluded that the responsibility lies with mathematics educators to intervene before these attitudes become firmly established. Meece, et al observed that teachers can help enhance students' valuing of math in several ways, including explicitly relating the value of math to students' everyday lives, making math personally meaningful, and counseling students about the importance of mathematics for various careers. However, in over 400 hours of classroom observation only a dozen instances of these strategies were noted, which echoes the concerns of Picker and Berry (2000), that teachers may be missing opportunities to have a significant positive impact on students' mathematics futures.

## Conclusion

Many students leave the study of mathematics after they have completed the minimum requirements for high school graduation, even though they may be academically capable of continuing in mathematics and despite the increasing need for strong mathematics skills required by the technology sector (Meece, Wigfield, & Eccles, 1990). The National Research Council (1989) predicted that this lack of enrollment in advanced mathematics courses would result in a future shortage of mathematicians and mathematics teachers. More recent research found that students and their teachers had little idea what opportunities are available in mathematics (Picker & Berry, 2000) and that students, despite ranking usefulness of mathematics to be the main reason for taking more mathematics (Wilkins & Ma, 2003), found mathematics to be boring and of little use beyond that of being a subject in school (Picker & Berry, 2000). Midgely, Feldlaufer, and Eccles (1989) found that the mathematics classroom environment, including the teacher's self-efficacy beliefs, significantly influence the students' motivation, confidence, and overall disposition toward mathematics. According to Wilkins and Ma (2003), teachers' choices of activities and mathematics problems "can have a strong impact on the values that are portrayed in the classroom and on how students view mathematics and its usefulness" (p. 62). This research seems to indicate that the teacher's self-efficacy beliefs and the effect of those beliefs on classroom instruction could play a pivotal role in a student's decision to continue the study of mathematics.

Pre-service teachers are the benefactors, through teacher preparation programs, of the research into teaching self-efficacy beliefs and they respond to intervention with heightened senses of teaching self-efficacy (Benbow, 1993; Vinson, 1995; Hoy, 2000; Wingfield, Nath, Freeman, & Cohen, 2000). However, teaching self-efficacy beliefs, while remaining unchanged during the first year of teaching, tend to decrease following the first year, eventually becoming static and resistant to change (Hoy, 2000). Thus it is the in-service teacher population, often taken for granted, that deserves attention.

The review of the extant research provides a starting point and frame of reference for this study, which will add to the existing literature on the specific relationship between middle school mathematics teachers and their students. The ultimate goal of mathematics education is to excite students about learning mathematics. If the education process is like a jigsaw puzzle, then middle school teachers fill in the crucial area between the border, established by the elementary teachers, and the core of the puzzle where high school teachers and university professors complete the big picture. The results of this study will have implications for those who design professional development opportunities for in-service middle school mathematics teachers whose teaching self-efficacy beliefs may need some bolstering in the face of the challenges presented by a diverse population of students who are beginning to make decisions about the place mathematics might have in their futures.

# CHAPTER III

## METHOD

### Overview

The purpose of this study was to examine middle school teachers' mathematics teaching efficacy beliefs, their classroom practice, and their students' attitudes toward mathematics. Of particular interest was whether a student's attitude toward mathematics was a predictor of that student's desire or plan to enroll in non-required mathematics courses. Quantitative data in the form of responses to a survey instrument were collected from the teacher sample in order to identify the students who would constitute the sample for the investigation of attitudes toward mathematics. Qualitative data in the form of responses to open-ended written and interview questions were collected from both the teachers and their students in order to paint a fuller picture of the interaction of teaching self-efficacy, classroom practice, and student attitudes. The researcher also observed at least two lessons in each of the teachers' classrooms. This chapter describes in detail the method and procedures that were be used to gather, analyze, and interpret data.

The questions that gave direction to this research were:

1) What is the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics?
2) What is the relationship between a student's disposition toward mathematics and his or her choosing to continue to study mathematics?

3) What influences middle school students' desire to continue studying mathematics?

Although pre-service teachers respond readily to intervention that is designed to strengthen efficacy beliefs, according to Hoy (2000), those efficacy beliefs may be compromised as the teacher faces the day-to-day realities of the classroom. It is worthwhile to inquire into the efficacy beliefs of teachers who have been teaching for a number of years. According to Smith (1996) and Enochs, Smith and Huinker (2000), those efficacy beliefs may influence a teacher's readiness to adapt his or her teaching according to suggestions for teaching reform advocated by professional organizations such as the National Council of Teachers of Mathematics. Newstead (1998) found that a student whose teacher implements the reform suggestions is more likely to have a positive disposition toward mathematics and Steinback and Gwizdala (1995) concluded that it is likely that a positive disposition toward mathematics will at least partially influence whether a student chooses to enroll in mathematics classes beyond the ones required. Toward an even more long term view is the potential influence of this positive disposition on whether the student will choose a mathematics-related major in college or a mathematics-related career. While there is existing research that examines the relationship between teacher self-efficacy and student achievement, there is a noticeable lack of research that attempts to describe a relationship between teacher self-efficacy and student disposition (Ashton, 1986; Tracz & Gibson, 1986). Therefore, there is a need for research that focuses on this interaction. This study contributes to the scant body of knowledge in this area.

## Mixed Methods Design

In the past decade a shift has taken place in the philosophical debate surrounding the choice of methodology in research design. Rather than the question being either qualitative or quantitative, as the purist would ask, more researchers are taking the pragmatic or dialectical position of asking where on a continuum between the two paradigms does research practice lie that will allow the researcher to address his or her question(s) most effectively (Greene & Caracelli, 1997; Creswell, 2003). Creswell (2003) stated that combining methods will neutralize the biases that are inherent in any single method and the results from one method can indicate the direction of another method. Greene and Caracelli (1997) reminded researchers that while each of the quantitative and qualitative paradigms offer valid and meaningful ways of gaining knowledge and understanding settings within social science inquiry, the reason for mixing methods of inquiry is "to generate deeper and broader insights, to develop important knowledge claims that respect a wider range of interests and perspectives" (p. 7).

As well as acknowledging that there are sound reasons for combining methods, Creswell (2003) advised each researcher to consider the following four areas that should inform his or her decision when choosing a strategy of inquiry:

- implementation (is data from qualitative and quantitative sources collected concurrently or sequentially)
- priority (is greater weight given to the quantitative or qualitative approach, especially with regard to analysis)
- integration (how will the researcher "mix" the data)
- theoretical perspective (is there a larger theoretical perspective that guides the investigation)

The responses to these four areas of consideration will determine which one of three broad strategies--sequential, concurrent, or transformative--a researcher employs in gathering, analyzing, and interpreting data. This study was a sequential, mixed-methods study, the purpose of which was to explain and interpret the relationship between middle school teacher mathematics self-efficacy beliefs, student mathematics dispositions, and the relationship between student mathematics disposition and student plans to take non-required mathematics courses.

### *Theoretical Perspective*

A researcher conducts a phenomenological study in an attempt to delve into the issues and meanings that lie below the surface of daily experiences (Creswell, 2003). Patton (2002) stated that phenomenology is focused on "exploring how human beings make sense of experience and transform experience into consciousness" (p. 104). As much as was possible, this researcher bracketed, or set aside, her own prejudices, viewpoints, and assumptions in order to grasp the meaning within the teacher-student relationship rather than imposing meaning from without. This study was guided by the phenomenological tradition and the data served to aid the researcher's description of the relationship between middle school mathematics teachers and their students.

### *Sampling Technique*

Letters outlining the study and requesting access to teachers and students were sent to superintendents of districts and principals of schools, including administrators of urban schools in the capital city, within 90 minutes' driving time from the researcher's home. In some cases follow-up email messages and telephone calls were used to remind administrators of this request after a reasonable amount of time had passed since the initial letter had been sent. Five principals agreed to provide access to their schools, therefore the sample of teachers and students in this study was not randomly chosen, but was defined by accessibility.

*Implementation*

Initially, teachers were asked to complete the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) and an open-ended questionnaire. Teachers were also asked to indicate whether they would be willing to continue their participation in the study beyond the initial survey and questionnaire. The results from the MTEBI were analyzed in order to identify those teachers who had either low or high mathematics teaching self-efficacy beliefs. The researcher selected two teachers, each of whose scores fell at one of the two extremes on the MTEBI, from each school, and their students to be included in the remainder of the study. In the second phase, three of the nine Fennema-Sherman Mathematics Attitudes Scales (F-S MAS) were administered to students whose parents had given consent for their participation in the study. The results of the F-S MAS were analyzed and served, along with responses to written open-ended questions, to identify those students whose attitude toward mathematics fell at either extreme of the positive/negative scale. In the third phase, interviews were conducted with the teachers and the two students from each teacher whose scores on the F-S MAS fell at the positive/negative extremes. The teacher interviews gave the teachers a chance to expand upon the information they gave in the initial questionnaire. The student interviews were designed to (1) search for a possible relationship between the mathematics teaching efficacy beliefs, as exhibited in their classroom practice, of in-service middle school mathematics teachers and their students' dispositions toward mathematics and (2) search for a possible relationship between student attitudes and student plans to take non-required mathematics.

*Participants*

Teacher participants were chosen from five middle schools within 90-minutes' driving distance of the researcher's home. Student participants were drawn from the classes of the teachers who agreed to further participation beyond the initial self-efficacy survey and questionnaire.

*Data Collection*

Responses to self-reported surveys from teachers and students, responses to open-ended questionnaires from teachers and students, as well as transcribed interviews and field notes from classroom observations were the sources of data for analysis. Data were collected from the teachers who responded to the initial efficacy beliefs survey, demographic survey, and questionnaire. When submitting their responses, the teachers had the opportunity to indicate whether they would be willing to continue their participation in the study. Of those teachers who agreed to continue their participation, those whose efficacy beliefs were at the high/low extremes were the pool from which student participation was solicited. Only those students whose parents consented to their participation and who themselves assented to participation were included in the study. The students were asked to respond to both a quantitative survey instrument and a qualitative open-ended questionnaire. Additionally, a number of students, whose selection was based upon responses to the survey and questionnaire, were interviewed. At least three observations were made in the classrooms of the teacher-student participants. The purpose of the observations was to document the teacher's classroom instructional strategies. The researcher did not intend to be a participant in the classroom during these observations; however, this issue of participant vs. observer will be addressed in chapters IV and V.

The researcher's interpretations were built upon a firm foundation of information gleaned from multiple data sources each of which contributed to a true rendering of the teaching efficacy/disposition phenomenon.

*Qualitative Measures*

*Questionnaires.* While both the teacher and student questionnaires (Appendices C and F) documented quantifiable, demographic information about the participants, the questions regarding mathematics teaching experience on the part of the teacher and mathematics learning experience on the part of the student were open-ended and were treated as qualitative data.

*Interviews.* A sample of the teacher and student participants were chosen for an audio taped semi-structured interview. Students were selected according to responses from the written questionnaire. The interview gave the students an opportunity to elaborate on responses to the questionnaire and gave the researcher the opportunity to ask questions prompted by responses to the questionnaire. The audio tapes were transcribed and analyzed. Copies of the interview protocols are included in Appendices D and G.

One could argue that teaching is comprised of many ill-structured problems or tasks that "require people to go beyond the information contained in the problem and use background knowledge or make guesses or assumptions in order to solve the problem" (Nespor, 1987, p. 324). Through open-ended questions, the researcher attempted to view the act of teaching from the teachers' perspectives in order to understand how self-efficacy belief systems influenced teachers' definition of goals for their students' learning and for their teaching.

*Observations.* Observations were made in the classrooms of a sample of the teachers who agreed to continue their participation in the study.

*Quantitative Instruments*

*Demographic/Background questionnaires.* The researcher designed questionnaires that sought particular information about the participants. According to Nespor (1987) (as cited in Pajares, 1992), a teacher's teaching beliefs are grounded in his or her episodic memory of past experiences, which color how the teacher will organize classroom activities and content that will become his or her classroom practice. The teacher questionnaire included not only questions about gender, ethnicity, number of years in teaching, college major, area and method of certification, grade levels taught, and subjects taught, but also about past mathematics experiences as a student and as a teacher as well as how the teacher came to be teaching middle school mathematics. The student information included questions about gender, age, ethnicity, grade level, and responses about the student's current mathematics teacher. Copies of the questionnaires are in Appendices C and F.

*Mathematics Teaching Efficacy Beliefs Instrument.* According to Bandura (1997), a person's self-efficacy beliefs influence his or her view as to whether personal behavior can have a direct effect on a situation's outcome. Ashton and Webb (1986) specified that teaching self-efficacy beliefs represent a teacher's attitude that s/he can, through his or her efforts, help students learn. In an attempt to quantify self-efficacy, Gibson and Dembo (1984) developed and validated their Teacher Efficacy Scale. The items on the scale were not context-specific, i.e. the items were not tied to any particular subject nor to any specific classroom situation. Riggs and Enochs (1990) developed the Science Teaching Efficacy Beliefs Instrument (STEBI-A) for in-service elementary teachers. This instrument consists of 25 items to which teachers respond by using a five-point Likert scale. Besides satisfying the immediate goal of determining where teachers are regarding their teaching efficacy beliefs, the authors noted an additional outcome of stimulating teachers to think about their beliefs, attitudes, and behavior patterns and they suggested that this self-reflection would be of value to pre-service teachers, which led to their creating the STEBI-B for pre-service elementary teachers.

By modifying Riggs' and Enochs' (1990) STEBI-B for pre-service elementary teachers, Enochs, Smith, and Huinker (2000) developed and validated the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) for pre-service elementary teachers. This instrument consists of 21 items to which teachers respond also by using a five-point Likert scale. Like the STEBI, the MTEBI includes items that reliably assess either personal (mathematics) teaching efficacy (PMTE) or (mathematics) teaching outcome expectancy (MTOE). Within Bandura's (1997) construct of self-efficacy, outcome expectancy is the belief that certain behaviors will produce desirable outcomes and personal or self-efficacy is the belief in one's ability to perform the necessary behaviors.

Parrott (2000) modified two items on the MTEBI in order for the instrument to be appropriate for pre-service secondary teachers. She found the reliability was not compromised by the change in wording on the two items. This study will utilize an instrument that preserves the wording of the STEBI-A for in-service teachers, while incorporating the modifications to reflect mathematics teaching found in the MTEBI and one of the adjustments by Parrott (2000) so that the instrument is appropriate for middle school teachers. Specifically, Parrott (2000) changed questions three and eleven to reflect the secondary perspective for the pre-service secondary teachers. However, since most of the participants in this current study were elementary certified but were teaching middle school mathematics, this researcher left question three, "Even when I try very hard, I don't teach mathematics as well as I can teach other subjects", as it was on the elementary MTEBI, but changed question eleven to read, “I understand mathematics concepts well enough to be effective in teaching secondary school mathematics”.

The instrument used in this study consisted of 21 items, 13 of which assess personal mathematics teaching efficacy (PMTE) and eight of which assess mathematics teaching outcome expectancy (MTOE). Also to be noted is that 14 of the items were positively worded and eight were negatively worded. In-service teachers were asked to respond to each of the 21 items. The responses were scored on a five-point Likert scale from strongly disagree (1) to strongly agree (5) and the eight negatively worded items were recoded for analysis. Possible scores on the PMTE range from 13 to 65 and possible MTOE scores range from 8 to 40, with higher scores indicating greater mathematics teaching efficacy beliefs. Illustrative items include ”I am continually finding better ways to teach mathematics” from the PMTE scale and “The teacher is generally responsible for the achievement of students in mathematics” from the MTOE scale. A copy of the MTEBI is in Appendix B.

*Fennema-Sherman Mathematics Attitudes Scales.* Fennema and Sherman (1976) developed their Mathematics Attitudes Scales (F-S MAS) as a means to study important, domain-specific attitudes that are related to the learning and valuing of mathematics. The authors of the attitudes scales cited the significant finding that although students may have been intellectually capable of doing well in mathematics, many were choosing not to study mathematics beyond the minimum high school requirements. Since one purpose of the project was to differentiate between those who chose to go on to take non-required mathematics courses and those who did not, the items were written to be appropriate for both mathematics students and non-mathematics students. The final form of the instrument consists of nine scales, each having 12 items, six of which are worded positively and six of which are worded negatively. Responses are given according to a five-point Likert which ranges from strongly disagree (1) to strongly agree (5). Of the nine scales, this study used three--confidence in learning mathematics scale, teacher scale, and usefulness of mathematics scale. Illustrative items include “I am sure I could do advanced work in mathematics” from the confidence in learning mathematics scale, “Math teachers have made me feel I have the ability to go on in mathematics” from the teacher scale, and “Knowing mathematics will help me earn a living” from the usefulness of mathematics scale. The negatively worded items will be recoded for analysis. A copy of the F-S MAS is in Appendix E.

## Evidence of Reliability and Validity

### *Teacher efficacy*

Enochs, Smith and Huinker (2000) found the MTEBI to be a reliable instrument, reporting Chronbach’s alpha coefficients of 0.88 on the PMTE scale and 0.77 on the MTOE scale. Although they did not report reliability on the scale as a whole, in her study with 60 pre-service teachers, Parrott (2000) reported alpha reliability coefficients of 0.68 on the PMTE scale, 0.76 on the MTOE scale, and 0.68 on the MTEBI scale as a whole. Chronbach’s alpha is appropriate for reliability analysis for the MTEBI instrument used in the previous studies since responses are made according to a Likert-type scale. The following table gives the alpha reliability coefficients for the MTEBI instrument used in the current study.

TABLE I
ALPHA (CRONBACH): RELIABILITY ANALYSIS
MATHEMATICS TEACHING EFFICACY BELIEFS INSTRUMENT

| Initial Teacher Sample | N = 23 |
|---|---|
| MTOE Subscale | Alpha 0.73 |
| PMTE Subscale | Alpha 0.77 |
| MTEBI | Alpha 0.82 |

The items in the MTEBI have been shown to relate to mathematics teaching self-efficacy and outcome expectancy (Riggs & Enochs, 1990). Further, Enochs, Smith, and Huinker (2000) used confirmatory factor analysis (CFA) in their study to determine if the data obtained from the participants may have reasonably resulted from the model offered by the survey instrument. Analysis showed a reasonably good model fit with respect to several measurement criteria. Additionally, the analysis showed that PMTE and MTOE scales were independent. Both of these outcomes contribute to the claim of construct validity of the MTEBI. Enochs, Riggs, and Huinker (2000) suggested that predictive validity of the MTEBI should be addressed in future research. Because of the established construct validity and the fact that the MTEBI continues to be used in research related to mathematics teaching self-efficacy and outcome expectancy (Parrott, 2000; Utley, 2004), the MTEBI was chosen for this particular study.

*Student attitudes toward mathematics*

Broadbooks, Elmore, Pederson, and Bleyer (1981) investigated the construct validity of the Fennema-Sherman Mathematics Attitudes Scales within a study that included 1541 junior high school students. Although there are nine scales in this instrument, two scales, confidence in learning mathematics and mathematics anxiety, were found to have a correlation of 0.89. Thus, Broadbooks, et.al. (1981) found that the scales were valid measures of eight distinct constructs within the domain of mathematics attitudes. Despite the length of time since its development, the F-S MAS continues to be used to investigate student attitudes toward mathematics and its learning (Melancon & Thompson, 1994, and Mulhern & Rae, 1998). The three previously mentioned scales (confidence in learning mathematics, teacher, usefulness) were determined to be appropriate for this study. Chronbach's reliability analysis for the three scales used in this study is given in the table below.

TABLE II
ALPHA (CRONBACH): RELIABILITY ANALYSIS
FENNEMA-SHERMAN MATHEMATICS ATTITUDE SCALES

| Initial Student Sample | N = 107 |
|---|---|
| FS-MAS Confidence Subscale | Alpha 0.90 |
| FS-MAS Usefulness Subscale | Alpha 0.88 |
| FS-MAS Teacher Subscale | Alpha 0.87 |
| FS-MAS (total of three subscales) | Alpha 0.93 |

## Procedure

Data for this study was collected during the fall/spring 2004-2005 semesters. Following IRB approval (Appendix A) and school district approval, the demographic survey/questionnaire and MTEBI instrument were delivered by the researcher to middle school teachers in the geographically defined region. These instruments were accompanied by a letter of introduction from the researcher, which also included a separate agreement to participate that the teachers completed and signed if they were willing to continue their participation. Those teachers who agreed to continue their participation supplied contact information and completed a separate informed consent that outlined the study.

The responses to the MTEBI were analyzed in order to identify those teachers who had either high or low mathematics teaching self-efficacy beliefs. During the second phase of the study, those teachers whose efficacy beliefs were at one of the extremes and who were willing to continue participating in the study were contacted so that arrangements could be made to obtain written parental consent and student assent. After the consent/assent forms were returned, the researcher administered the F-S MAS and a written questionnaire to the students. The student questionnaire asked about previous and then-current mathematics experiences.

Responses to the F-S MAS were analyzed in order to identify those students who had a strong positive or negative disposition toward mathematics as indicated by the three aforementioned scales. The researcher conducted audio taped interviews with selected teachers and their students. Both the teacher interviews and student interviews gave the researcher the opportunity to ask the participants to clarify and elaborate on responses made to the questionnaires. According to Rubin and Rubin (1995), in a semi-structured interview, the researcher introduces a topic for discussion and uses specific questions to guide the discussion. While a predetermined interview protocol guided the interviews, each interview, like any conversation, “is invented anew each time it occurs” (Rubin & Rubin, 1995, p. 7) and a flexible attitude allowed the researcher to explore avenues as they became apparent and relevant.

## Data Analysis

Data from the MTEBI was used to identify those teachers who have high or low mathematics teaching efficacy beliefs in order to define the initial sample of students who were included in the study. Data from the F-S MAS was used to identify those students who comprised the sample to be interviewed. Item responses from both instruments were analyzed by using SPSS 11.0 for the Macintosh (SPSS, 2002). Responses were entered as they appeared, but negatively worded items were recoded so that the scores consistently reflected efficacy beliefs or attitudes. High scores indicated high self-efficacy beliefs or positive attitude while low scores indicated low self-efficacy beliefs or negative attitude. Means and standard deviations will be reported for each instrument as well as for the subscales of each instrument in chapter IV. The researcher determined how scores should be interpreted in order to define "high" versus "low" or "positive" versus "negative".

In order to gain insight into the relationship between the teachers' efficacy beliefs and their students' dispositions in this study as well as the individual experiences of the teachers and students, careful attention was paid to the collected qualitative data. After preparing (transcribing interviews, typing field notes) and organizing the data (sorting into types according to source of information), Creswell (2002) suggested first reading through all of the data to get an overall impression of what the participants have said. Merriam (2002) used the term *horizontalization* to describe the attitude of the researcher during this initial reading of the data. In other words, all pieces of the data are viewed as being on the same level as far as relevance, value, and significance.

The researcher separated the components of data, e.g. sentences, individual responses or issues, into broad categories. These initial categories were coded according to topics that contributed to the exploration of the research questions. This initial coding served the purpose of simply describing events. However, as well as recognizing separate elements of the data and tying them to individual topics, Maxwell (1996) suggested using *contextualizing strategies* to identify relationships among these different elements. Categories may need to be broken apart and recombined. Codes may need to be redefined and renamed. Newman and Benz (1998) called this process one of *focused coding*. Emerging patterns and themes among the categories, which were grounded in the data, formed the framework upon which the researcher constructed meaning. The coding has served the purpose of building theory, according to Patton (2002).

### *Trustworthiness*

The traditional mandate has been for researchers to be objective in their reporting, analysis, and interpretation of results. Objectivity implies that the researcher is looking for one reality or that there is only one perspective when telling a story. Patton (2003), however, suggested that more appropriate mandates for the qualitative researcher would be ones of credibility, trustworthiness, and authenticity. According to Patton, in order for qualitative research to be credible, the researcher must adopt a neutral stance, with a commitment to a fair and balanced reporting of evidence, whether it confirms or contradicts any suggested conclusions. Trustworthiness and authenticity refer to the researcher's being conscientious in reporting multiple perspectives, multiple interests, and multiple realities. Additionally, by virtue of being the instrument of data collection, the qualitative researcher must acknowledge and reflect upon sources of bias and error.

### *Acknowledgement of Researcher Bias*

Through personal observation and readings, the researcher came to this study with the biased assumption that middle school mathematics teachers may not be as well prepared to teach mathematics as their high school (grades 9-12) counterparts or even their elementary counterparts. This perception was borne out of the fact that some middle school teachers, particularly those at the sixth grade level are elementary teachers who, due to position availability, accept a middle school position when they, in fact, chose elementary education because of a lack of confidence or a weakness in the conceptual understanding of mathematics. The researcher would expect there to be a wider range of mathematics teaching self-efficacy beliefs among middle school mathematics teachers than among secondary, or even elementary, teachers. Research literature reports that many students who expressed a positive disposition toward mathematics and confidence in learning mathematics in elementary school, adopt negative dispositions toward mathematics, citing rules, facts, and elusive procedures as being what mathematics is, when they leave middle school. For these reasons, the researcher chose middle school teachers and their students for this study.

### *Credibility*

Multiple sources of data were collected in order to maximize the opportunity for deeper insight into the phenomenon under study.

### *Ethical Considerations*

By assigning a numerical code to each participant, the researcher attempted to preserve participants' anonymity. If specific references are made to particular participants, pseudonyms have been used to ensure privacy and confidentially. All participants received a written assurance of privacy and confidentiality.

## Summary

The purpose of this study was to examine the relationship between teachers' mathematics teaching efficacy beliefs and disposition of students toward mathematics, with an eye toward the ultimate question of what influences students to want to continue to study mathematics. Following are the research questions that were addressed and the related instrument(s) of measure that were administered:

(1) What is the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics? Descriptive statistics (minimum scores, maximum scores, subscale scores, total scores, means, and standard deviations) were calculated for the MTEBI and the F-S MAS. Responses to open-ended written questions, as well as notes made during classroom observations were coded and examined for patterns and themes.

(2) What is the relationship between a student's disposition toward mathematics and his or her choosing to continue to study mathematics? Responses to open-ended written questions and interview questions were coded and examined for patterns and themes.

(3) What influences middle school students' desire to continue studying mathematics? Responses to interview questions were coded and examined for patterns and themes.

Data was analyzed and the results are presented in Chapter IV while a discussion of findings, interpretations, and implications is in Chapter V.

# CHAPTER IV

# RESULTS

Quantitative and qualitative methodologies were used in this study that examined the teaching/learning relationship between middle school mathematics teachers and their students. The researcher used analysis of the responses to quantitative surveys to determine which teachers and students would be included in the final sample. Through the collection of responses to a qualitative questionnaire and interview questions, the researcher focused on particular aspects of the teaching/learning relationship and analysis of those responses contributed to a deeper understanding of the relationship than that enjoyed by those outside of the research environment.

The research questions that prompted the researcher to conduct this study were:

1) What is the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics?
2) What is the relationship between a student's disposition toward mathematics and his or her choosing to continue to study mathematics?
3) What influences middle school students' desire to continue studying mathematics?

In Chapter II the researcher reviewed the existing literature on teaching self-efficacy beliefs, classroom practice, the middle school concept, and attitudes of students toward mathematics. Data collected in this study will contribute to all of these areas.

Chapter III outlined the methodology of the study. In this chapter the researcher shares the results from the quantitative and qualitative sources that contributed information to this phenomenological study. The analysis of data will contribute to an understanding of the culture of the middle school mathematics classroom from both the teachers' and the students' perspectives. Crotty (1998) reminded the social scientist, "Phenomenology is about saying 'No!' to the meaning system bequeathed to us. It is about setting that meaning system aside" (p. 82). Thus the researcher, as much as was possible, engaged with the teachers and students in their world, setting aside her assumptions and notions of what the middle school mathematics classroom should or might be.

## Mathematics Teaching Self-Efficacy Beliefs

Ashton and Webb (1996) used Bandura's (1977) concept of self-efficacy as a model for their construct of teaching self-efficacy. Two components contribute to a teacher's sense of teaching self-efficacy. One component, that of outcome expectancy, is the belief that a teacher's actions can have direct bearing on student learning. The second component is the teacher's personal teaching efficacy expectations, the belief that he or she is capable of performing the actions that will lead to student learning. Enochs, Smith, and Huinker (2000) further focused the two teaching self-efficacy factors on mathematics teaching in developing and validating the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). Eight items on the MTEBI address outcome expectancy with items such as "The inadequacy of a student's mathematics background can be overcome by good teaching" and "The teacher is generally responsible for the achievement of students in mathematics." Thirteen items on the MTEBI, such as "I know the steps to teach mathematics concepts effectively" and "I am continually finding better ways to teach mathematics," measure personal mathematics teaching efficacy. Twenty-three middle school mathematics teachers in five schools completed the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). Responses to both outcome expectancy and teaching self-efficacy constructs were analyzed. The responses to the MTEBI were scored on a five-point Likert-type scale from strongly disagree (1) to strongly agree (5). Negatively worded items were recoded for analysis. The data provided a broad image of the self-efficacy beliefs among these middle school mathematics teachers. Descriptive statistics for the responses to the two constructs and to the instrument as a whole are shown in the table.

TABLE III
MINIMUMS, MAXIMUMS, MEANS, AND STANDARD DEVIATIONS
MATHEMATICS TEACHING EFFICACY BELIEF INSTRUMENT

| | N | Min | Max | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Outcome Expectancy | 23 | 18 | 32 | 27.13 | 3.88 |
| Personal Teaching Efficacy | 23 | 39 | 63 | 54.91 | 6.02 |
| Total | 23 | 60 | 94 | 82.04 | 8.54 |

Given the potential range of 21 to 105 on the MTEBI total score, one can observe that none of the respondents' scores fall into what would be called the "low" category and while there was a fairly high mean of 82.04, the standard deviation of 8.54 shows that there was considerable variability from the mean. Although it was not part of the researcher's original intent to use elementary certification versus secondary certification as a part of the discussion of middle school mathematics teachers' self-efficacy beliefs, an interesting result did come out of the responses to the MTEBI. The researcher was curious as to whether there was any difference in the mathematics self-efficacy beliefs between those middle school teachers who were elementary certified and those who were secondary certified. For the outcome expectancy construct there was no significant difference in the means between the elementary certified teachers and the secondary certified ones (a mean of 27.47 for the elementary certified versus a mean of 26.43 for the secondary certified). However, for the personal teaching self-efficacy construct, the researcher observed a mean of 56.87 for the middle school teachers who were elementary certified and a mean of 51.43 for those who were secondary certified, a difference of 5.44. The variations of the means on the two constructs for elementary certified versus secondary certified contributed to the elementary certified teachers' showing a mean of 84.33 on the total of the MTEBI while the secondary certified teachers showed a mean of 77.86. This seems to be consistent with the research of Midgley, Feldlaufer, & Eccles (1989), who found that elementary teachers felt more efficacious in the classroom than their secondary counterparts and that elementary teachers perceived that they were more responsible for their students' successes or failures than did secondary teachers.

Of the twenty-three respondents to the MTEBI, only thirteen agreed to continue their participation in the study. None of the teachers in one of the schools agreed to continue their participation. Using the responses to the MTEBI, the researcher selected two of the consenting teachers from each of the four remaining schools. The teacher with the lowest score and the teacher with the highest score from each school, relative to the discussion about the range of scores in the previous paragraph, were approached about continuing in the study. Responses to questions on a demographic questionnaire, in particular those concerning current grade level, type of certification, and certification area, were also used in the cases of there being equal MTEBI scores. The researcher's objective was to include at least one teacher from each of the grades 6, 7, and 8, at least one teacher who was alternatively certified, and a ratio of elementary to secondary that was consistent with that of the original sample of twenty-three teachers.

The four schools in which the teachers and students in this study were engaged were very diverse in their demographic descriptions. The researcher feels that the reader's understanding of the participants would be enhanced by the inclusion of the following information.

TABLE IV
SCHOOL DEMOGRAPHIC DATA

| | School 1 Rural | School 2 Suburban | School 3 Urban | School 4 Urban |
|---|---|---|---|---|
| Ethnicity | | | | |
| African American | 36% | 4% | 22% | 29% |
| Asian American | 0% | 1% | 6% | 3% |
| Caucasian | 56% | 91% | 49% | 44% |
| Latino/Hispanic | 4% | 1% | 13% | 16% |
| Native American | 3% | 4% | 10% | 7% |
| Students Receiving Free/Reduced Lunch | 83% | 32% | 74% | 73% |
| Parents Attending P-T Conference | 90% | 100% | 50% | 55% |
| Enrollment (Fall 2002) | 303 | 693 | 690 | 613 |
| Number of Regular Classroom Teachers | 20.3 | 29.2 | 42.6 | 42 |
| Teachers' Average Number of Years Exp | 7.4 | 12.7 | 8.8 | 8 |
| At least 70% of students performing at a level of satisfactory or above on 8th grade state math test | no | yes | no | no |

Participants

The researcher personally delivered the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) and a demographic/background questionnaire to twenty-six mathematics teachers in four middle schools and one elementary school (K-6). Two of the schools were in an urban setting, two were in a suburban setting, and one was in a rural setting. Twenty-three of the teachers completed the MTEBI and questionnaire (88% return rate). The following table describes the teachers who answered the MTEBI survey.

TABLE V
DEMOGRAPHICS OF IN-SERVICE TEACHER PARTICIPANTS
INITIAL SAMPLE: N=23 in Five Schools

| | | N | % |
|---|---|---|---|
| Teaching Major | | | |
| Elementary | | 16 | 70 |
| Secondary (Math Education) | | 5 | 22 |
| Mathematics | | 1 | 4 |
| Other | | 1 | 4 |
| | | | |
| Certification Area | | | |
| Elementary | | 16 | 70 |
| Secondary | | 7 | 30 |
| | | | |
| Type of Certification | | | |
| Standard | | 19 | 83 |
| Alternative | | 4 | 17 |
| | | | |
| Number of Years Teaching Experience | | | |
| 0-10 | | 10 | 44 |
| 11-20 | | 7 | 30 |
| 21+ | | 6 | 26 |
| | | | |
| Range | 1-35 years | | |
| Mean | 13.2 years | | |
| Median | 12 years | | |
| Mode | 13 years | | |
| | | | |
| Gender | | | |
| Male | | 4 | 17 |
| Female | | 19 | 83 |
| | | | |
| Ethnicity | | | |
| African American | | 2 | 9 |
| Asian American | | 1 | 4 |
| Caucasian | | 18 | 78 |
| Native American | | 1 | 4 |
| Other | | 1 | 4 |

| | N | % |
|---|---|---|
| Grade Level Currently Teaching | | |
| $6^{th}$ | 8 | 34 |
| $7^{th}$ | 7 | 30 |
| $8^{th}$ | 6 | 26 |
| $7^{th}/8^{th}$ | 1 | 4 |
| $6^{th}/7^{th}/8^{th}$ | 1 | 4 |
| Taken Mathematics Subject Area Test | | |
| yes | 5 | 22 |
| no | 18 | 78 |
| Earned Middle School Endorsement | | |
| yes | 18 | 78 |
| no | 5 | 22 |
| Number of Hours of Mathematics Taken in College | | |
| 0-12 | 3 | 13 |
| 13-18 | 6 | 26 |
| 19+ | 11 | 49 |
| Not Sure/Not Reporting | 3 | 13 |

The teachers were given the opportunity to participate in the research study beyond completion of the MTEBI and questionnaire. Of the twenty-three, only thirteen agreed to participate in the remaining part of the study. None of the teachers in one of the suburban schools agreed to participate, thus the final sample of eight teachers and their students was drawn from only four schools. The teacher who scored lowest on the MTEBI and the one who scored the highest on the MTEBI in each school were selected by the researcher to continue in the study, constituting the final sample of eight teachers. The researcher would like to introduce the reader to the eight teachers who comprised the final sample for this study. All names are pseudonyms.

**Veronica** was an elementary certified teacher who had been in the classroom for three years and taught at School 3. She had previously taught in a self-contained fifth grade classroom, but was teaching sixth grade math at one of the two urban schools in this study. As an elementary education major, she took only eight hours of college mathematics, but since being in the classroom she had taken and passed the intermediate level mathematics subject area test that is required for middle school teachers. Veronica had not taken any post-college mathematics classes nor had she participated in any professional development math workshops, but she was hoping to begin a master's degree program through one of the state universities that would enhance her knowledge of mathematics education. She remembered that her math teachers taught strictly from a textbook, assigning many problems to do. They did not use manipulatives or activities to augment instruction. She preferred to teach the middle school students because she believed that they were capable of learning mathematics by many different ways. "I'll wait" was her signal to her students that she was stopping the current discussion until they had quieted down and were ready to refocus their attention.

**John** was a first year teacher, also at School 3, but the route by which he came to be in a sixth grade mathematics classroom was quite different from Veronica's. He was an engineer, by training and profession. When the local facility for a national technology business closed, John found himself wondering what was next. While doing some volunteer coaching, he had found that he enjoyed middle-school-aged children. With fifty credit hours in undergraduate mathematics and his appreciation for the pre- and early-teen child, he felt that teaching was a reasonable option for this new stage in his life. At the time of this study, he was in the alternative program for secondary certification through the state department of education and was enrolled in a general teaching methods course at a local state university as part of the block of professional education courses that were required for certification. He had taken and passed the intermediate level mathematics subject area test that was required for middle school teachers. As an engineer, he was familiar with and saw the value of learning by problem-solving and wished he could incorporate that method in his classroom teaching. However, as a first-year teacher who was overwhelmed by the specter of objectives, standardized tests, and teacher accountability, he felt it was more time-efficient to teach by giving his students the information they needed to work the problems in the textbook. He did not feel that he was in the position to veer too far from the traditional course.

**Marsha** taught seventh grade math at School 4. She had been teaching for seven years, but this was the first year that she had taught math. Her college major was health and physical education and she was secondary certified. As well as having a strong science background, Marsha also took eighteen hours of college mathematics. She actually comprised "half of a team" for the seventh grade by teaching both science and math. Thus, unlike the other middle school teachers in this study, Marsha had only two different groups of students throughout the day. Although her preferred grade level/subject area was high school health "because in order to teach this subject properly, I get to use every subject I love," the opportunity to teach mathematics allowed her to teach her "first love." She wanted her students to see mathematics as a real-life tool, not just a school subject.

**Beverly** was the only veteran teacher who had taught mathematics throughout her entire career. She was secondary certified and having been a math major, knew that she had lots of college mathematics hours, but could not remember how many. When asked what stood out in her memory of the math teachers she had as a student, Beverly said, "the love of math!" Although she had taught grades 7-12, she took the opportunity to teach eighth graders at School 4 because she enjoyed the age group and felt that she could make a difference in the students' lives and could help them to learn math. "I'm a rules person" was her description of her classroom philosophy and she reminded her students of this as she emphasized how important the rules were in solving the problems her students encountered in their textbook.

**Daphne** remembered her math teachers as "male, bland, and not very effective" and strived to be very much the opposite of this characterization in her classroom. During her elementary certification, Daphne felt that she was most prepared for teaching reading and language arts, and she felt that the nine hours of college mathematics courses she had was not enough to prepare her for the math she was teaching. She had taught third through twelfth grades, but preferred the fifth through eighth grade students because "they are independent thinkers and learners and are exciting to teach." When asked what prompted her decision to teach what is considered middle level mathematics, which includes pre-algebra, Daphne said she was assigned to teach the self-contained sixth grade class, so the decision was not hers to make. The small rural district in which Daphne taught consisted of a K-6 elementary school, School 1 in this study, and a 7-12 high school, separated in such a way as to give the respective principals equity with regard to number of students. Daphne's and Jack's, whom the reader will meet next, situation was unique for the researcher in that due to constraints surrounding physical education, Daphne taught math to only the sixth grade girls, while Jack taught math to only the sixth grade boys. Daphne had not taken the intermediate level mathematics subject area test that was required for middle school teachers nor had she taken any post-college mathematics classes or participated in any professional development mathematics activities.

**Jack** was the senior member of the participants, although he had been teaching for only ten years. He took six hours of mathematics for his elementary certification, had not taken the intermediate mathematics test required for middle school teaching, and had not participated in any professional development activities for mathematics teaching. His love was social science and he would have liked to teach U.S. history, government, civics, and world geography to sixth, seventh, and eighth graders. However, at the time of this study, he was teaching in a self-contained sixth grade classroom next door to Daphne in School 1, as well as teaching one class of seventh grade geography at the high school. As an older male in an elementary school, Jack found himself cast in the role of "grandfather" to many of the children. In his classroom, he placed as much emphasis on socialization and development of life skills as on academics. Jack worried about how his students would make their way in the demanding world after high school.

**Jean** had the most classroom experience, having taught for 28 years. She obtained her elementary certification through the alternative certification process and had her master's degree in reading specialization. Despite her strong background in reading, Jean had always liked math and took at least fifteen hours of college mathematics. She had not taken the intermediate mathematics test required for middle school teaching, but had participated in enough professional development mathematics activities to earn a middle school endorsement in mathematics. The middle school, School 2, in which Jean taught, included only sixth and seventh grades, unlike the two urban middle schools that also housed the eighth grade classes. Jean had taught second grade in the past, but much of her teaching career was spent as a reading teacher for both sixth and seventh grade at the middle school. A few years ago, when reading taught as a separate class was removed from the curriculum, Jean took the opportunity to move into an available seventh grade mathematics position, which she held at the time of this study.

The program by which **Kristi** earned her elementary certification required no college mathematics courses. However, when she took an opportunity to teach seventh grade math, she went back to take eighteen hours of college mathematics as well as two classes for teaching elementary school mathematics. She had also taken the intermediate mathematics test required for middle school teaching. Kristi said that her father was a mathematics teacher and others in her family were strong in mathematics so she felt that she had come by her mathematics ability “naturally”. She and Jean taught in the same middle school and the curriculum that guided their teaching was a form of inquiry-based learning that was different from the traditional textbook curriculum that the researcher found in the other three schools. The reader will find out more about the issues surrounding curriculum later in this chapter.

The researcher personally distributed parental consent and student assent forms to the students in one of the classes of each teacher. She then administered three of the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS) and a demographics/ attitudes questionnaire to the 107 students who returned their consent and assent forms. After calculating the scores on the F-S MAS, the researcher selected one low-scoring student and one high-scoring student from each of the selected classes. Only one student in Jack’s class returned his consent/assent forms, so he was the only one of his students to be involved. The final student sample included fifteen students. The following table provides demographic information about the fifteen students in this study.

TABLE VI
DEMOGRAPHICS OF STUDENT SAMPLE
STUDENT-REPORTED
N = 15

| | n | % |
|---|---|---|
| Gender | | |
| Male | 8 | 53 |
| Female | 7 | 47 |
| | | |
| Age | | |
| 11 | 7 | 47 |
| 12 | 4 | 27 |
| 13 | 3 | 20 |
| 14 | 1 | 7 |
| | | |
| Grade | | |
| 6 | 7 | 47 |
| 7 | 6 | 40 |
| 8 | 2 | 13 |
| | | |
| Ethnicity | | |
| African American | 0 | 0 |
| Asian American | 2 | 13 |
| Caucasian | 5 | 33 |
| Latino/Hispanic | 1 | 7 |
| Native American | 0 | 0 |
| Other | 6 | 40 |
| Not Reporting | 1 | 7 |

The eight teachers responded to several written open-ended questions, such as their reason for teaching middle school mathematics, their preferred grade level and subject area, as well as what strategies they regularly used in their classrooms, e.g. manipulatives, problem-solving, cooperative groups, and lecture. Through audio taped semi-structured interviews, the researcher followed up on these written responses and asked questions that required the teachers to reflect on their perceived significance in their students' mathematics learning and achievement. Additionally, the researcher conducted three or four observations in each of the eight classrooms in order to see first hand how the teacher's classroom practice compared to the written and interview responses.

Besides responding to the items on three of the scales on the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS), the fifteen students responded to written open-ended questions and participated in an audio taped semi-structured interview with the researcher. Although the researcher was primarily an observer while she was in each classroom, she did have occasion to work with students as they worked on problems and even was asked by one of the teachers to present a lesson on a topic about which the teacher lacked confidence.

## Research Question 1

The first question asked about the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics.

### *Mathematics Teaching Efficacy Beliefs Instrument*

As mentioned earlier, for each of the four schools included in the study, the teacher with the lowest self-efficacy beliefs and the teacher with the highest self-efficacy beliefs, as indicated by their scores on the MTEBI, were selected for this research, although none of the scores of the original teacher respondents on the MTEBI really fell into the low category. Total scores on the 21-item instrument could range from 21 to 105 with 63 being the midrange score. One score of 60 was the lowest. The remaining total scores were above 63, with ten falling between 63 and 84 and twelve falling between 84 and 105. Therefore, when the researcher selected teachers who had the lowest and highest scores, the reader should realize that the designation of a score as being "low" or "high" is a relational measure as opposed to an absolute measure. All scores of the eight teachers in the final sample were 73 or higher. The difference between the lowest and the highest MTEBI scores for the two selected teachers at each school ranged from three to twenty.

Although the researcher was primarily interested in the teachers' personal teaching self-efficacy beliefs and the effect of these beliefs on their classroom practice, feelings about outcome expectancy were a natural byproduct of the discussion. The specific items from the MTEBI that prompted the interview questions were:

- Even when I try very hard, I don't teach mathematics as well as I can teach other subjects (for those certified in elementary education)
- I generally teach mathematics effectively.
- The teacher (both in general and personally) is generally responsible for the achievement of students in mathematics.
- I am typically able to answer students' mathematics questions.
- I am not very effective in monitoring mathematics activities.
- The inadequacy of a student's mathematics background can be overcome by (my) good teaching.
- When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.
- I am continually finding better ways to teach mathematics.
- I understand mathematics well enough to be effective in teaching secondary school mathematics.

These items speak to the amount of responsibility the teacher accepts for his or her students' learning and to the teacher's perception of his or her ability to fulfill this responsibility.

### *Interviews with Teachers*

Although according to their MTEBI scores all of the teachers felt that they were able to do what was necessary to help their students learn math, the researcher wanted to hear how the teachers came to that perception and what indicators supported the perception. Throughout this discussion of the results from the teacher interviews, the researcher will insert direct quotes from the participants in order to reinforce themes and patterns. The researcher, as much as possible, will not edit these quotes, except as might be necessary for clarification. Italics are used for emphasis and clarifications will be added in parentheses. The researcher feels that no one can speak about the issues of efficacy and teaching practices better than those who were willing to trust her with these very personal responses. The reader will find that some teachers were more outspoken than others, some expressed themselves more concisely than others, and some were more concerned with what they said than with how they said it. All of these differences contribute to the fullness of the flavor than the researcher hopes the reader will experience. The researcher will also provide evidence from classroom observations to bring the reader through the door into the teachers' and students' world.

*Teachers' perceived responsibility for student learning*

As is the case with many semi-structured interviews, none of the eight teacher interviews took exactly the same path as any other, but the researcher consistently asked each teacher the same first question about the level of responsibility that the teacher felt for his or her students' mathematics learning. Seven of the teachers immediately said they felt that they were directly or absolutely responsible for their students' learning. When asked why they felt this responsibility, Veronica said that one of the reasons is because of "the position you have as a teacher … the knowledge you have I believe you need to pass that on to the students …I feel really responsible for what they're (learning) … When they're in this classroom then that's my job." John said that he tries to prepare for all of his students. Kristi followed along this same line by saying that teachers need to meet different learning styles to accommodate the different ways children learn.

Despite this initial claiming of responsibility, when asked specifically if they felt that when their students did well or poorly on either a classroom assessment or a standardized assessment that their students' performance was a direct reflection on their teaching, all of the teachers qualified their responses, some citing pre-existing conditions that might also influence student learning and therefore performance. Marsha explained, "I also feel like there are also factors in that as far as, you know … at home … whether they get any extra support and things like that because when they have that they tend to show more learning, I guess." John: "It's shared. Absolutely. Because I don't feel … I don't know what type of environment or learning skills they really came from. I kind of inherited …" Jack minced no words as he reflected on responsibility. When asked the first question about how responsible he felt for his students' learning, his response required no clarification. He immediately responded,

> I feel about 60% responsible. I think 40% of it should come from home. They (the students) should have an idea of how to read when they get here. They should have some sort of idea as to how to figure problems out, and they should have some working knowledge as to where they are geographically (recall his love is social science).

When the researcher asked what the source of this prior knowledge would be, unlike the other teachers who implicitly referred to "prior experience," he did not hesitate to bring into the conversation those he felt should be the partners in the process of educating children,

> Parenting has a lot to do with it, but at the same, as parents we just generally stick our kids in front of a TV set and let the TV do the babysitting. Well, we need to start doing better as parents. So I think the

> teachers should be responsible for under 60% of the kid's learning—especially book learning.

Beverly offered a different perspective to the relationship between teacher efficacy and student learning by placing the relationship on a more personal level. She, too, acknowledged that students come to the classroom with some degree of prior knowledge, but she also suggested that much of learning depends on the student: "It depends on the … the student. There is always the student that has personality conflicts that will not learn with certain teachers. I mean a fraction of them … if they won't *accept* your teaching they're not going to learn. So … it depends on that." Daphne also brought the students into the circle: "It's a joint effort. I can't open their heads and pour the information in. It's not just me, it's the kids, too. They have to be willing and open and I have to find a way to motivate them, and get them going." Jack spoke to the teacher's role of motivator:

> I understand one thing; there are some kids in these classrooms that don't want to learn anything right now. They keep telling me about motivation. Motivation is an inward experience—not an outside thing. All I've got to do is be a *catalyst*. Now if there's something I say that might inspire you—you still have to have motivation to get up and do what it is you've been inspired to do.

Jean talked about "letting go" of her responsibility for her students' learning: "I wish I could learn for them. I get really frustrated when they don't seem to care (about their learning) as much as I do." When asked if she thought that her students' performance on assessment tests reflected on her teaching, Jean reluctantly said, "You know, yeah. That's part of letting go. And … I'm not always real good about letting go. I feel like they should do better." So some of the teachers viewed the student's role as one of stepping up to take some responsibility for their learning, while Jean focused more on her inability to let go of her responsibility and allow the students to shoulder more of it.

All of the teachers acknowledged to some degree that their students come into their classrooms with varying abilities born out of just as varied previous experiences. Therefore, the researcher asked them to speak to the item on the MTEBI that states that a student's inadequate background can be overcome by good teaching. The eight teachers' responses, when asked about their ability to help their students excel despite poor background, showed a wider range of efficacy beliefs than that indicated for student learning. Jean's response indicated that there are just some inadequacies that the teacher should not be expected to address: "And there's some kids that just … don't have the foundation skills that they need in order to do well, and I do know that is a factor. And … so … I … can't take time to go back and teach them their multiplication (facts)." Others of the teachers acknowledged that they needed to take their students from where they were and try to actively help them to learn missing concepts, but neither were they sure about how to go about doing this nor were they especially positive about how feasible it was to hope to get all of the students up to competency. Marsha: "No … I don't want to say it's hopeless. Um … I think some situations are harder than others. I do think there's lots of kids you can reach by using different things … but then a lot of it also falls back on them as afar as the responsibility of wanting to learn. I mean you can't make somebody want to learn." Recall that Jack said that teachers were responsible for 60% of what students have learned and that parents should be responsible for about 40%. When asked if he thought it was the responsibility of the teacher to try to make up for that missing 40%, he was quick to say, "We have to. Cause if we don't, these kids are going to be in bad shape. They'll join the ranks of a bunch of illiterates as far as I'm concerned."

*Monitoring mathematics activities*

Another item on the MTEBI refers to the teacher's perception that he or she is effective at monitoring mathematics activities. The researcher was interested in how the teachers described what they and their students do in the classroom as learning is taking place. As mentioned earlier, the researcher also spent time in each classroom so that she could compare the teachers' descriptions of their classroom activities to what was directly observable. According to Smith (1996), a teacher's teaching self-efficacy exerts a strong influence on his or her decisions for classroom practice and consequently on his or her students' learning. For many teachers, their sense of mathematics teaching self-efficacy is based upon being able to organize the information into tidy packages that their students will take in and then reproduce on a test. This model of "teaching by telling" is safe, predictable, and manageable, as opposed to relinquishing absolute control by allowing students to generate their own mathematical knowledge through problem-solving, cooperative learning and communication, as recommended by the NCTM (2000).

With the above contrasting viewpoints in mind, the researcher asked the eight teachers how they created the learning environment for their students. The answers were as varied as the teachers themselves. Most of them were very traditional in that they relied on the lesson in the textbook to guide classroom work. Veronica, characterizing herself as an authoritative teacher, felt that her students needed to be instructed as to what was being taught and shown what they needed to do. She was aware that current math education researchers encourage teachers to give students the opportunity to work together to make sense of math concepts, but the "instructing and showing" must come first. She showed little confidence in her sixth graders' abilities to read the lesson in the textbook and "figure out what they are doing." Maybe some could, but the majority could not. She looks for them to be "focused, reading, following along" during her instruction.

Beverly voiced a similar need to be more in control when beginning a new concept with her eighth graders. She does tell them to read the textbook at the beginning of the lesson "so that they read the terminology, they see an everyday example where that is used and they can see how it's worked in the book." Beverly emphasized that she wanted her students to learn the rules and techniques, "because I am a very rules-oriented person and I make a real distinction between arithmetic rules and algebra rules and exponent rules and those kinds of things because I want them to be a aware that it's very different and there is a set rule that goes with each topic (and) that you have to follow in order to get the right answer." When asked about alternative ways of working through a concept, ways that might enliven her students or pique their interests, Beverly admitted that there are "certain things that you can do … but with the push for testing now … some things you just can't do because you don't have the time to do it anymore."

Marsha had a holistic philosophy about her teaching and her students' learning. The classroom is not the only site that figures into a student's learning, nor is the brain the only organ that is working toward that student's learning. Thirteen low-income apartment complexes fed into the district in which Marsha's school was located. She said, "You know … when they (students) come to school hungry, they're not worried about what they can do on this paper. They need food in their stomach, THEN you can get them to work." Later in the conversation, she came back to this theme of meeting the needs of the whole child, when she reported that she reminds her students "you need to take a bath tonight and put on your deodorant or you need to make sure you have your materials here cause if you don't you're going to be failing my class." She reflected on her dual role of teacher/parent, "I mean it's all … we're here to teach, but not just math, not just science, but how to make it in this world." So if her students are ready to learn, what does Marsha do to introduce a new concept? She admitted that she does not use the same launching method all the time, but she likes to use a puzzle, example, or problem to "get them thinking about something. Whether it's right or wrong it doesn't matter … cause they act like they're so afraid to make a mistake." She acknowledges that her students like to do hands-on activities where they can talk about what they are observing or discovering, which puts them more in control of their learning. With releasing her own control comes an increase in noise level and a decrease in predictable structure. Marsha conceded that these consequences still make her uncomfortable since the teachers who taught her always maintained structured and QUIET classrooms.

Daphne's and Jack's teaching was dictated by the textbook. Recall, they were teaching sixth grade at the small rural school and hence were using the same textbook, which was new for the academic year during which this research took place. Their dependence upon the textbook was motivated by the fact that neither of them was comfortable teaching mathematics—Daphne's specialization area was reading and language arts while Jack's was social studies. What the researcher found interesting were their critiques on the textbook. Daphne said that the teachers had not felt that the students were being prepared well enough when using the previous textbook, so the teachers who had been teaching mathematics the previous year adopted the one that Daphne and Jack were using during this study. Daphne: "Well, the kids are struggling with _____. It is so much harder than anything we've done, but I think after a year or so of it, maybe we'll be okay." Jack could not remember what book had been used previously, but "I'm really impressed with this one. It makes it a little more concise, you can understand the examples a lot better, and it's a lot easier to teach from." Each of them was basing his or her assessment of the book on two different perspectives. Daphne was taking the students' viewpoint that the new book placed higher expectations on their learning which was difficult for them, while Jack was speaking as the teacher who would use the book. Since it included structured lessons and abundant supplementary materials, he reacted positively toward the book.

Jean and Kristi were in unique positions among the teachers in this study. The curriculum they were using was inquiry-based rather than the traditional definitions-examples-problems format by which students were given a task to perform or a problem to solve as the introduction to a new concept. For example, the students were working with the area concept when the researcher first began spending time in Jean's and Kristi's classrooms. The students were given grid paper and told to draw as many rectangles as possible having a given area, such as 24 square units. By examining the different rectangles that had this given area, many students realized that they could simply find all the pairs of whole numbers whose products were the given area and some students even extended their pairs to those that included fractions, such as 48 and 1/2. Through this exploration students found the formula for the area of a rectangle, Area=Length X Width. Although the curriculum is inquiry-based, the exploration activities are fairly structured, but students also have the opportunity to ask their own questions and search for answers. Kristi reported that she liked to just let her students work through the exploration activities and answer any of their own questions that might come up. She followed up the activities with whole-class discussions in which the students were given a chance to talk about what they had learned. Jean, whose master's degree is in reading, said she always begins with vocabulary so that the students have the necessary terms to use to communicate their ideas. Although she was positive about the fact that this curriculum lets the students be more responsible for their learning, Jean reported, "I *present* a lesson and then they (the students) have to go through the process of discovering really what it is that they're doing." In this way she still exercises control over the development of conceptual learning.

John was asked the same question about how he launched a new concept with his students and he gave an answer that was consistent with what the majority of the other teachers had given. "Probably give them the definition (of area for example), … vocabulary, … of what area is. And how it's related to its computation. And try to make them understand that." This response did not surprise the researcher since she had heard this basic outline from more than one of the teachers. However, later in the conversation, after discussing several topics related to his teaching and his students' mathematics experiences, John said:

> And they're (the students) pretty creative. I mean if you could … change the teaching environment … that we have over here you know …somehow … to be able to let them work in groups and you know … put the idea here and we're going to talk about mass (for example) and let them (the students) go do the research and develop ideas, but I know it would be tough. I think it would be a novel way for them, and I think that they would learn. If they're involved they're going to learn more.

John scored relatively low on the MTEBI but certainly not due to a lack of confidence about his mathematics content knowledge. However, he was a first-year teacher and he was very sensitive to the threat of testing that was looming on the horizon for his students and the potential assessment of his teaching that would result from their performance. He lamented that he had to sacrifice what he felt would be a more student-centered classroom for one in which he was in control, in the interest of "covering" the list of objectives that would be on the standardized test.

*Monitoring students' mathematics learning*

The researcher broadened the construct of the teacher's effectiveness in monitoring mathematics activities to include the teacher's effectiveness in monitoring students' mathematics learning. In other words, the interest was not only on what environment the teacher is providing for his or her students' learning, but also how that environment nurtures the students' learning and ultimately what indicators the teacher uses to assess student learning. All eight teachers indicated that they were able to monitor mathematics activities, but in the interview the researcher asked each teacher how they determined whether or how much their students were learning. As might be expected, all of them reported that tests were the primary assessment tool as mandated by each administration, which echoes the emphasis on accountability via testing suggested by the No Child Left Behind legislation. The researcher was interested in how teachers felt about the testing and what other opportunities they gave their students to show progress toward mastery of the state objectives.

Kristi's seventh graders were not in the state standardized test cycle, but she knew that it probably would not be long until all grades are tested and her reaction to that prospect was: "I'm not a big one on tests." When asked what her suggestion would be for assessing her students' content knowledge, she responded that the students should have the opportunity to explain their strategies and that a rubric should be used to evaluate the student's level of understanding, based upon how that understanding is exhibited during the problem-solving. This suggestion is consistent with the philosophy of the inquiry-based curriculum that was described in the earlier section. Students were required to write about their thinking and to share ideas with their peers as well as with their teacher. As her students were working in their groups, Kristi listened to the discussions and often asked students to explain how they arrived at an answer. She also used her whole-class discussions as a way to bring everyone into the conversation, and through this conversation, she monitored progress. This informal assessment, as well as journal responses, performance on homework assignments, and testing provided a complete picture of her students' learning.

Jean used the fact that her students could connect a new concept to something learned previously or could use a concept previously discussed to explain why a new concept worked. Daphne echoed this when she explained that her students did a lot of their work on the chalkboard. They must not only explain what the steps are to solve a problem, but they must also explain WHY they do the steps. Veronica quickly enumerated a variety of ways she supplements information from tests to determine whether her students were learning: whether they were paying attention in class, what kind of questions they asked, were they focused, reading, following along, were they thinking through their work (she used the term "processing"), were they talking to each other about the problems on which they were working. Beverly relied on quizzes and tests as the main tools of assessment for her eighth graders. However, each day as her students worked on assignments, she informally monitored their learning as she moved throughout the classroom. She looked to see whether they have learned the technique and followed the rules for the particular type of problem they were solving.

John, when asked about his students' learning, said, "Of course we give tests" in a matter-of-fact kind of way, but he also used classroom behavior as an indicator. He considered whether his students were "contributing to the class" during his daily question-and-answer time during the lesson. Although the same students typically responded when he asked for a show of hands, John tried to bring in others. As part of this conversation on student learning, John confessed that he was surprised by the low ability of many of his students. "I wonder how in the world they made it this far. Some of them don't do anything at all. I've had kids in this class that sit there 70 minutes everyday. Won't bring anything in, won't turn anything in." He seemed at a loss as to what to do about these students.

*Preparation for middle school teaching*

In the teacher preparation programs in the state in which this study took place teacher candidates major in either elementary or secondary education—there is not a specific major for middle school teaching. Among the eight teachers in this study there were five who were elementary certified and three who were secondary certified. The researcher was interested in what, if any, special preparation the teachers had received for teaching middle school mathematics and from their perspective in the classroom what they would suggest teacher preparation program faculty should do to help teacher candidates who are going into the middle school classroom.

Marsha, who was a K-12 health/physical education major, regretted that the only methods class she took in college was for reading. As for being prepared to teach the middle school child, Marsha reported that there was some mention made of the "changes they're going through" in her health classes, but nothing was discussed in depth. She was eager for workshops that would address the needs of the middle school student and she was unaware of research by Beane (1993) and others who actively lobbied for taking the diversity of students at this level into consideration when designing middle school curriculum. The NCTM (2000) suggested that differences in intellectual development, emotional maturity, and sensitivity to peer-group perceptions challenge the middle school mathematics teacher to create a learning environment that nurtures the learning of mathematics for everyone.

The researcher asked John, who was in the process of meeting certification requirements that were stipulated by the alternative certification program, what opportunities he had to prepare him for teaching middle school. He responded, “I'm here,” so his classroom is his first field experience, unlike current teacher candidates who clock hundreds of observation and clinical teaching hours during their teacher education experiences. Although he was taking a general methods course at the time of this study, John said that a methods course that focused on mathematics content, one that outlined the state mathematics objectives for middle school, would be very helpful. As it was, he was given the textbook and told what to cover during the school year. Although he had some prior experience in working with the middle school age child in his coaching, he did not have an educational psychology course that addressed issues of early adolescents in the classroom. Fortunately, John had a good working relationship with Veronica, who was his mentor teacher, so he could coordinate lesson planning with her and they could exchange ideas for activities.

Since Veronica has come into the conversation, the researcher will consider her responses to the amount of middle school preparation she had. She had her elementary certification, but taught fifth grade only one year before moving to sixth grade to teach mathematics. In fifth grade she taught all core subjects, but she liked sixth grade because “then you learn yourself better methods to teach. When you’re teaching all subjects you don’t have … you’re preparing all subjects … you’re in a lot of work there. And see you’re barely touching the tip of the iceberg … teaching all subjects … everyday.” She liked that she had more time to plan for her teaching so that she could focus on different methods and incorporate more hands-on learning. Veronica attended a community college and a state university during her preparation for the classroom. At both institutions she had classes that were directed toward mathematics teaching—one for geometry and another for elementary school mathematics. In both of these courses the teacher candidates could work with children in the children’s classrooms. When asked what else would have been helpful to her, she responded that practical teaching ideas would have been very helpful. Although there are many resources—both print and online articles—that are designed to help teachers implement classroom practice that reflects current research trends on mathematics learning, Veronica did not seem to know how to go about accessing the information.

Although certified to teach secondary mathematics, Beverly saw the high school students as “set in their ways,” unwilling to change their attitudes toward mathematics. She viewed her middle school students as still being able to see mathematics with open minds. She said no distinction was made between junior high and high school students when she went to school over thirty years ago, but she thought “they do a better job (now) than when I went to school.” However, according to more recently graduated teachers, as mentioned earlier, this is not the case. Beverly wished, like John, that she had had a better idea of what is to be taught in each grade prior to getting “out there in the real world (of teaching).” Her methods courses were focused on “how to teach… how the motivate them (the students), what to do, and those kinds of things, it wasn't subject matter at all."

Whereas most of the teachers seemed to be focused on content regarding preparation for middle school teaching, both Kristi and Jean reported that they would have liked to know more about the middle school age students themselves— emotions, social pressures, physical, psychological—the psycho-social developmental issues. Jean said her education about middle school students had come from being in the classroom, much as John noted earlier. Kristi thought that although her early teaching experience had been with younger children, the students whom she had encountered in middle school recently, for the most part, are not much more mature than the third graders she taught early in her career. She said students were less respectful, had difficulty staying focused, and showed less responsibility with regard to turning in assignments.

The researcher has saved Daphne and Jack until last because they were in unique positions for their mathematics teaching. Each of them taught a coed sixth grade class, but because the administration required that boys and girls take physical education separately, Daphne and Jack taught math to only boys or girls while the other group is in PE—Daphne taught twenty girls and Jack taught nine boys. When asked about being prepared to teach middle school age children, Jack cited his stint as a substitute in a school in a large city as his opportunity to get to know a wide range of age groups. After being almost a permanent fourth grade substitute, he "got tired of being with the little people and went up to the junior high school and I found … kind of related a little bit more to the older kids. But since I've been here at _______ it's just like one great big family. I'm just adept with the kids; the little bitty kids and the older ones. So it doesn't matter." Daphne said she had no prior experience with the middle school age group and no formal introduction to either the pre-adolescent developmental issues or middle school content requirements in her elementary certification program. She said even when she went to workshops or meetings she found little about middle school students: "I go and I look and I get disgusted, well, look at the HUGE sections on elementary and … this "small" (one) for middle school." In one breath Daphne expressed uncertainty about how to deal with her students' unpredictable natures, but in the next breath she confessed that their unpredictability is just what makes them so interesting to work with.

The researcher asked Daphne and Jack about their impressions regarding teaching math to just one gender. While both teachers downplayed the significance of the boys' or girls' being separated from the other gender during math, Daphne did concede that the classroom atmosphere was "more relaxed" and that her girls were probably more willing to take risks during math lessons such as solving problems on the chalkboard. Many of the sixth grade girls in her class this year are very assertive—go-getters, as she called them—so they are equal to the boys in their boldness to answer questions during whole class discussions. However, historically boys have been more willing to jump in and answer questions and Daphne felt that being away from the boys during math would ameliorate that situation. The researcher would like to share the exchange between herself and one of Daphne's students, Olivia:

Researcher: "How do you like being in there with just girls for math?"
Olivia: "It's better … the boys are always rowdy and they like to talk and everything and we can't get concentrated when they're in there."
Researcher: "There's really been a lot of research that says that girls do better, particularly in math and science, when they're by themselves than when they're with boys …

Olivia: “I think the reason for that is because all the girls, all they care about is just talking to the boys and doing all this other stuff … Some of the boys I can tell them to be quiet and they’ll be quiet, but the other ones they’ll just be quiet for like a minute and they’ll start talking again. In all the other classes, it’s OK, they’re easy for me, so…”
Researcher: “So, it’s more important maybe in math class that you can focus a little bit more than maybe in the other classes?”
Olivia: “Yeah.”

Jack was sure that his boys paid little attention to whether the girls were in the classroom or not. Since the boys were just at the beginning of pre-adolescence, he did not think that the boys were yet seeing themselves as being “different” from the girls socially, emotionally or psychologically, so they were just as content to be by themselves as not. Interestingly, when the researcher asked Jack’s student, Harry, about his feelings as to whether separating the boys from the girls created a better learning environment, his perspective was different from Olivia’s:

Researcher: “There is an argument that it’s better for them (boys and girls) to be separated (in the classroom). So, do you think the girls are a distraction to the boys or vice versa and does separating them allow each group to learn more easily?”
Harry: “I’m not too sure … well, I mean, the teachers just focus on everybody and it’s harder to get one person to learn everything. You can have a bunch of confused people and go one at a time and by the end of class some people don’t even know what the lesson was about, they (the teachers) don’t have any help with all 30 of us in the class.”
Researcher: “so maybe you’re saying it’s better, not necessarily boys versus girls, but just that it (separating the sexes) makes the classes small?”
Harry: “It makes the classes a ton smaller, easier to focus on everything.”

The researcher felt privileged to visit with all of these teachers as they spoke about their students, as they expressed real concern for the world that awaits their students when they leave the relative security of public education, and as they worried about how their students would make their way in that world. Jack was most open about this appreciation for his students when the researcher asked him if he would like to add any comments beyond his responses to the interview questions.

> Well, I think that my students are better than a slice of bread. I really do and I tell them that. I always try to tell them how much I care about them, and I also try to tell them … I let them know that right now our state—we were the 3rd from the bottom, and now I think we're on the bottom of the list. And I tell them right quick—it's not about the money. That's not what a teacher is … It's the idea of being … cause I'm very jealous of my time with them … Those are my kids and I let them know that I really appreciate them. And I appreciate them for being in school and coming to school. And I'm trying to get them out of the idea of telling them the only reason they're coming to school is because their parents are making them… (he tells them) I want you to want to come. I want you to be so excited about coming to school that you can't wait to get up and come to school the next morning, and that's the way it is.

*Teachers' confidence about teaching mathematics*

Finally, the researcher was interested in each teacher's confidence about teaching mathematics, but specifically those teachers who have come to teaching mathematics either from another content area or from the elementary setting in which they taught all core subjects. This year was Marsha's first opportunity to teach math after teaching science and health. As noted earlier, she had always loved math and was excited to be able to teach math to seventh graders. She said that her confidence about her own mathematics knowledge had always been strong, but what this first year had done was to force her to face the fact that many of her students do not have mastery of even the most basic arithmetic facts. So this first year was a learning opportunity for her as well as for her students. Marsha had gained a better idea of what her students do and do not know. Her confidence hinged not on content knowledge but on pedagogical content knowledge, i.e. how to teach as opposed to what to teach. Marsha wished that she had more guidance as far as appropriate methods for teaching the math concepts included in the state learning objectives for seventh grade.

Jean, who had come from teaching reading to teaching math, confessed that at first it was difficult to make the transition because she had not been in a math classroom since college. However, after attending the training workshop for the inquiry-based curriculum that she was using, Jean felt that she was just as knowledgeable as most of the other math teachers. Kristi, who was teaching from the same inquiry-based curriculum, said that she had gained confidence in teaching math during the years since she left elementary teaching because she had a better idea of what worked with her students and what did not.

Daphne, whose specialization during her elementary preparation was in reading and language arts, felt much less confident about teaching math, but her overall confidence about teaching served to carry her through lessons about which she was unsure of herself. Both she and Jack frequently would go to the eighth grade teacher in the high school building for some quick review and suggestions for methodology. Jack would have liked to be teaching only social studies, but he, too, was teaching in a self-contained situation and must teach math. His confidence about teaching math was tied to the textbook and was anchored by relying on the teaching style of the teachers he had in school. He liked the current textbook for all of the teacher supplements, particularly extra worksheets, that he could use to reinforce the skills he wanted his students to master.

Veronica, who had come from teaching fifth grade to teaching sixth grade math, said that she felt confident about teaching mathematics, but she used her students to gauge her effectiveness. She was very enthusiastic about learning new methods and seeing how her students responded to those methods: “And if I see the students grasping that (concept) and the majority of them using/getting it, I probably would stick with it and just improve on that one idea.” Most indicative of her sometimes feeling overwhelmed by the many approaches to teaching was her comment, “There’s always something new to add to it. It’s … not easy.”

The researcher asked each of the teachers whether s/he was aware of the NCTM’s (2000) recommendations in the *Principles and Standards for School Mathematics*. None of the teachers possessed a copy of the *Principles and Standards*, although some had a vague idea that the standards were included “somewhere in the curriculum.” Interestingly, none of the teachers was a member of the NCTM or the state chapter of the NCTM.

### *Classroom Observations*

How does a teacher’s efficacy beliefs guide his or her classroom practice? The researcher was able to be present for all or part of three or four lessons in each of the eight teachers’ classrooms. She would like to preface this discussion of classroom practice by assuring the reader that everyone—parents, administrators, curriculum designers, policy makers, and elected officials—could gain valuable insight by spending just one typical day in the public school classroom. No matter how detailed the description the researcher could provide, there is no substitute for immersing oneself in the ambience of the classroom setting and experiencing the issues surrounding the mandates that have been set out for public education.

A cursory glance at the field notes from the observations allowed the researcher to classify the teachers into two broad categories—those who preferred more control and structure in the classroom and those who could live with less control and/or structure in the classroom. This came as no surprise. One facet of the reform movement in mathematics education is the contrast between teacher-centered and student-centered classrooms. Battista (1999), reflecting on the intent of the then-fifteen year-old reform movement in mathematics education, suggested that mathematics instruction should be centered around problem-solving and that students should be encouraged to generate their own mathematical knowledge. By reflecting on this constructed knowledge, students begin to make the transition from reliance upon concrete models to being able to work within the sophisticated realm of mathematical symbols. This allows students to construct their own mathematical knowledge and translates into classroom environments that are noisier and more active than many traditionally taught classrooms. The teacher must give up some control over the pace of classroom instruction and must change his or her perspective from one of knowing how a concept should be "taught" to one of exploring to how a concept can be "learned."

Beverly, Veronica, John, Jack, and Marsha preferred or were more comfortable when they were in control of the teaching and the students' attention was focused on them. Daphne was more flexible in her expectations of structure so that her classroom was often more active with students talking to each other, either at the board or at their seats. Kristi's and Jean's classrooms, by virtue of the inquiry-based curriculum they were using, tended to be scenes of students working with each other, asking and answering questions within their groups, but as the reader will learn, the teaching styles of the two teachers differed. Given the generalizations the researcher has just made, she would like to provide the reader with brief snapshots of each teacher's classroom, so as to set the stages on which the student interviews will be played.

The desks in Beverly's classroom were arranged in rows, facing the front of the room and the overhead projector, Beverly's desk, and computer station. The state mandated mathematics objectives for eighth grade were prominently displayed on the wall, and Beverly had circled all of the objectives that she had taught during the school year so that her students knew what they would be responsible for knowing on the end of the year exam. Beverly taught regular eighth grade mathematics, as well as algebra I, and it was the algebra I class with which the researcher worked during this study. This was the only designated "advanced" class with which the researcher was involved. Beverly typically stood at her classroom door and greeted many of her students, but when the bell rang, she quickly began her lesson. She generally collected the previous day's assignment, often going over problems about which the students may have had questions. Beverly required her students to read the textbook, either on their own or with her, because of the state testing, She said, "They have to read mathematically." Using the overhead projector, she worked through the examples that were in the book with the students, focusing on the procedure and the rules involved in the particular problem.

After finding out that Beverly began her teaching career with high school students, the researcher was interested to know how, if at all, Beverly had adjusted her pedagogy when she began working with middle school students. "It's about the same because you can't … (you have) to give them handles and processes to follow to … have success and that's what I did for the—those that had failed. They just didn't learn the rules; I make them learn the rules. I give them quiz (after) quiz on the rules. Of course I'm a rules person so that's how I teach." As questions come up during the lesson, Beverly answers the question herself. For example, a student asked Beverly whether "y = - x + 9" was the same as "x + y = 9," Beverly simply said that yes it was the same, taking the position of authority rather than redirecting the question back to the class to discuss and determine whether the two equations were equivalent.

Following the lesson, Beverly gave the day's assignment and students were allowed to spend the rest of the period on the assignment. They worked quietly, but there was discussion among students about particular problems. The students stayed focused on their work because they wanted to finish as much as possible during class so they would have a minimal amount of homework. Beverly circulated throughout the room as her students worked and monitored their work. Another example of her comfort with being in control could be seen when a student was unsure of how to proceed when working a problem and asked Beverly for assistance. In this situation, it was common for Beverly to take the student's pencil and work through the problem on his or her paper, explaining how the problem should be worked, rather than trying to ask the student questions that might prompt him or her to be able to work the problem. Beverly remained actively engaged with her students throughout the time she had with them.

By arranging the desks in her classroom in groups of four, Veronica told the observer that her students were allowed to work together, but she still demanded that she be the focus during her teaching. "Well, I feel I'm an authoritative teacher," she told the researcher and if her students were not "focused and watching and listening, then that's their responsibility … I believe that they need to raise their hand, ask questions so I can really explain it to them." When she told her students, "Look this way so that I know you are ready to start" and announced, "I'll wait" when she was waiting for them to settle into listening mode, Veronica made it clear to her students that she expected their full attention during the lesson.

Veronica wrote the particular state mathematics objective that the lesson addressed on the board. She used the overhead projector so that she could maintain eye contact with her students—she believed this helps to keep their focus on her. These are some comments heard during her lessons: "You're going to find as you do the steps that it's confusing," "No pencils, just watch me," "Show your work so that I can show you what you have done wrong," "8 – 1.65—this could be tricky—it's not 7.65." During her class Veronica constantly monitored her student's reactions to what she was teaching by asking if they had any questions. She very much saw her role as that of keeping her students from being uncomfortable in their learning and if they did struggle, then she tried to "explain away" the confusion rather than giving them a chance to work with each other to make sense of concepts. "If they can organize their information, then they're going to be able to understand it a lot easier than to give them a jumbled up bunch of vocabulary that they don't understand what's what. And if they're not organizing (their thoughts), then you ask questions. And they're asking questions."

Following her lesson, Veronica's students worked on the day's assignment, but the noise level was higher than that in Beverly's classroom. Veronica's students were two years younger than Beverly's and were more vocal and active in their interactions with each other. Instances of inappropriate classroom behavior and the necessity of a disciplinary response were more of an issue in Veronica's classroom than in Beverly's. Veronica used incentives of special privileges or an occasional party as tangible rewards for her students to maintain appropriate decorum in the classroom. Veronica also circulated throughout the classroom, monitored student work, answered questions, and remained actively engaged with her students while they were in her classroom.

John taught sixth graders in the same school as Veronica, but the atmosphere in his classroom was much different. The students' desks were arranged in rows, facing the teacher's desk/computer station and the overhead projector. John wrote "bell work" problems on the board for the students to work when they came into the classroom. His intention was for the problems to engage his students' mathematical thinking so that they would be prepared to begin the day's lesson. However, only a few students seemed to view the bell work problems as a significant activity in the day's routine. Some students worked on the problems, but many did not. John reminded the students several times during the roll-taking process that they were to be working the bell work problems and, although several students did begin to work on them, there were always some who did not.

His students tended to be easily distracted and not as involved in whole class discussions as Veronica's students were. Occasionally John would ask a student to read from the textbook; sometimes he read from the book. Lessons consisted of his working example problems (performing operations with fractions and exploring the relationship between fractions and decimals were the learning objectives during the period of classroom observation), supposedly with the students, who were to be taking notes. However, many students were not participating in the discussions. The casual observer could come to the conclusion that while John seemed to be aware of a lack of involvement of many of his students, he was not actively trying to bring them into the discussion.

Since the researcher had the privilege of being in John's classroom on several occasions, she did observe two instances when John was able to generate some interest in the classwork. During one lesson John asked his students, "Tell me some of the things that we have learned together about fractions" and several students responded with relevant information. The students were animated and they were anxious to show what they knew to the point that there seemed to be a little competition to come up with a fact that someone else had not mentioned. Later in this same lesson, John wrote two problems on the overhead projector and asked students, "Who would like to walk us through this problem?" He first asked for answers to the problem and wrote all of them on the overhead. Then he asked a particular student to "walk through" the solution of the problem to determine which of the responses was the correct one. Again, many of the students were actively vying to be the one to "walk through" (the term he uses) the problem. In both of these scenarios, the students were given the opportunity to be the authorities. However, following the lesson, when students were allowed to work on homework, John would circulate throughout the room, being concerned with keeping students in their seats and encouraging them to do at least a few of the homework problems before they left the classroom. Recall John's lamenting that some of his students "don't do anything at all … sit there 70 minutes every day … won't bring anything in, won't turn anything in." He remained actively involved with his students during the 70-minute class period, but except for the two previously mentioned situations of enthusiasm, many of his students seemed less than willing to meet even his minimal expectations.

Marsha, who taught seventh grade math/science at the same urban school as Beverly taught, as well as Daphne and Jack, who taught sixth grade at the small rural school, had similar approaches in working with their students. They worried about their students beyond what they were supposed to be teaching them in the classroom. In each of these classrooms, the observer would see these teachers asking students about their families and after school activities. They also tried to impress upon their students the importance of doing well in school, not just for the immediate purpose of a grade for that class or even for performance on a future standardized test, but for life after school. All of these teachers expressed concern for how their students will make a place for themselves in the world. They wanted their students to see school as the bridge that will take them into adulthood, equipped with skills that will make them successful.

As did Beverly, Marsha posted the state mathematics objectives on the wall of her classroom. Since she fulfilled the role of a "half team," teaching both science and math to the same students, her classroom was a science room. The students sat at long tables, four to a table. When the researcher began working with Marsha, the tables were arranged in a U-shape so that students could face each other, but by the last time the researcher observed in the classroom, the tables were arranged in rows. Marsha said it was easier to maintain her students' attention if they could not be distracted by facing each other, although she conceded that this arrangement took away from the facility of having whole class discussions. Around the periphery of the room, science equipment covered counters that were topped with the familiar indestructible black lab surface. Each student was able to have his or her own drawer in which to keep school materials, which alleviated the issue of not having necessary materials for class.

When Marsha's students came into her classroom for math, they would see the "warm up" problems she had written on the board for them. After she took roll, she went through the problems with her students and most of the students had at least attempted to solve the problems. Marsha's situation was unique among the eight teachers in that she had three non-native English speakers in her class. When the students began the school year with her, they spoke no English. Each student had a peer who translated for him or her and Marsha expressed amazement at how far these students had progressed in their English language acquisition after six months of being in school. During the time that the researcher was in Marsha's classroom, her students were learning about solving linear equations, operations with integers, and the application of integers to the Cartesian coordinate system. Marsha was using a commercially available hands-on system that purports to facilitate the learning of the process of solving linear equations. She had attended the training in the use of this system and was enthusiastic about its use of concrete manipulatives. She would invite a student to set up an equation to be solved on the large teacher's version while the other students solved the equation at their seats using the student version. Then another student would come to the front of the room and show the class how the system pieces were manipulated to solve the equation. After the student was finished Marsha would ask the student's classmates if they agreed with the solution. In other situations, Marsha would write a problem on the board and invite students to come to the board to complete the solution and the class would have an opportunity to agree or disagree with the solution.

Marsha created situations for her students to be actively engaged in the lesson rather than passive receivers of information. Certainly, there were times when Marsha lectured and her students listened, but she interspersed enough activities that her students feel accountable for their learning. However, while acknowledging the value of creating activities for learning, she expressed concern that these "fun" ways of learning precluded her students' learning the discipline that is necessary for committing to memory the basic addition and multiplication facts. She gave her students weekly timed drills on basic addition, subtraction, multiplication, and division and checked to see if the scores improved. Although she had been teaching for a number of years, this was her first opportunity to teach math, and she told the researcher that her students depended upon being told "step-by-step how to solve a problem and that they can't/won't think it through." During class, she encouraged her students to "stop and think." As she circulated throughout the room while her students worked on the day's assignment, she stopped to ask how a particular student worked a problem; she patted someone on the back or arm as encouragement and positive reinforcement; and generally tried to make personal contact with each student at least once during the class period.

When the researcher walked into Daphne's and Jack's sixth grade classrooms, she felt as if she were in her own childhood elementary school. Unlike the other three schools, these sixth grade classrooms were in the elementary school in this small rural community, although sixth grade is technically considered "middle school" level in many school districts and is housed with the seventh, and often with eighth, grades. The middle school sixth grade teachers in this study taught only math, but Daphne and Jack, as elementary school teachers, taught all of the core subjects in their self-contained classrooms. Although the classrooms in this small school were equipped with computers, the school had not had the facility upgrades that the researcher found in the three middle schools, and it still had the ambience of an elementary school of the 1960's or 1970's. Daphne's sixth grade girls often abandoned their desk chairs to sit or lie on the carpeted floor to get closer to the front of the room during a math lesson or during reading time. During the period when the researcher was observing Daphne's and Jack's classrooms, they and their students were exploring beginning statistics concepts, as well as the concepts of least common multiple (LCM) and greatest common factor (GCF) and how these two concepts related to fractions.

Jack began his math lesson by going over the previous day's assignment with his students. He would ask a student to give the answer to a particular problem and then the other students could agree or disagree. Generally they were able to determine what the correct answer was, but on more than one occasion, when there was no consensus, Jack became the authority and would tell the students what the correct answer was. As the reader may recall, Jack's preferred teaching area is social studies and he admitted to a lack of confidence in his mathematics knowledge. During one lesson, when the students were working review problems for an upcoming test, they were to solve the equation "$p - 7 = 17$". There was some disagreement among the students as to whether the correct solution was 10 or 24. Jack initially gave the correct answer as 10, and only after a student who believed the correct solution was 24 persisted in his argument, did Jack look at the solution in the teacher's edition of the textbook and found that the correct solution was 24, not 10.

During a lesson concerning LCM and GCF, it was clear that the students were confused about the difference between these two concepts and Jack was at a loss as how to illustrate the distinction between the concepts and how to outline a process by which each of the values could be found for any two given numbers. The students in this study were comfortable with having the researcher in their classrooms and in all cases there were instances of students' asking the researcher for help with problems. However, in Jack's case, he was relieved to have the researcher in his classroom as a resource for his teaching and he used this as an object lesson for his students. He admitted to them that he was unsure about some of the mathematics concepts that he was supposed to be teaching, but that everyone has weaknesses. He told them that there is no reason for embarrassment or to avoid the weak area, but that the important thing was to know how to find resources to fill in the gaps in one's knowledge. Therefore, during the lesson on LCM and GCF, as well as a lesson about mean, median, and mode, Jack requested that the researcher assist in the lesson, which she was happy to do.

When Jack was conducting a whole-class discussion, he randomly selected students to respond to a question by saying, "Talk to me, _________" and he used the chalkboard as a medium by which his students could justify their work. He was fully engaged with his students, and since he had some of them all day as their sixth grade teacher, he took on a more significant role in their lives than the departmentalized middle school teacher who was teaching each group of students for only one period each day. Jack was aware of the state mathematics objectives for his students and would tell his students what they were supposed to know. However, he was not interested in only being able to say he had "covered" the objectives; he wanted his students to show that they had mastered them. "I always read them (objectives) to them … 'when you're finished with the lesson you should be able to do this, this and this.' So we'll have a lesson – we'll have a quiz on the lesson. We'll have a quiz at the end … then we'll have a chapter quiz. If you didn't (do well) … I go back to the first lesson, and we start all over."

The young girls in Daphne's math class were a melding of the students she had all day in her self-contained classroom and Jack's female students. When the researcher asked Daphne if she did anything in particular in her teaching that she thought worked well, she replied, "I'm just silly with them … whatever it is … it's spur of the moment what I come up with, you know," which the researcher has since come to understand to mean that she tried to make math, or any subject that she is teaching, seem like something fun. She was often exaggerated in her explanation of a concept or in her surprise at discovering or revealing a relationship between a mathematics topic and something from real life to which her students might relate.

Since the researcher saw these girls only in the math setting and not with the boys during the remainder of the day, she cannot compare the girls' conduct in the two situations nor can she compare Daphne's classroom presentation between the two situations. In the interview with Daphne the researcher cited research that found that girls perform better and are more confident in single-sex classes (Streitmatter, 1997), and asked Daphne if she could speak to this issue. At first she said that she thought there was little difference between how the girls behaved away from the boys as compared to when they were with the boys, but after reflecting she admitted, "I think you're probably right when it comes to this … yeah … okay … they 'harangue' each other but not like the boys do. And it's a little more good natured."

Jack said that he taught the old-fashioned way, like his teachers taught him. He taught the lesson, for example the statistics lesson, from the textbook, worked through the examples and gave his students problems to do. In comparison, when Daphne began the statistics unit, she put her students into groups and gave them the task of designing their own survey. Coming out of the 2004 elections and having recently answered the researcher's survey, there was ample opportunity to discuss types of surveys, sampling techniques, sample size, audience, bias, and appropriate questions. This approach put responsibility for learning in the hands of the students rather than on the shoulders of the teacher. Daphne gave up some classroom control during these discussions, taking on the role of a coach. This is not to say that she approached all units in this way, but it does serve to show that she was willing to break out of the traditional mold of lecture, drill, and homework.

Her students were very comfortable with working on the blackboard: “Come do some of these problems on the board. We’ll see if we agree with you.” The girls at their seats were not reticent about voicing their agreement or disagreement. Sometimes the interactions among the students got loud and out of control. The researcher witnessed one student moved to tears of frustration during a discussion, but Daphne reported that just comes with the age of the students and that by the next day everything would be back on an even keel. Daphne, like Jack, occupied a more significant role in her students’ lives than the typical middle school teacher. The girls came to her for advice and for a shoulder to cry on and if she felt that her students were making poor decisions, she did not hesitate to step in as a parent would and discuss the consequences of those decisions and suggest alternatives.

Kristi and Jean were teaching from a inquiry-based mathematics curriculum in their seventh grade classrooms. Although both teachers used the same curriculum, the researcher observed different implementations of the curriculum. Whereas Kristi’s room contained eight round tables, each of which seats four students, Jean’s room contained individual desks. At the beginning of the time period that the researcher was in Jean’s room, the desks were arranged in groups of four so that students could easily cooperate on the activities, but by the end of the data collection period, Jean had separated the desks for a recent test and she said they would stay that way for “a while.” Each concept, such as perimeter or area, is “launched” with a discovery activity during which the students are given tasks to do, through which they are to make observations and connections that will contribute to their construction of understanding. For example, by drawing rectangles of specified dimensions on grid paper, then counting the squares in each rectangle's interior, the students would theoretically find that the formula for finding the area of a rectangle is length X width.

Kristi was comfortable letting her students work through the activities with a minimum of direction. Following the exploration, she usually would sit at the overhead projector on which she had transparencies that corresponded to the pages on which her students had been working and would ask questions that allowed the students to communicate what they have found. When she asked a question, she wrote all responses on the overhead so that all students could see what had been said. The responses ranged from simple, descriptive observations to higher order responses, which demonstrated that some students were already beginning to analyze and synthesize the information. Once all responses had been voiced, Kristi would use other questions, which she often answered herself, to generate student thinking that had not been expressed yet. Unless time got away from her, she summarized the discussion and her students would generally take notes in their journals. Throughout the whole-class discussions, the students remained actively engaged, with occasional instances of a student's attention wandering or gazing off into space. Kristi seemed to enjoy the discussions with her students and even when they had forgotten a fact that she clearly felt they should know, she was positive, often playful, but firm, as she reminded them of the forgotten fact. Likewise, her students seemed to enjoy working with the materials and with her.

Jean liked more control in her classroom and she constantly reminded her students that she was the authority in the classroom. Even when she reminded her students of when an assignment was due, it took on the inference of being a threat. For example, on one day that the researcher was in the classroom, Jean reminded her students that their journals were due the next day. She outlined the format in which the information was to be and she concluded, “You got that?” When a student asked a question, Jean’s response was, “We talked about that yesterday, if we listened.” Rather than letting her students begin on the launch activities with minimal instruction and finding out what they already know about a concept, Jean reported that she always first gave them the vocabulary words, citing her reading background as being the justification. When her students were working together in class, Jean often set a timer for the amount of time she had allotted for a particular activity and was bothered by the amount of noise generated by her students. In Kristi’s classroom one heard few reminders about behavior but Jean seemed to think it was necessary to remind her students about keeping down their voices, staying on task, putting away materials, and following directions. Kristi had similar expectations for her students, but she seemed to assume that they would meet her expectations, whereas Jean seems to assume that her students would not. While there were some students who were confident enough to ask Jean questions and make comments, there were many who relied on their fellow students for clarification.

## Student Attitudes Toward Mathematics

Kempa and McGough (1977) have outlined mathematics attitudes as being one’s perception of the difficulty of learning mathematics, one’s enjoyment and liking of mathematical activities, and one’s views on the usefulness of mathematics. The researcher gained preliminary insight into the students’ attitudes toward mathematics through written responses to items on a mathematics attitudes survey and to questions on a demographic questionnaire.

*Fennema-Sherman Mathematics Attitude Scales*

Fennema and Sherman (1976) developed their Mathematics Attitudes Scales (F-S MAS) as a means to study important, domain-specific attitudes that are related to the learning and valuing of mathematics. The authors of the attitude scales cited the significant finding that although students may be intellectually capable of doing well in mathematics, many are choosing not to study mathematics beyond the minimum high school requirements. Since one purpose of their project was to differentiate between those who choose to go on to take non-required mathematics courses and those who do not, the items are written so as to be appropriate for both mathematics students and non-mathematics students. The final form of the instrument consists of nine scales, each having 12 items, six of which are worded positively and six of which are worded negatively. Responses are given according to a five-point Likert-type scale which ranges from strongly disagree (1) to strongly agree (5). The negatively worded items were recoded for analysis. Of the nine scales, this study used three--confidence in learning mathematics scale, teacher scale, and usefulness of mathematics scale. Illustrative items include "I am sure I could do advanced work in mathematics" from the confidence in learning mathematics scale, "Math teachers have made me feel I have the ability to go on in mathematics" from the teacher scale, and "Knowing mathematics will help me earn a living" from the usefulness of mathematics scale. One hundred seven sixth, seventh, and eighth grade students in four schools responded to items on the three aforementioned scales of  the Fennema-Sherman Mathematics Attitude Scales (F-S MAS). Responses were analyzed and the data provided surface indications of how these students viewed mathematics on the day they responded.

It is important for the reader to know that for most of the students, the F-S MAS was their first encounter with a survey, particularly one that employs the Likert-type scale. In fact, many of them said it was the first time anyone had been interested in their opinion on anything. Additionally, due to the wide range of not only mathematics abilities but also reading abilities possessed by the students, many of the items were difficult to understand for at least some of the students. One of the items on the Confidence in Learning Mathematics Scale is “Most subjects I can handle O.K., but I have a knack for flubbing up math.” Both “knack” and “flubbing up,” while being familiar terms for the researcher’s generation, were unfamiliar to the students. The Usefulness of Mathematics Scale includes the item “Mathematics will be of no relevance to my life.” The researcher needed to clarify the term “relevance” for many students. Although the Flesch-Kincaid reading grade level for the F-S MAS is 3.7 (as calculated by the researcher’s word processing program), many students were challenged to understand all of the items. The researcher tried to impress upon the students the importance of their responses and assure them that their responses would be kept confidential. Descriptive statistics for the responses to the three scales are shown in the table below (individual response data may be found in Appendix I).

TABLE VII
MINIMUMS, MAXIMUMS, MEANS, STANDARD DEVIATIONS
FENNEMA-SHERMAN MATHEMATICS ATTITUDES SCALES

| | N | Min | Max | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Confidence Scale | 107 | 17 | 60 | 42.10 | 9.871 |
| Usefulness Scale | 107 | 26 | 60 | 48.42 | 8.292 |
| Teacher Scale | 107 | 18 | 60 | 43.81 | 8.525 |
| Total of Three Scales | 107 | 86 | 180 | 134.34 | 22.11 |

The total score for each of the three scales could range between 12 and 60, with the total for all three scales ranging between 36 and 180. The researcher set a “low” score as being below 90 for all three scales and set a ”high” score as being above 126 for all three scales. In each of the four classrooms, there were at most two or three students whose scores would fall into the low category, but many students whose scores would fall into the high category. The researcher’s objective was to interview one student who fell into the low category and one who fell into the high category for each of the eight teachers in the study. In the cases of there being equal low or high scores, the researcher considered responses to questions on a demographic questionnaire, specifically those referring to whether the student liked math, whether the student understood the math s/he was taking, and whether the student thought his or her teacher understood the mathematics s/he was teaching. Based upon these criteria, the researcher selected two students from each of seven teachers’ classes. Since only one of Jack’s male students returned his parental consent/student assent forms, he was the only one of Jack’s students to be included in the interview phase. Thus, the researcher interviewed a total of fifteen students.

*Demographic Questionnaire*

As mentioned in the previous paragraph, each student was asked whether s/he liked math, whether s/he understood the math s/he was taking, and whether s/he thought his or her teacher not only understood the mathematics s/he was teaching but also whether s/he enjoyed teaching mathematics. For each yes or no response, the students were asked to explain why they answered as they did. As the researcher observed the students while they were completing this part of the questionnaire, she saw that they were quick to say yes or no, but they puzzled longer when they had to justify their response. There were two responses that were very unclear, so those were discarded from tabulation, leaving only 105 responses. Over all, ninety-four of the students (90%) thought their teachers both enjoyed teaching math and understood the math they were teaching, while eight of the students thought their teachers neither enjoyed teaching math nor understood the math they was teaching. Most of these eight students were a in single classroom.

Considering the fifteen students who were selected for interviewing, the majority (12 out of 15) of the students thought their teachers enjoyed teaching math, with one student replying both yes and no because “she’s a math teacher, but some of us give her headaches.” For explanations as to why they thought their teachers enjoyed teaching mathematics, some of the students observed that since their teacher was teaching math, s/he must enjoy doing it, e.g. “She has stuck with her job for a long time so I think she likes it” (one of Kristi’s students) and “He hasn’t quit his job yet!” This comment was made by one of John's students. The reader may recall that John is a first year teacher. Other students offered more substantive observations as to why they thought their teachers enjoyed teaching math: "She looks interested in it" (one of Marsha's students); "She is always nice and happy and glad to answer questions" (one of Beverly's students); and "They are always interested in how we do in math and why we do and don't do well" (Jack's student).

Three students definitely thought that their teachers did not enjoy teaching math and the researcher will sort out the interesting observations for the reader. The three students were split between two teachers, Daphne and Jean. In Daphne's case, one of the two students who were selected to be interviewed said she thought that Daphne enjoyed teaching math because "She is always trying to find fun ways to do math and making it fun for her too," whereas the student who thought Daphne did not enjoy teaching math said, "She gets mad a lot." Interestingly, the first student reported that she herself liked math while the second one reported that she did not.

Both of Jean's students who were selected to be interviewed reported that they did not think Jean enjoyed teaching math. One student scored high on the F-S MAS and reported liking math. Her response to the question as to whether she thought her teacher enjoyed teaching math was, "Not really. She screams a lot and doesn't explain things." On the other hand, the second student scored low on the F-S MAS and reported that he did not like math. He seemed confused by the questions as to whether he thought his teacher enjoyed teaching math. He responded "yes," but then in the explanation he said, "She gives us homework almost everyday and she sometimes makes us look like idiots in front of the whole class and sometimes yells." Thus, these two students who were quite diverse in their mathematics attitudes, held similar opinions as to their teacher's attitude about teaching.

The students were also asked their opinion as to whether their teachers understood the math they were teaching and to explain their response. Again, the majority (13 out of 15) of the students thought their teachers understood the math they were teaching. The reasons they felt this way generally were founded on the teacher's ability to explain problems and answer questions, e.g. "He explains it with good details" (one of John's students); "She explains it very well" (one of Veronica's students); and "She always knows how to answer my questions" (one of Beverly's students). Others had less self-focused reasons for thinking their teacher understands the math s/he is teaching: "She goes to little workshops and things" (one of Kristi's students); "She teaches it good and can do math really quick" (one of Beverly's students); "Because he has studied math" (one of John's students); and finally, the ultimate reason, "She always does her problems on the board instead of using the book for help" (one of Daphne's students).

The same three students who were of interest in the previous discussion about the teacher's enjoyment in teaching math deserve attention here as well. The young man in Jean's class who seemed confused about how he determined whether she enjoyed teaching math gave an intriguing response to the question whether he thought she understood the math she was teaching. He said that he did think she understood the math she was teaching because "she uses words and units we don't understand." He seems to think that if the students don't understand the discussion then surely the teacher must! The second student in Jean's class felt that Jean just *knew* what she was teaching, but that she didn't really *understand* it because "She just reads from the book and if someone doesn't understand she picks a student to explain it out loud." The reform movement in mathematics education, as supported by the NCTM (2000), encourages teachers to call on students to provide explanations and justifications as a means of allowing students to become more active participants in the sense-making of mathematics. However, it seems that this student views her teacher's practice of asking another student to explain a concept indicates her lack of understanding. Daphne's student who felt that she did not enjoy teaching math also thought she did not understand the math: "She messes up and she hardly makes it where I can understand." Recall that Daphne's other student cited her ability to do problems on the board without any help from the book. It seems that the students' perceptions of their teacher's competence is at least somewhat colored by their own attitude toward mathematics.

Now the discussion will turn to the students' own attitudes toward math. The researcher asked students to respond as to whether they understood the math they were taking and whether they enjoyed or liked math. These questions were on the back of the questionnaire and while the researcher verbally reminded the students to complete the back, some of the students did not do so. Also, the students were less definite in their responses to these questions than they were to those that focused on the teacher. Some students said "sometimes," "yes and no," "it depends," or "maybe" to either or both questions. In some cases the researcher could gather more definitive information from their explanation, but sometimes not. Due to these circumstances, the researcher could accumulate only 84 definite answers to these two questions. Of those, 49 (58%) reported that they understood the math they were taking and enjoyed or liked math, while 20 (24%) reported that they neither understood the math they were taking nor enjoyed or liked math. Interestingly, there were thirteen (15%) students who understood the math they were taking but did not enjoy or like math and there were two students who said that although they did not understand the math they were taking, they did enjoy or like math!

After the students were asked whether they understood the math they were taking, they were asked these follow-up questions:

1) If you said yes, what does your teacher do to help you understand?
2) If you said no, do you think that your teacher knows the math but just cannot help you to understand it?

As mentioned above, these were difficult questions for the students to answer. For the students who said they did not understand the math they were taking, some of the students placed the responsibility on the teacher's shoulders and said that they felt their teacher knows the math but is not able to help the student to understand it. However, a significant number of students took responsibility for their lack of understanding: "I think he could help me understand but I'm just not focusing on it," "I just can't figure it out," "She knows it (the math), she just doesn't know that I don't know it," "I just daydream most of the time. Because it's the end of the day and I'm all tired because of all the other classes," "It is just that I don't listen to parts and some I do, but sometimes I feel embarrassed to tell her I think she will get mad sometimes." Only two or three of the students who said they did understand the math said something to the effect that they just always understand math without needing any extra help; one student said, "She doesn't help—my parents do"; but the rest of the students gave some amount of credit for their understanding to the teacher. The most common responses as to what the teacher does to help the students understand is that s/he breaks down the problem, goes step by step, shows lots of examples, and gives repeated explanations. These responses reflect traditional classroom practice of mathematics instruction. Other students, however, indicated that their teachers were employing other means to aid understanding: “hands on stuff,” “explains what everything is and why every step is important,” “She shows us with blocks and stuff,” “She uses blocks, the alphabet, numbers, and shapes.”

After responding to the question as to whether they enjoyed or liked math, the students were asked why or why not. For the most part, those who did not like math said that it was hard, that they didn’t understand it, and/or that it was boring. However, those students who said that they liked math offered a wide array of reasons and the researcher would like to share a number of those with the reader in hopes of eliciting the same sense of hopefulness that she experienced when reading these genuine responses:

“It’s fun/easy.”
“You can do all sorts of projects about it and with it.”
“I like a challenge, and math gives challenges.”
“I love numbers so I enjoy math.”
“It gives me a challenge and it will help me for my job.”
“I enjoy some of the work.”
“I ♥ math. The great thing is, it is alike everywhere.”
“I enjoy it because it keeps my brain running.”
“I like to know about math and it isn’t boring to me.”
“Being able to expand your knowledge.”
“The fact that you get to think logically and figure stuff out.”
“All the problems and it is so much fun!”
“Just actually using your brain and knowing that it will be useful in life.”
“Numbers, adding, subtraction, division, and multiplying. I love it!”
“I really like working with varibels (sic).”
“I like it when we are working out equations.”
“I like it when we graph things. I don’t like when we do problems that take up like a whole page.”
“Learning new strategies.”

"I enjoy the challenge I give myself."
"Because I'm learning almost new things everyday."

The researcher also asked the students to tell her what makes a teacher a good math teacher. As one might expect, typical criteria were that the teacher should be understanding, nice, fun, patient, know how to explain, know how to answer questions, and have a sense of humor. However, it seemed that some students perhaps had thought about what the requirements for a teacher should be and took the time to explain:

"If she gets excited about her work and is real active with her students."
"Knows what he/she is talking about."
"Takes out her time to teach her class. She don't just give a page out of her books and tells us to get to work. She explains to her class."
"She always has the way to explain to her students."
"They have to want to help and they have to be fun, but not all of the times."
"She/he challenges you without making it too difficult."
"Teaches at a pace everyone could learn at, helps us with problems most of the time, points out our mistakes, and makes us practice every single school day."
"When they really care they will like move your seat if your talking. Ask you to stay after school, ask you what do you need help on."
"When they treat you like they know you are smart and not stupid."
"One that does more interactive types of math."
"She seems happy when she teaches."
Finally, not to overlook the academic requirements: "She goes to school to learn the math and then she comes back to are (sic) school and teaches us."

In the introduction to Chapter I, the researcher cited Gibson (1994), who found that students could effectively use metaphors to explain the feelings that mathematics evokes, and she was curious as to how the students in this study would complete the sentence "Mathematics is like ________ ." This was the last item to which the students were asked to respond on the written questionnaire. Many students were at a loss as to what they were being asked to do and the researcher tried to clarify the task without putting words into their mouths. It was clear that they had not had any exposure to the idea of thinking metaphorically. Some students completed the statement literally: "interesting and sometimes useless," "easy and hard at the same time," "science," "thinking a lot," "boring," "very hard," "fun," "enjoyable." However, just as many students were very creative as they exercised their imaginations in completing the statement. The researcher would again like to share a number of these with the reader.

"riding a bike—you can only ride it for so long until you crash and burn."
"swallowing nails."
"a hammer—it hurts my brain."
"shaving stuff in your head."
"running through the forest blindfolded with no sound."
"a dream, but then again a nightmare."
"a car that you will use all the time in your life unless the car breaks down."
"exercising—I need the workout but I can't do it."
"a torcher (sic) chamber."
"finger nails scratching a chalk board."
"trying to get a frog to walk on 2 legs."
And the researcher's favorite: "a festering bug bite that never goes away and right when you think it's actually gone, you're back in math."

Not all of the images were negative, although as the reader will see, the positive ones were not as evocative as some of the negative ones:

"a breeze of wind."
"rainbows."
"a tool you need when you grow up."
"a jail cell—the walls keep closing in, but once I get it, I'm free."

"a maze—complicated yet fun."
"a confusing yet fun wheel of excitement."
"a Christmas present—you don't know what to expect."

Two students definitely hold their teachers accountable for their emotional response to math:

"the slide you don't want to go down because it is too scary, but once you try it is fun (with some teachers)."
"a puzzle—when you have a good teacher the pieces fit, when you have a bad teacher the pieces don't fit!"

Among the fifteen students whom the researcher selected for interviews, seven students reported that they liked math, six reported that they did not like math and the remaining two said "kind of" and "sort of." The students who said they did not like math said they did not understand it, it was boring, it was hard, and it was not fun. Only one student mentioned the teacher as the reason: "The teacher is strict and gives us a lot of homework." Only one of the seven students who said they liked math mentioned the teacher in her reason, but not as one might expect: "Well, I enjoy learning (math) but not from Mrs. _________." This student was in Jean's class and she was the teacher to whom this student referred.

Researchers report that lower percentages of middle school students report liking mathematics than elementary grade students (Lang, 1992). Given this decline, this researcher was pleased to find that at least half of the middle school students who participated in this study reported liking mathematics. Historically, some research has shown that attitudes toward mathematics have little influence on middle school students' mathematics achievement (Smith, 1973); however, more contemporary research has shown that attitudes toward mathematics may predict mathematics achievement

(Thorndike-Christ, 1991). This researcher was more interested in the long-term effect of the mathematics attitudes of the students in this study, as will be examined in the remaining part of this chapter.

*Reform Curriculum and Student Attitudes*

As mentioned in Chapter II, according to Smith (1996), a teacher's mathematics teaching self-efficacy beliefs may influence what goals s/he sets for his or her students' learning and what activities s/he plans that will help the students to accomplish those goals. Those decisions and the implementation of those plans, in turn, may directly affect his or her students' mathematics learning. This researcher was curious as to whether there was a difference in attitudes toward mathematics between those students who were in classrooms of teachers who followed a more traditional classroom format—teacher lecture, teacher demonstration of examples, and drill and practice homework—and those who sere in classrooms in which teachers implemented the inquire-based curriculum.

Jack, Daphne, Marsha, Beverly, Veronica, and John were following a more traditional format, while Jean and Kristi were implementing the inquire-based curriculum, as noted earlier. The researcher looked at the means for the three individual scales and the total of the Fennema-Sherman Mathematics Attitudes Scales, comparing those for the first six teachers to those for the latter two.

TABLE VIII
Comparison of Means of Individual Scales and Totals
Traditional versus Inquiry-Based Curriculums

| Curriculum | Confidence Scale | Usefulness Scale | Teacher Scale | Total |
|---|---|---|---|---|
| Traditional | 41 | 49 | 44 | 134 |
| Inquiry-based | 44 | 48 | 42 | 134 |

As can be observed, there was no statistical difference in attitudes between the two groups of students, contrary to what those who advocate the reform in mathematics education would like to find. Granted, this study included a very small sample of teachers and students, which limits the significance of these findings.

*Mathematical Disposition*

In the previous discussion, the questions of whether the students liked or understood mathematics were explored via the responses to written questions on the demographic questionnaire. The answers to these questions, along with responses to the F-S MAS, are at the heart of the students' attitudes toward mathematics. However, the researcher broadened her attention to the concept of *mathematical disposition*. . Implicit attitudes toward mathematics become explicitly expressed as what the National Council of Teachers of Mathematics (NCTM) terms a "mathematical disposition" in its *Curriculum and Evaluation Standards for School Mathematics* (1989). Mathematical disposition "refers not simply to attitudes but to a tendency to think and act in positive (or negative) ways" (p. 233). The NCTM outline that mathematical disposition includes (1) interest and curiosity, (2) perseverance, (3) confidence, (4) flexibility, and (5) valuing the application of mathematics. Specifically, through the interview process the researcher was trying to elicit the students' development in regard to indicators (1), (3), and (5). A positive disposition is manifested in a number of ways, such as higher achievement levels (Butty, 2001), but perhaps even more significantly as a continued interest in mathematics on the part of the student (Steinback & Gwizdala, 1995), which then could be exhibited as the student's participation in non-required mathematics courses (Lantz & Smith, 1981).

## Student Interviews

The researcher's conversations with the fifteen students who were selected for interviews were the sources that contributed to her insight into these student-centered issues. Throughout this discussion of the results from the student interviews, the researcher will insert direct quotes from the participants in order to reinforce themes and patterns and, as much as possible, will not edit these quotes, except as might be necessary for clarification. Italics are used for emphasis and clarifications will be added in parentheses. The researcher feels that no one can speak about his or her personal disposition toward mathematics better than the students. As was the case with the teacher interviews, the researcher found that some students were more comfortable with the interview process than others. Two students, in particular, were very reluctant to speak. In the previous discussion, direct quotes were selected from among the original 107 students who completed the demographic questionnaire, thus no specific names were used. However, in this section in which the researcher reports information from the fifteen student interviews, specific names, all pseudonyms, will be used. For clarification, these are the teachers and their students:

Veronica: Deidre and Yang
Marsha: Leslie and George
Jack: Harry
Daphne: Susan and Olivia
Beverly: Jodie and Derek
Kristi: Roger and Jessica
Jean: Erica and Richard
John: Rebecca and Juan

The responses to several items on the three Fennema-Sherman Mathematics Attitudes Scales (F-S MAS) that were used in this study could reflect a student's mathematical disposition, and, hence, the researcher was interested in giving the students an opportunity to verbalize their feelings with regard to these items. The specific items from the F-S MAS that prompted the interview questions (with the specific scale from which the item came in parentheses) were:

- I have a lot of self-confidence when it comes to math. (confidence scale)
- I'm not the type to do well in math. (confidence scale)
- I study mathematics because I know how useful it is. (usefulness scale)
- I will use mathematics in many ways as an adult. (usefulness scale)
- Taking mathematics is a waste of time. (usefulness scale)
- Mathematics will not be important to me in my life's work. (usefulness scale)
- My math teachers have been interested in my progress in mathematics. (teacher scale)
- My teachers think I'm the kind of person who could do well in mathematics. (teacher scale)
- Getting a math teacher to take me seriously has usually been a problem. (teacher scale)

In addition to the above items, the researcher asked the students other questions that could serve to gain an understanding of these middle school students' mathematical dispositions and how they may or may not relate to their teachers' mathematics teaching self-efficacy beliefs.

*Teacher as all-knowing*

The researcher asked the students if it had ever happened in their class that a student had asked the teacher a question and the teacher had said that s/he did not know the answer and if so, how did the student feel about that? Eleven of the fifteen students who were interviewed said that it did not/would not bother them if their teacher occasionally did not know the answer to a question. Deidre said, "I don't think anybody's perfect." Harry said that both of his parents were teachers, and "I know how hard it is for them, so I don't expect much out of my teachers. I expect enough to help me learn, but not to part the sea." The fact that Marsha was teaching math for the first time during this study prompted the researcher to follow-up on the question about the teacher's understanding the mathematics she is teaching from the written questionnaire and ask her student, Leslie, whether she thought her teacher understood everything she was teaching or whether she thought that her teacher was learning things along with the students:

Leslie: "She's said so herself she's learned things along with us."
Researcher: "And how does that make you feel about learning mathematics?"
Leslie: "Um. I think it's really cool, because sometimes it seems like we're going to end up teaching her stuff, so, like everyone likes teaching their teacher things (laughs)."
Researcher: "That's right, so you're kind of in it together, to figure out how things are working, so do you think it's important, do you think a teacher should know everything that she's going to teach before he or she teaches it?"
Leslie: "No, 'cause I think it would make it more exciting and fun if she didn't know all of it and we kind of figured it out together."

Clearly, Leslie thought that between the teacher and the students it was possible to understand the mathematics concepts within the seventh grade curriculum. On the other hand, four of the fifteen interviewed students said that it would bother them if their teacher did not know the answer to a question asked by a student. Rebecca said, "Yeah, if he didn't know then he might be teaching us wrong." Even Yang, who conceded that it would be hard for his teacher to know everything about 7$^{th}$ grade, said that if there were numerous occasions when his teacher seemed not to know how to do problems then that "would be kind of weird because they're like the teacher, and they could be teaching the wrong stuff and when you get older, they could have taught you the wrong thing and you'd do it when you get older and then it might be embarrassing sometimes." All of the students, regardless of whether or not they thought their teacher should know everything, said that if the teacher did not know how to work a problem or why a process works the way it does, s/he should find out and report back to the students, preferably the next day. How did the students expect the teacher to find out? Most thought that the teacher could ask another teacher or go to the Internet.

As cited earlier, the National Research Council (NRC), in its 1989 document, *Everybody Counts*, reported that for each year between ninth grade and graduate school, about half of students leave the area of mathematics for other fields of study, which could result, warn Picker and Berry (2000), in a continued shortage of mathematicians and mathematics educators. The NRC (1989) lamented, “Mathematical illiteracy is both a personal loss and a national debt” (p. 18). Given the significance of whether or not students continue to study mathematics beyond what is minimally required, the researcher was interested in whether these young people were beginning to think about their futures in mathematics education and in what could influence their decision to study mathematics.

## Research Question 2

The second research question asked what is the relationship between a student’s disposition toward mathematics and his or her choosing to continue to study mathematics?

### Curiosity

Curiosity about mathematics is one of the factors of a student’s disposition toward mathematics and could motivate a student to explore a mathematical question beyond just surface knowledge. Rather than simply asking the students if they were curious about mathematics, the researcher asked them if they ever wanted to know more about the discovery or development of a particular concept, rule or formula. Only two of the students could recall that they or anyone in their classes asked such a question. Olivia said, “I usually just say, oh well … sometimes I may look it up on the Internet, but that’s it.” Interestingly, Richard said that there was one girl in his class who tended to ask such questions, but “she’s like, she has a poor attitude towards the teacher, a bit of a trouble maker, she asks a lot of questions to our teacher and everything and the teacher usually has to answer all the questions and she gets pretty annoyed.” By describing this student as a troublemaker, the researcher inferred that Richard did not think it was the students’ place to ask questions beyond those concerned with what the teacher was showing them to do.

## Excitement about Mathematics

Rather than using the terminology “positive disposition” with the students when broaching the question as to how they might decide whether or not to continue studying mathematics, the researcher decided to use a descriptor that might better get at the crux of the issue by asking them whether they were “excited” about mathematics. The students were free to interpret the idea of being excited in a way that made sense to them. During their interviews, the researcher had asked the teachers if they thought their students were excited about math. Most admitted that they did not think their students were excited about mathematics, but Veronica said her students were excited about math when they could see it applied in the real world. Kristi said hers liked the math curriculum used in her school because of the hands-on activities and real-life applications. Marsha thought that her students could be excited about mathematics, but that the reason some kids lose interest or become discouraged in math during and after middle school is because they do not know basic facts from elementary school and then they are expected to apply those basic facts when solving an advanced math problem.

It seems, as far as the teachers were concerned, that the inclusion of real world problems should spark their students' appreciation of mathematics. However, Beverly had a longer perspective on the current rush by textbook publishers to provide problems that apply mathematics concepts to real-world situations. When asked about verbal problems for which students are expected to apply a particular concept, Beverly gave this assessment: "It is … all so wordy … problems with reading levels the way they are right now in our school, it's difficult for the kids to understand what they're asking. They're trying to tie the topics and careers into the math, but they're making it too difficult." The teachers did not seem to perceive that they had any direct influence on whether or not their students were excited about mathematics, but as the students will report, the teachers' influence is more than peripheral.

The students were evenly divided between being excited and not being excited about mathematics, and the levels of excitement varied from lukewarm to impassioned. Roger's interest in mathematics is heightened because he can see how important it will be to his plans of becoming a mechanical engineer. Jodie said she is excited about math whenever it is "fun and easy." Erica said that she is excited about learning new "stuff," but not about how her teacher is teaching this year. Derek said his teacher this year is the reason he has more interest in mathematics. Deidre said that it is "fun learning different ways to do math problems." Leslie loves math and when the researcher asked her if there was anything in particular that her teacher did that made her love math, she said, "Just the way she can explain things and the way she makes it seem so exciting, I mean, all of my teachers never did it like that … she explained math and did it really excitingly, like she'd do it in real like (sic), so …" The researcher responded, "So, if your teacher's excited about it, then that makes…" Leslie completed the thought, "that usually makes us excited about it." At the other extreme, Susan is not excited about math and could not imagine that there would be any teacher who could change her attitude.

The researcher, in trying to determine what role the teacher played in the evolution of the students' level of excitement about mathematics, gave the students four possible classroom influences—the teacher, the textbook, other students in the class, and the topics being studied—from which to choose as the factors that might influence their affective response to mathematics. Six of the students ranked the teacher as being at least 50% important to how they felt about mathematics and five of the students ranked the teacher as 75% important. Three said the teacher was equally important as the textbook and one said that she did not like mathematics and could not see that there had been nor would be a teacher that could influence her opinion one way or the other.

Rebecca, when asked if she could imagine that a teacher could influence her to take more math, said, "Uh-huh, if it was a teacher that I knew I could trust and a teacher that believes in me and wasn't just saying it so I would take it." Harry, as justification for the teacher's being the most important factor in his attitude toward math, said, "The teacher, the way the teacher is, if the teacher's afraid of math, you're going to be, you're not going to know what you're doing, if they're afraid of math and stuff like that you're not going to get anywhere." Several of the students reported that they were concerned about math at the beginning of the school year because of the math instruction they had experienced the previous year, but that their current teacher had helped to alleviate their fears to the point that they sometimes even liked math. About half of the students who were interviewed reported that their attitude toward mathematics had changed from slightly negative to slightly positive during the current school year and all of these students attributed the change to the teacher. Not all of them could pinpoint what teacher characteristic or behavior influenced their attitudes, but Deidre was eager to explain.

Deidre: My teacher last year she'll just explain it once and then she'll go back to her seat and if you ask her for help she'll get mad, she said that when you look, you're supposed to know how to do it when you look at the page."
Researcher: Oh, okay, and your teacher this year, what does she do?
Deidre: She explains how to do it and she'll tell you this way and that way how to do it."
Researcher: Does she ever get impatient?
Deidre: No.
Researcher: Does she ever, does she make everyone feel like they can learn math, do you think?
Deidre: Yes.

Olivia also liked her teacher this year because she explains things "step-by-step." Harry liked fact that his teacher "just drops everything and listens when students are having trouble." He said that last year's teacher did not do this.

All but one of the remaining students said that their attitude about math had remained the same from last year to the current year. Erica said that her attitude had changed from being positive toward mathematics to being more negative. She said that she was excited about math at the beginning of the school year, but that changed after she "got into the class and our schedule, our daily schedule, I didn't like it very much at all. Later in the interview, the researcher asked Erica about what characteristics she would like her math teacher to have:

Erica: I think she should be friendly, she should be ready to learn every day and interact with the kids and teach everything she can and have just a fun feeling about it because you can't just go to class and have someone who's not excited to teach and who doesn't want to, you feel like they don't want to be there and it's hard to teach.
Researcher: And is that what you feel like this year with your teacher?

Erica: Yes

Researcher : Is that every day, if it is just like periodically, you know, everyone has bad days, or is it just, you get the sense that the material doesn't excite your teacher?

Erica: It's almost every day, I think.

The students liked teachers who not only seemed to care about whether they were learning but who also seemed to enjoy what and whom they were teaching.

Feelings of confidence or empowerment

A third factor that the researcher thought would influence students in their attitude toward mathematics was how empowered they felt about their mathematics learning. From the results on the F-S MAS, the mean score on the Confidence in Learning Mathematics Scale, for the 107 students who responded, was 42.1 from a possible of 60. This mean is above the middle score of 30, so it would not be labeled as low, but relative to the means on the other two scales, the Usefulness Scale and the Teacher Scale, this mean is the lowest of the three. To supplement the quantitative results, this researcher asked the students about what happened in their classrooms when a student asked the teacher a question. Did the teacher just answer the question or did s/he try to guide the students to answer the question for themselves? Ten of the students said that their teacher usually helped them to figure out the answers to questions for themselves. Derek said that he thought that his teacher (Beverly) had done that a "couple of times," but as the researcher noted earlier, she observed that Beverly routinely answered questions without giving the students the opportunity to have an active role. How did the students feel about answering their own questions?

Leslie said, "It makes me feel less lazy, like, um, I did it, I should have done it the first time without asking her." Jessica said, "I like to figure it out myself so if I'm like, cause she's not always going to be there like if I need to do something somewhere else, so …sometime it helps to do it yourself so you can remember for the future." Juan thought "it wouldn't be fair" for his teacher to just answer the question. He preferred that the teacher help him figure out the answer. Furthermore, Juan likes to "explain things to other people" because it made him feel good.

Jodie recognized the competing goals of students' being responsible for their learning and the efficient use of time when she said, "I think it's kind of better for us to try to figure it out on our own because then it will help us learn it more, but … it would be a lot easier if we just got the answers (laughed)." George didn't see the higher goal of his becoming self-sufficient when his teacher gave him the 'opportunity' to figure out an answer to a question for himself: "I start guessing until I get it right. It's too hard to figure it out."

Roger said his teacher helped the students by showing them where the textbook had the information they needed to answer the question. He liked the use of the word empowered to describe the benefits of the students' answering their own questions: "Because when she just gives us straight the answer, I don't remember, like know where it came from or so I just take it and go with it, but if I actually find a place where I can actually see it, that it's actually there, that actually helps me."

Rebecca said her teacher asked several students what they thought about the answer to a student's question, wrote down all of the responses, then the students voted on what the right answer might be. If the students chose the wrong answer, then the teacher worked with the students to help them to redirect their reasoning. Susan, who, for the most part, was disinterested in the questions the researcher asked her, was very direct in the reason she preferred that her teacher help her to figure out the answers to her questions: “Because I don’t want to grow up and be dumb because my teacher just told me the answers because I don’t learn anything when she tells me the answers.”

Yang not only liked to feel empowered by answering his own mathematics questions in the classroom, he has gained mathematical empowerment outside of the classroom as well. He reported that one time when he and his mom had been out to dinner, she gave him the money to pay the bill and the restaurant employee had not given him enough change.

Researcher: Have you ever had to correct someone when they’ve give you your change?
Yang: Yeah.
Researcher: And so, did you point it out to them?
Yang: Yes.
Researcher: And how did that work out? Because wasn’t that person an adult?
Yang: Yeah, I showed them the receipt and all that and they said, ‘I’m, sorry,” and gave me my change back.
Researcher: So how did you feel about that?
Yang: It felt good, actually good.

## Research Question 3

The third research question asked what influences middle school students’ desire to continue studying mathematics?

### Usefulness of Mathematics

One of the indicators of a positive disposition toward mathematics is appreciating the application of mathematical concepts to situations outside of the classroom and one might conjecture that if students view mathematics as being useful or relevant in their lives this belief would influence them to continue studying mathematics. With regard to the usefulness scale on the F-S MAS, of the fifteen students whom the researcher interviewed, eleven scored highest on the usefulness scale when compared to their scores on the other two scales. The researcher was interested in whether teachers were responsible for inculcating a belief in the usefulness of mathematics in these students.

The researcher asked the fifteen students whether their teachers reinforced the importance or usefulness of mathematics during their classroom interactions. All of them reported that their teacher told them how useful mathematics is. Derek said, “Yeah, she always talks about it, how people have, just do math problems all day for jobs and stuff like that.” Rebecca said that her class was working in fractions, how to simplify them, and how to do arithmetic operations with them.

Researcher: “And do you think it’s important to know about fractions?”
Rebecca: “Uh-huh.”
Researcher: “Why?”
Rebecca: “Because you have to use them in the future.”
Researcher: “Can you think of an example when you might have to use fractions?”
Rebecca: “Um … no.”

Rebecca said later in the interview that her teacher had told the students that one cannot go through life without math. Susan said that her teacher had told the students that math is important for them to know, but that she had not given them any examples showing how it could be used. Initially, Erica said that she didn’t “really know how I’m supposed to use the stuff (math) outside (of school),” but later in the interview did recall that during the previous school year she had studied how to calculate tax and that she had been able to figure out the tax when she had been shopping with her family. Three of the students reported that their teachers had tried to indicate what jobs required math skills. Harry said that his teacher, “Lectures us all the time about how you can’t go through life without using math, you can’t do anything, you can’t become anything without math,

math or geography, he always says, are the two things you can never get by in your whole life."

It would seem that the teachers believed that it is important for their students to view mathematics as being useful and relevant and their students mechanically repeated that mathematics is useful and relevant outside of the mathematics classroom. However, the researcher did not find that the students themselves had been provided any opportunities to experience mathematics as being a coherent whole within which concepts build upon and interconnect with each other. Nor did it appear that the students had been afforded the opportunity apply mathematics in contexts outside of mathematics. In fact, Richard, who cited science as his favorite subject, said that science and math "have nothing in common." The idea of mathematics concepts' contributing to a strong structure upon which other mathematics concepts can be built, as well as connecting with other disciplines, is one of the teaching standards championed by the NCTM (2000). To his credit, Richard did concede later in the interview that the measurements he did in his science class, as well as the use of formulas for density, mass, and volume, were occasions during which mathematics connected to science.

## Participating in Mathematics Outside of the Classroom

The researcher also asked the students if they had participated or if they would be interested in participating in a summer mathematics program. Several of the students said that such a program would be an infringement on their summer vacation so they would not be interested. Only Deidre had participated in a summer math camp and she said, "Like whatever problems you had they would take you into a different room and they would let you go over it." She worked on fractions and long division to prepare her for the upcoming school year. The majority of the students who expressed an interest in a summer math camp also saw it as an opportunity for them to work on weak areas or have a preview of what they would be learning during the next school year. A couple of students saw summer programs as opportunities to “do something maybe a little bit fun and different from regular class” (Leslie and Roger) or to learn something completely new like computer programming or computer graphics (Derek).

## Career Plans?

The researcher was interested in whether these young students had given any serious thought to what career they might have. Richard was the only one of the fifteen who had no answer for this question. As for the remaining fourteen, after each student told the researcher what job s/he might have, she then asked each student whether s/he thought that knowing mathematics would be a requirement for the job. In each case, the researcher will give the chosen profession and what the student responded when asked if s/he thought mathematics would be useful in that profession.

Erica wanted to be an interior designer. “ Like space, like the length of things for like curtains and any furniture and stuff in the space that I’m working on.” Erica’s math class had just finished the unit on perimeter and area and she said that one of the projects associated with the unit was designing a house, so she felt very positive about the relevance of mathematics for her career.

Susan, Jodie, and Leslie wanted to be veterinarians and Yang wanted to be an ichthyologist. All of them said that they would need math for these careers that relate to animals, but none of them could give any specific applications of mathematics.

Rebecca wanted to be a secretary in a hospital like her grandmother. Although she had never been at work with her grandmother and thus did not know exactly what her grandmother did in performing her job, Rebecca was pretty sure she would not need any math.

Derek wanted to be a computer programmer or an architect; Harry wanted to study diesel mechanics toward the time when he will take over his grandfather's farm and ranch; and Roger wanted to be a mechanical engineer. All three young men knew that mathematics concepts would play a significant role in each of these technical careers so while they may not have been "excited" about mathematics, they were committed to trying to learn whatever their teachers were trying to teach them.

Olivia, who wanted to be an actress, and Jessica and George, who wanted to be writers, plan to take only enough math to satisfy high school graduation requirements. However, Jessica said that her writing would include writing songs and that she would use math in counting measures and time signatures.

Juan, who wants to be a football player, was not sure if he would need any mathematical knowledge for his career. He thought maybe he would need to know math "like, two to the third power," but did not have an explanation for his hypothesis.

Deidre wanted to go into real estate and was sure she would need to know mathematics for the "financial stuff."

All but two of the students thought they should take more math or as much as they could for vague reasons such as "I need it for my job" or "to help me later in life." Few of them were at the point in their education that they could point to specific instances when they knew mathematics would be necessary.

*Statistical Observations*

Throughout the observation and interview phases of data collection, the researcher was curious as to whether there was a statistical relationship between a teacher's mathematics teaching self-efficacy beliefs and his or students' attitudes toward mathematics. She intuitively felt that there was none. The following table shows each teacher's MTEBI score and the mean of his or her students' scores on the F-S MAS.

Individual teacher scores on the MTEBI and individual student scale scores on the F-S MAS are found in Appendices H and I.

TABLE IX
MTEBI Scores and F-S MAS Mean Scores

| Teacher | MTEBI Score | F-S MAS Mean |
|---|---|---|
| Daphne | 75 | 141 |
| Jack | 78 | 142 |
| Beverly | 86 | 146 |
| Marsha | 78 | 138 |
| Jean | 73 | 129 |
| Kristi | 93 | 139 |
| Veronica | 80 | 116 |
| John | 93 | 128 |

The researcher used SPSS 11.0 (2002) to calculate the Pearson correlation coefficient between the MTEBI scores and the F-S MAS mean scores and found that the coefficient was 0.0392, which is not statistically significant. Therefore, there does not appear to be a statistical relationship between a teacher's mathematics teaching self-efficacy beliefs and the attitude toward mathematics of his or her students.

However, the researcher still felt that the teacher did exert some influence on the affective responses of his or her students toward mathematics. Recall that the students responded to items on three of the nine Fennema-Sherman Mathematics Attitude Scales—the teacher scale, the confidence scale, and the usefulness scale. The researcher again used SPSS 11.0 (2002) to calculate the Pearson correlation coefficient between each pairing of the three scales. The following table shows the results of the calculations.

TABLE X
Pearson Correlation Coefficients for
Fennema-Sherman Scale Pairs

| Number of Students | Scale Pairs | Pearson r |
|---|---|---|
| 107 | Teacher/Confidence | .596** |
| 107 | Teacher/Usefulness | .533** |
| 107 | Confidence/Usefulness | .454** |

**Correlation is significant at the 0.01 level

The significance of the correlation values indicates that there is a relationship between a student's attitude toward his or her teacher and his or her confidence about learning mathematics. Additionally, there is a relationship between a student's attitude toward his or her teacher and his or her perception of the usefulness of mathematics. Note that the correlation between the teacher scale and the usefulness scale is higher than the correlation between the confidence scale and the usefulness scale. Therefore, it seems that there is a stronger relationship between a student's attitude toward his or her teacher and how useful s/he views mathematics than that between a student's confidence in learning mathematics and how useful s/he views mathematics.

## Conclusion

This research project explored the broad relationship between middle school teachers' mathematics teaching self-efficacy beliefs and the attitudes toward mathematics of their students. Of particular interest was why the students felt as they did about mathematics and what factors would motivate the students to take more mathematics throughout high school and college. Quantitative data in the form of responses to a mathematics teaching efficacy beliefs instrument (MTEBI) were collected in order to determine where teachers placed themselves along a continuum of having low mathematics teaching efficacy beliefs to having higher mathematics teaching efficacy beliefs. Other quantitative data was in the form of student responses to a mathematics attitudes instrument (F-S MAS). Qualitative data in the form of written responses to questions, as well as results from semi-structured interviews, were collected from both teachers and students. Finally, the researcher had the privilege of being in the classrooms of the eight teachers in the study and was able to observe the dynamics of the interactions between teacher and students.

While there was some variability in scores on the MTEBI among the initial sample of 23 teachers, the scores among the thirteen teachers who agreed to participate in the study were homogeneous. Eight teachers, four who scored relatively low on the MTEBI and four who scored relatively high on the MTEBI were selected to participate in the full study. Fifteen students, two from each of seven teachers and one from the eighth, were selected from the 107 students whose parents granted permission for their participation. Except for the single student from the eighth teacher (this was the only student whose parent granted permission), the researcher selected students based upon their scores on the F-S MAS, half scoring relatively low and half scoring relatively high.

All of the teachers felt that they knew the mathematics they were required to teach well enough to be competent, although two of them were unsure of the best methods to use. The teachers felt it was their responsibility to present the material to the students in a logical and sequential outline. The students were supposed to follow along, pay attention, ask questions and apply concepts as they worked problems on homework, quizzes and tests. However, the teachers felt that whether the students did or did not perform well should not be a direct reflection on a particular teacher's teaching competence. The students must want to learn; the teacher cannot "make" the students want to learn.

All of the teachers use the state mandated learning objectives to guide their curriculum choices. The students are apprised of these objectives to varying degrees from school to school. More than one teacher used the phrase “step by step” to describe how s/he explained concepts. Other teachers emphasized that students must learn the facts, rules, and procedures that would help them to work the problems. Two of the teachers used an inquiry-based curriculum and focused more on exploration of open-ended questions, application of strategies, and problem-solving. All teachers assessed student learning through testing. Some looked for student behaviors such as paying attention, asking questions, and explaining strategies. A few of the teachers felt that the current expectations for middle school students were unreasonable and unrealistic, given the diversity among the middle school population with regard to background, reading levels, socio-economic and family structure issues, and parental/family support. Additionally, one teacher said that not only had the number of topics or concepts that she was expected to address increased over what it was fifteen years ago, but younger middle school students were expected to learn concepts that were not covered until high school. The teachers generally thought their students were not excited about mathematics and did not think there was anything that they could do to directly affect their students’ attitudes. None of the teachers felt that their teacher education programs had adequately prepared them for teaching at the middle school level. One teacher pointed out that at a recent conference, there was a significant number of resources for elementary teachers, but very few resources available for middle level teachers.

The students in this study accepted the fact that mathematics is something that they must take in school, although some said that it would have no relevance in their adult lives. When describing how their teachers teach mathematics, the students used terms like “explains step by step,” “shows us how to do the problems,” and “can explain it in different ways.” Most of the students told the researcher that their teachers had told them that mathematics would be important to them in “real life,” but they could not cite a specific example beyond simple calculations and sales tax. Students also felt that it was important for them to take as much math as they could, but again they could not give a firm reason why. Several students’ attitudes toward learning mathematics changed for the positive because of how they felt about the teacher in whose class they were at the time of this study. In some cases, the students remarked that if they understood the concepts then they liked mathematics. Only two students reported that they liked learning mathematics for its own sake.

Being in the classroom afforded the researcher the opportunity to observe the day-to-day rhythm of mathematics learning as experienced by the teachers and students. Most of the eight teachers taught by following the traditional template of going over the previous day’s homework, presenting examples for the new lesson, assigning problems, and giving students time in class to work on the assignment. The students were placed in the position of being passive recipients of knowledge and it was clear that was the role to which they were accustomed. Teachers would ask questions that were supposed to monitor understanding but which actually required that the students merely repeat what the teacher had said or mimic the behavior the teachers had been modeling.

In Chapter 5, the researcher will discuss the results of this study and interpret those results with regard to the guiding research questions. She will also examine the results against the backdrop of mathematics education and teacher education and suggest what implications the results have for these areas. Limitations of this study and spin-off questions will lead to a discussion of future research options.

# CHAPTER V

## Summary, Discussion, Implications, Recommendations, Conclusion

### Introduction

The purpose of this study was to examine the mathematics teaching efficacy beliefs of eight middle school mathematics teachers and their students' attitudes toward mathematics. The research questions that guided this study were:

1) What is the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics?
2) What is the relationship between a student's disposition toward mathematics and his or her choosing to continue to study mathematics?
3) What influences middle school students' desire to continue studying mathematics?

The researcher will address each question as indicated by analysis and interpretation of the collected data. Additionally, she will discuss what implications for mathematics education and teacher preparation are suggested by the results of this study, as well as offer ideas for future research in this area.

The researcher would like to begin this chapter with some cogent statements from some teacher-student teaching pairs from this study:

T1) "Sometimes they (students) don't even associate math with geography. I mean … what's the distance between point A and point B and you're using a scale … one inch equals 200 miles … you're still doing mathematics."

S1) "We do that (use manipulatives) every once in a while if we're stumped, but we don't … basically what we do is work and get our stuff done and learn, we don't play very often."

T2) "I make them learn the rules. I give them quiz after quiz on the rules. Of course, I'm a rules person so that's how I teach."

S2) " I just, I don't think … I think if I asked (where particular rules come from) I don't know if she'll have the answer for it because they made them up like a long time ago …"

T3) "I'm not as confident in the teaching methods in math because I didn't do a lot of that along the way. But as far as the knowledge of math, I feel just as confident if not more than I do in some of the other areas."

S3) "I keep on asking people, like, do you use pre-algebra or algebra in your job or work, no one can come up with that answer unless they're teachers …It (doing math) makes people who do lots of math and stuff like that, it's kind of a black and white personality, you know, things in black and white."

T4) "I think that they've (students) got to look up to somebody in the class and that's the teacher … and if the teacher is not presenting the material in the manner they're comprehending it, then I would say, yeah, that the students' learning is a measure of how effective their teacher is."

S4) "She (my mom) was dividing … adding … I don't know, it was kind of cool seeing how she did it really fast. She said that she learned how to do it in school because she paid attention every day."

Each of the above teacher quotes characterizes his or her sense of mathematics teacher self-efficacy and each student quote characterizes his or her attitude about mathematics. One teacher feels responsible for helping his students see how mathematics impacts other content areas and situations outside of the classroom while his student sees using concrete models, such as maps, in math class as "playing," not real work. A second teacher impresses upon her students that mathematics is a logical system, complete with vocabulary and rules that dictate all processes while her student doesn't really think anyone knows from whom the rules came—they have just been handed down from teacher to student. A third teacher relies on her mathematics content knowledge and her teaching experience in other content areas to bolster teaching efficacy during her first year to teach mathematics while her student sees mathematics as being useful only to teachers and prolonged use of mathematics as stifling the development of a well-rounded personality! Finally, the fourth teacher is new to teaching, having come from industry into the classroom, and he is sure that he is responsible for most of his students' mathematics learning while his student thinks that if she pays attention to her teacher everyday, she will be able to do math "really fast" like her mom.

## Research Question 1

A teacher's mathematics teaching self-efficacy beliefs influence his or her classroom practice, enthusiasm about teaching, and level of engagement with students ((Tschannen-Moran & Hoy, 2001; Ashton & Webb, 1986). Thorndike-Christ (1991) found that a student's attitude toward mathematics was a good predictor of his or her final course grade and whether or not the student would enroll in mathematics courses beyond those that were required. The middle grades student is beginning to develop strong attitudes toward mathematics and it is during the middle grades that teachers have the opportunity to influence how their students view mathematics' potential relevance for their futures (Picker & Berry, 2001). While mathematics self-efficacy beliefs have been linked to student achievement and confidence about learning mathematics (Tschannen-Moran & Hoy, 2001), this research question asked whether there was a relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' attitudes toward mathematics.

Since the simple correlation between the teachers' MTEBI scores and the means of their students' F-S MAS scores was 0.0392 (from Table VII in chapter 4, p. 129), there was no statistical relationship between the MTEBI and the F-S MAS. Therefore, the surface answer to the first research question is no, there does not appear to be a relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' attitudes toward mathematics. However, that is not to say that the teacher does not exert any influence on the students' attitudes. Six of the students ranked the teacher as being at least 50% important to how they felt about mathematics and five of the students ranked the teacher as 75% important. The students were not concerned with whether their teachers could answer all of their questions; rather they used phrases like "she explains how to do it and she'll tell you this way and that way how to do it;" "he can explain things well and he worries about whether everybody understands;" "he tries to make us understand it and if we don't he'll stop everything and just go to each of us." When the students were given the prompt to "design the perfect math teacher," they asked for teachers who were fun, nice, patient, explained what was supposed to be done step-by-step, and didn't give a lot of homework. Thus, although the NCTM (2000) recommends that teachers do less telling and explaining and do more guiding and facilitating, the students in this study value a teacher who can tell them what they need to know and who doesn't become frustrated if the students need multiple explanations.

The teachers who had the higher scores on the MTEBI tended to be teachers who had been teaching more than five years and tended to do more teaching by telling, maintaining more of a center stage presence in the classroom. On the other hand, the two teachers who were teaching math for the first time and had relatively lower mathematics teaching self-efficacy beliefs were willing to give the students more responsibility in classroom learning. This is in contrast to Ashton's and Webb's (1986) findings that it was the teachers with lower teaching self-efficacy beliefs who saw their role as one of imparting information, facts, and rules. This researcher hypothesizes that this contrast might be explained by the fact that the teachers with the higher sense of mathematics teaching self-efficacy feel that their methods work for them and, thus, are less inclined to look for a change. The teachers who are new to teaching mathematics do not yet feel that they have a tried and true teaching presence and are more flexible with regard to how their students participate in the classroom, recognizing the value of more active participation on the part of the students. However, despite their intuition regarding the long-range benefits of allowing their students to work with concepts in a more informal and less structured setting, these new teachers already are conscious of the extra time this classroom strategy involves. Both mentioned to the researcher that they are reluctant to consistently use the extra time required by activities such as non-routine problem-solving, student demonstration, and allowing students to answer each others questions in small group interaction, in the face of state mandated objectives and standardized testing.

The researcher did find one very important result that was consistent with Ashton's and Webb's (1986) research. They showed that teachers who had a high sense of teaching self-efficacy tended to make the student the center of attention, were engaged with their students, and expected them to behave and stay on task. Additionally, although these teachers gave their students assignments to work on in class, they remained actively involved with students by monitoring individual student progress and offering encouragement. All eight teachers who participated in this study were actively engaged with their students. None of the teachers sat at their desks while students were in the classroom. Even the teachers who relied on working examples while students took notes were constantly watching their students for reactions and prompting them to answer questions, albeit ones that primarily required that the students simply repeat what the teacher had said or give answers to the examples that were being worked. After assigning the day's homework, the teachers were constantly circulating among their students and monitoring their work, seeing if they needed assistance and encouraging those students who were remaining on task.

While examining the teachers' mathematics teaching self-efficacy beliefs was the initial point of this study, the ultimate goal was to learn about the students' attitudes toward mathematics. The answer to the first research question is that statistically there is no quantifiable relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' attitudes toward mathematics, but the qualitative data did show that the teacher exerts a powerful influence on his or her students' attitudes toward mathematics. Although the students whom this researcher interviewed had opinions regarding whether their teachers were comfortable with or competent at teaching mathematics, neither of these variables seemed to influence their feelings about learning mathematics. Of most importance to the students was how their teacher interacted with them as they were learning. To let the students speak for themselves, the researcher would like to finish the discussion about the first researcher question with this excerpt from her exchange with Roger:

Researcher: "Suppose you had a teacher who didn't make you feel like you could ask questions, didn't really seem to care whether you could discover things for yourself or figure things out, would that affect how you feel about math? Would that change your attitude at all, would that change your confidence at all?"

Roger: "Yeah, actually it would probably change my attitude, because I like to be, like free to ask questions and the teacher actually help me answering these questions, but if the teacher is just telling you what to do and just do it without even being able to ask her I think would make me kind of discouraged."

## Research Question 2

According to the National Council of Teachers of Mathematics (1989), a student's disposition toward mathematics includes the factors (1) interest and curiosity, (2) perseverance, (3) confidence, (4) flexibility, and (5) valuing the application of mathematics. During this study, the researcher was primarily interested in factors (1), (3), and (5) and how they might influence a student's tendency to study mathematics.

When the researcher asked the middle school students in this study if they could see themselves taking more mathematics beyond what was required for graduation, most said that if they needed it for a job or if they needed it when they were an adult, or if they thought it would be easy, then they would take more math. As mentioned in chapter 4, the students have no driving curiosity about mathematics and do not see themselves studying any subject just for curiosity's sake. The students' perception of mathematics' relevance or usefulness, in addition to how well they think they might perform in future mathematics classes (confidence), are the two dominant disposition factors that influence their desire or lack of desire to continue studying mathematics.

Also, as can be seen from Table VI in chapter 4, p. 103, the students' mean score for the confidence scale on the F-S MAS was not statistically low, but was lowest relative to the means on the other two scales. The students' frames of reference that bound their feelings of confidence about learning mathematics were restricted to the recent past and the present. When this researcher asked them to think about their past experiences with learning math, only two of them recalled any memories from a time prior to the grade of the previous year. For these middle school students, their school experiences have had almost a transitory effect on their perceptions. They live very much in the current moment. Regarding the students' past experiences with learning math, this researcher was not interested in their performance as measured by grades, per se, rather, she was interested in the students' affective responses to mathematics learning. When the students spoke of their previous mathematics learning, all of them tied the experience to the teacher's behavior. If the teacher was "nice," "explained things well," or "did fun activities," then the students felt good about learning math. This is consistent with the results from Table VIII in chapter 4, p. 130, that showed a strong relationship between a student's attitude toward the teacher and his or her confidence in learning mathematics.

Realizing how important the teacher was to the students' levels of confidence, the researcher wanted to find out if it was only the teacher's behavior that affected feelings of confidence. The researcher asked the students how their teachers responded when asked a question in class. The majority of the students said that the teacher often guided them so that they could answer the questions themselves. All but one of the students said that they liked to try to answer their own mathematics questions and their success at answering their own questions bolstered their confidence.

## Research Question 3

The long-term interest in this study is whether these middle school students would continue to study mathematics beyond high school requirements. Since middle school students have no practical choice about whether they take more mathematics in school, from their perspective, their desire or lack of desire to continue studying formal mathematics is a moot point. In order to get to the idea of taking mathematics when one is not required to do so, the researcher asked the students two questions. The first question asked all of the students if they had ever participated or would consider participating in a summer mathematics program. As was seen in chapter four, most of the students saw that a summer mathematics camp would be an opportunity to work on weak areas or to work on material that would prepare them for what they would be learning during the upcoming school year. Only one student wished for a camp that would teach him something new just for the fun of learning. Again, the sense that a summer math camp would be of practical use drives any desire to participate.

The researcher has included Table X from chapter 4 to remind the reader of the particular F-S MAS subscales that she used in this study. Also, the reader should remember that this researcher feels that confidence in learning mathematics and the perceived usefulness of mathematics are the primary motivators for the middle school student to take a math class.

TABLE X (from Chapter IV)

| Number of Students | Scale Pairs | Pearson r |
|---|---|---|
| 107 | Teacher/Confidence | .596** |
| 107 | Teacher/Usefulness | .533** |
| 107 | Confidence/Usefulness | .454** |

**Correlation is significant at the 0.01 level

The significance of the correlation values indicates that there is a relationship between a student's attitude toward his or her teacher and his or her confidence about learning mathematics. Additionally, there is a relationship between a student's attitude toward his or her teacher and his or her perception of the usefulness of mathematics. Note that the correlation between the teacher scale and the usefulness scale is higher than the correlation between the confidence scale and the usefulness scale. Therefore, it seems that there is a stronger relationship between a student's attitude toward his or her teacher and how useful s/he views mathematics than that between a student's confidence in learning mathematics and how useful s/he views mathematics. This researcher concludes that the teacher, whether s/he realizes it, has the potential to influence a student's decision to study mathematics. The researcher would like to let a student speak for herself regarding this influence.

Researcher: "Do you think a teacher could influence you as to whether you wanted to take more math?"

Rebecca: "Uh-huh, if it was a teacher that I knew I could trust and a teacher that believes in me and wasn't just saying it so I would take it."

## Implications for Mathematics Education

The students' attitudes toward mathematics ranged from slightly negative to extremely positive (scores ranging from 86 to 180, out of a possible range of 36 to 180). When given the four choices of teacher, book, curriculum, and classmates as possible influencers on their attitudes, the majority of the fifteen students said that the most influential of the four choices was the teacher. On the other hand, the teachers themselves seemed unaware of their influence. They acknowledged that they shared some degree of responsibility with the students regarding the students' mathematics achievement, but for the most part, they did not feel that their students were excited about mathematics and if they were it would be in response to a particular concept, activity, or project. However, the researcher and the reader must not overlook what Leslie said about her teacher:

Researcher: "OK, so if your teacher is excited about it (math), then that makes …"

Leslie: "That usually makes us excited about it."

Research is not undertaken for its own sake. The results of any education research must serve to inform all interested parties, heighten awareness of positive educational practices, and act as a catalyst for reexamining poor practice. This reexamination should preclude effecting changes that lead to better educational experiences for future students. When the teachers consented to be a part of this study, the researcher gave them the option of receiving a summary of the findings. All of the teachers requested a summary.

The researcher will include the above quote in her summary as well as other confirmations of how important they are to their students. If the opportunity to have access to their students' perceptions serves to pique the teachers' complacency about the importance of their roll in their students' mathematics education experience, then the goal of informing the community has been met.

## Implications for Teacher Preparation and Teacher Retention

In 2001, the Conference Board of the Mathematical Sciences (CBMS) recommended that teacher preparation programs provide a program of at least 21 semester-hours of mathematics designed specifically for teachers of middle grade students (grades 5-8). This coursework should first strengthen and broaden the teacher candidates' own mathematical knowledge so that they will have an understanding of the connections between elementary and middle grade mathematics as well as between middle grades and secondary mathematics. Secondly, this coursework should facilitate the development of a deep understanding of the mathematics the prospective middle grades teachers will be teaching as well as an understanding of the types of reasoning middle grade students are capable of undertaking. Therefore, interwoven within all coursework should be abundant opportunities for teacher candidates to observe middle grades teachers and students as well as opportunities to tutor groups of middle grade students.

In their publication, *Principles and Standards for School Mathematics*, the National Council of Teachers of Mathematics (NCTM) recommended that middle grades mathematics teachers create a safe environment in which learning communities can develop and flourish and in which all students feel comfortable to take risks when engaging with peers (NCTM, 2000). Teachers should provide, through challenging problems and tasks, the opportunity for students to deepen their understanding of rational number relationships, even as the focus shifts to the development of algebraic reasoning and the discovery of geometric relationships. All mathematics content taught in the middle grades should be integrated within the mathematics curriculum and with content areas outside of the mathematics classroom. The NCTM (2000) states, “Instruction that segregates the content of algebra or geometry from that of other areas is educationally unwise and mathematically counterproductive” (p. 213). In the *Professional Standards for Teaching Mathematics* (NCTM, 1991), teachers are encouraged to

- help students work together to make sense of mathematics
- help students rely on themselves to determine if something is mathematically correct rather than looking to the teacher as the sole authority
- help students reason mathematically
- help students conjecture and use inventive thinking to solve problems
- help students see the interrelatedness of mathematical ideas and applications

Furthermore, the NCTM recommends that teachers assess their students’ mathematics understanding through a variety of methods such as evaluating written responses, oral discussions, and problem-solving, with an attention to communication, reasoning, and application of concepts. These assessment tools should work in tandem with in-class written and standardized tests. All assessment tools should be consistent with instruction and with the developmental level of the students.

Many states have implemented credential requirements for middle grade teachers, such as those suggested by the CBMS (2001). Similarly, state and national policy makers point to the NCTM recommendations as being sound pedagogy and they call for their implementation in the mathematics classroom. Despite these mandates, however, few university colleges of education have moved to implement specialized programs for middle school teachers, as the teachers in this study confirmed by reporting that their teacher preparation programs included no components specific to middle school mathematics. Similarly, the teachers reported no familiarity with either of the aforementioned NCTM publications or the specific recommendations. All eight teachers, those who were secondary certified as well as those who were elementary certified, regretted their lack of preparation for the middle-grades student, and they suggested that such preparation would have bolstered their confidence and self-efficacy beliefs.

Ashton and Webb (1986) reported on the influence of teaching self-efficacy beliefs on classroom practice by pointing out that teachers with higher teaching self-efficacy beliefs often redirected student questions back to the student by asking, “What do you think?” or “Try it and find out” (p. 137), which is consistent with the recommendations of the NCTM. This placing of responsibility for active learning on the student was a marked difference between the pedagogies of the teachers with a high sense of teaching self-efficacy and the teachers with a low sense of teaching self-efficacy. According to Ashton and Webb, those teachers with low teaching self-efficacy saw their role as one of imparting facts and answers, remaining the sole authority in the classroom; although this was contradicted by the results in this study, as mentioned earlier in this chapter.

These results should alert college and university teacher preparation faculty to the needs of the middle school mathematics teacher. Through partnership with in-service middle school teachers, those responsible for designing teacher preparation programs should use the CBMS’s and NCTM’s recommendations as the foundation upon which to build a program to meet these needs. The results from this study should also alert middle school administrators to the needs of their in-service teachers. As a first step toward fostering the development of in-service teachers' pedagogical content knowledge, these administrators should provide their teachers with incentives to join the NCTM and provide financial support toward the purchase of copies of the *Principles and Standards for School Mathematics* and the *Professional Standards for Teaching Mathematics* for each teacher.

While having resources available that recommend, encourage, suggest, and outline best practice, teachers, just as with their students, learn best by being actively involved in their learning. The Southwest Education Development Laboratory website (SEDL, 2005) reviews the objectives of the lesson study process, as outlined by Lewis (2002). Through lesson study teachers are able to

- think carefully about the goals of particular lesson, unit, and subject area.
- study and improve the best available lessons.
- deepen their content knowledge.
- think carefully about long-term goals for students.
- work collaboratively to plan lessons.
- examine student learning and behavior.
- develop powerful instructional knowledge.
- see their own teaching through the eyes of students and colleagues.

Content and instruction are the foci of the lesson study process, not the instructor. The instructor is part of a team of teachers who collaborate to examine content, select or develop lessons and thereby strengthen their own mathematical knowledge, adopt effective strategies and consciously reflect on their classroom practice. Observers watch as the lesson is demonstrated in the classroom and give feedback to the team that developed the lesson. Individual reflection, group discussion and evaluation are the final stages of the lesson study.

The researcher had the opportunity to visit with a friend who had participated in a lesson study, and watched a video of the lesson that she demonstrated, and watched a portion of her reflection on the experience. The teacher felt that the lesson study process was a valuable learning experience, and she was excited about how her students would benefit from what she had learned. This reaction, coupled with remarks by Marsha, which the researcher will share later in the chapter, spurs the researcher to suggest that administrators would do well by their in-service middle school mathematics teachers if they would pave the way for them to become involved in the lesson study process.

## Suggestions for Future Research

Throughout the data collection and analysis phases of this research study, some areas in which further research would be helpful occurred to the researcher.

- Daphne's and Jack's situation of teaching mathematics in single-sex classrooms prompted the researcher to see what results have been found in studies that examined mathematics instruction in single-sex classrooms. In a study conducted in an urban middle school with a high minority enrollment, Baker (2002) found that girls were the benefactors of single-sex classroom instruction, showing more positive attitudes, better self-concepts and feelings of empowerment, but no higher achievement levels. Conversely, the single-sex classroom environment had a negative effect on boys' self-concepts, feelings of empowerment, and self-perceived intelligence. On the other hand, Davis (2004) reported on a study by Davis, Choi, Ronau, and Munoz that both girls and boys experienced achievement gains in all content areas as a result of their being in single-sex classrooms. Streitmatter (1997) found that the single-sex classroom became an environment in which the middle-school-age girls were more comfortable with risk-taking behaviors such as asking and answering questions, but she did not conduct a comparable study with boys. Recall that in this study, Olivia felt that “the boys are always rowdy and they like to talk and everything and we can’t get concentrated when they’re in there,” so she found being in the mathematics classroom without the boys was more conducive to learning. However, Harry felt that the advantage of being in the mathematics classroom without the girls was merely one of there being fewer students who were vying for the teacher’s attention. This researcher was not in Daphne’s and Jack’s classrooms long enough to see either how mathematics achievement levels differed between boys and girls or how mathematics achievement for the current year compared to that of the previous year, during which boys and girls were in math class together. Given the conflicting research results and the curiosity born out of the current study, the researcher would like to explore the notion of single-sex mathematics classrooms for both rural and urban settings.

- John’s situation of being not only a first year teacher, but also one who came from industry through the alternative certification program, was intriguing to the researcher. He expressed a desire to allow his students to learn in the same way as he did when he worked at his previous job. He wanted to give his students a problem to solve, put them in groups, provide opportunities for them to do research, facilitate their brainstorming, nurture their creativity, and allow them to test their ideas, all the while keeping the state-mandated learning objectives at the forefront. However, being a first year teacher and knowing that to some degree the evaluation of his performance as a teacher would be dependent on his students’ performance on one or more standardized tests, he was reluctant to veer too far from the structured classroom practice modeled by his mentor teacher and others. The researcher would like to work with John and monitor his teaching over the next few years.. During the first year, she would provide him with access to materials such as the *Principles and Standards for School Mathematics* (2000) and the *Professional Standards for Teaching School Mathematics* (1991) from the NCTM. She would also encourage him to teach one unit each semester from a problem-solving approach rather than the traditional teaching-by-telling format. Over the next few years, as he settled into the role of teacher, felt more comfortable about defining a classroom practice that was more student-centered than teacher-centered, and allowed his students to be active learners, he and his students would be the subjects of a descriptive case study. The purpose of such a study would be two-fold, depending upon the perspective of the interested party. From an administrator's or politician's point of view, one would be interested in whether students who have experienced mathematics in a student-centered classroom environment perform at a higher level on an appropriate criterion-referenced test when compared to their peers who experience mathematics in the traditional teacher-centered classroom. Of additional interest would be whether the former students show greater increase in their knowledge base from the beginning of the school year to the end when compared to the latter group. Results from pre- and post-testing tracked over the duration of the study would provide quantitative data, analysis of which would answer both questions. Of more interest from this researcher's point of view is whether the students who have experienced mathematics in a student-centered classroom have a more positive affective response to mathematics when compared to that of their peers who have experienced mathematics in the teacher-centered classroom. Toward answering this question, this researcher would probably use the Attitudes Toward Mathematics Inventory (ATMI) that has been developed by Tapia and Marsh (2004) for reasons as outlined below. Additionally, the researcher would be interested in conducting interviews with the students, both at the beginning and end of the school year in order to discover any trends or changes in attitudes.

- In this study, the researcher captured the students' attitudes toward mathematics during the brief time she was with them. Of more interest for the future of mathematics education is how these attitudes evolve from elementary school to high school and what factors influenced these attitudes throughout their evolution. Therefore, the researcher would like to identify a small group of elementary students and work with them as they progress through K-12 mathematics education, using both quantitative and qualitative data collection instruments within the case study design. The purpose of such a long-term descriptive study, according to Merriam (1998), is to "chronicle a sequence of events (or developments)" and as such, the study is not "guided by a desire to formulate general hypotheses" (p. 38). The researcher, in conducting such a case study with a sample of students, would focus on what factors during each child's mathematics education disposed a particular child to value and enjoy mathematics and therefore want to continue to study and what factors disposed a child to want to terminate the study of mathematics when minimum requirements have been met.
- Since she administered the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS) for this study, the researcher has found that Tapia and Marsh (2004) have

developed a new instrument to measure students' attitudes toward mathematics, the Attitudes Toward Mathematics Inventory (ATMI). The instrument measures four factors: self-confidence, value of mathematics, enjoyment of mathematics, and motivation. In a study with 545 eighth through twelfth graders, Tapia and Marsh found that the Chronbach's reliability coefficient was .96, which was consistent with that of the F-S MAS. This newer instrument was designed to require a shorter response time than the complete F-S MAS (the ATMI contains 49 items as opposed to the 108 items on the F-S MAS). This researcher experienced two drawbacks with the F-S MAS: students' difficulty understanding some items and the length of time required to complete it. This, coupled with the fact that the ATMI has not been administered to younger students, piques the researcher's interest in using the ATMI with $6^{th}$, $7^{th}$, and $8^{th}$ grade students to see how reliable it is in gauging their attitudes toward mathematics. Ideally, she would like to go back to the same students who participated in this study and administer the ATMI to them. She would also ask the students which of the two instruments they preferred and why. The F-S MAS was a valid indicator of attitude toward mathematics as supported by interview data. If analysis of the results of the ATMI data also show that it is a valid indicator of student attitudes and if the students reported a preference for the shorter ATMI, then it would seem that the ATMI is suitable to use with these younger students.

- This researcher would like to explore the potential effect of curriculum on student attitudes toward mathematics. She would like to work with large samples of teachers and students in whose classrooms a traditional mathematics curriculum is being implemented and teachers and students in whose classrooms the curriculum reflects at least some of the strategies suggested by the advocates of mathematics education reform. Noting that Kristi and Jean were both implementing the inquiry-based curriculum, but that there were inconsistencies between the two, the researcher would also examine the issues surrounding consistent implementation of reform pedagogy.

## The Relationship between the Researcher and the Researched

### Unexpected Results

One purpose of research activity is to gain an understanding of the unknown or enhance understanding of the familiar. When this researcher went into the middle school classrooms, she entered as an outsider, an observer, an interested, but disengaged, party. The administrators who gave her permission to be in their schools were cordial and willing to help pave the way for her to work with their teachers, but after the initial meeting remained aloof from the ongoing study, other than an occasional "How's it going?" The teachers who agreed to participate in the study, although interested in what results might be found about their relationships with their students, were honest about their already full plates containing state mandated objectives, classroom issues, extracurricular activities, and obligatory testing. The students were curious about a visitor to their classrooms, but initially kept her in the periphery of their classroom consciousness.

Regardless of how strongly one tries to hold to the observer status, it is impossible neither for the researcher not to have an effect on the setting in which s/he is working nor for the setting to have an effect on the researcher. During the multiple visits to each classroom, the eight teachers warmly greeted this researcher and conversations about topics outside of the classroom took place. The researcher saw these conversations as a sign that the teachers felt she was a trustworthy individual, someone they could consider as an ally in their work, and someone who was interested in their work. In at least three cases, the teachers asked the researcher for input during a classroom lesson, in order to give the students another perspective on a concept. Furthermore, as mentioned in Chapter IV, Jack requested that the researcher take over his role on more than one occasion when he felt unsure of his own content knowledge. The researcher was happy to assist him and saw this as a way to show her support of his work and her appreciation for his allowing her to be in his classroom. The teachers' public acknowledgement of the researcher's credibility enabled the researcher to gain the trust of the students and to define her position as one of reinforcing their teachers' efforts. Several students began to greet the researcher with "Oh, are you back today?" and they included her as a source of help in the classroom. In a few classrooms, she actively worked with students during the times when they were working at their seats, as a means of assisting the teacher while s/he was working with other students.

As explained in Chapter IV, beyond fulfilling the requirements for obtaining their middle school mathematics endorsement, none of the teachers in this study had taken any graduate coursework nor were they familiar with the results from formal academic research focusing on how children learn mathematics. However, they continually reviewed daily results from the action research they were informally conducting in their own classrooms. To the students, college was a long-term goal, held up to them as a gateway to job opportunities, not a door to academic pursuits. In short, the research community was a vague unknown to most of the participants in this study. This researcher's status as a mathematics educator and as a graduate student personified "research" and academia for the teachers and students. In fact, Veronica expressed interest in beginning a master's program and spent some time discussing options with this researcher. Jack, after informally discussing some of the recommendations from the NCTM with this researcher, expressed interest in sitting in on her content/methods courses for elementary education majors. The students were interested in the fact that, although this researcher had a job and was of an age that was older than that of the traditional college student, she was still learning and finding out more about teaching and learning. This researcher felt she fulfilled the role of advocate for life-long learning and was grateful for the willingness of the teachers and students to be partners in this learning activity. Finally, the researcher found herself drawn into each microcosm, and, in each case, there was a teacher and students who deserved her attention and concern, and even her fascination, admiration, and respect.

## Limitations

The limitation that has the greatest potential to influence the validity of the results of this study was that the teachers who participated in this study constituted a self-selected sample. As was mentioned in chapter 3, the researcher obtained access to only five schools for this study. The initial sample of twenty-three teachers who responded to the MTEBI were within these five schools, but the teachers who agreed to participate further in the study were concentrated in only four of the five schools. The school that was eliminated from the study was in a location that had a higher socio-economic status than the other four and was the only one at which $8^{th}$ grade core curriculum tests were given and on which students consistently met the benchmark of 70% performing at the satisfactory level and above. Because participation in the study was voluntary, this segment of the middle school population was not represented in this study. Furthermore, all of the teachers who agreed to participate in the study were interested in receiving a summary of the researcher's findings with the hope that they would learn something about their students that could serve to guide their classroom instruction. Even though these teachers cited just as many demands on their time as did the teachers who refused to participate, the desire to learn more about their teaching overrode the toll that their participation in the study would take on their time.

The researcher's goal for this ethnographic study was not to obtain results that would generalize to the larger population of middle school mathematics teachers and their students, but rather to provide a valuable puzzle piece that might fit into what is already known about that larger population. That being said, she regrets that the sample of teachers and students was not larger or more diverse because a larger, more diverse sample and the resultant data bring the potential for additional information that would contribute to the completion of the puzzle.

The negative issues associated with the Fennema-Sherman Mathematics Attitudes Scales, that is, the students' difficulties with vocabulary, the amount of time required, and the students' unfamiliarity with the Likert-type method of response, could be a limiting factor in the validity of the results. However, as mentioned earlier the results of the F-S MAS did seem to accurately portray the students' feelings as supported by answers to the written questionnaire and interview questions.

Although the researcher was in the eight classrooms that were included in this study for six months, which, with the issues of scheduling observations and interviews, seemed like a significant period of time, it was only long enough to glimpse a snapshot of the lives of the teachers and their students. A longer involvement in the classroom environment would have afforded the researcher the opportunity to see a fuller picture of the dynamic relationships between teachers and students.

## Ongoing Interest

This study began one year prior to this writing, at the beginning of the school year. The researcher could not help but wonder how the teachers were doing as the current school year was beginning. She went to each of the four schools and was able to visit with each of the eight teachers. The Human Subjects Approval had not quite expired, so the researcher could have gone to the schools still in the role of researcher, but chose instead to go as an interested friend. She carried no notepad, no tape recorder, not even a writing instrument. As she walked into each school, she felt comfortable and she saw familiar office staff, one of whom said, “Oh my gosh, I haven’t seen you in forever!”

The teachers were happy to see her and pleasantries were exchanged before the researcher asked what was really on her mind—how was the school year going? Perhaps the reader also would like to know how the teachers have faired. Marsha, is back to teaching only science, so she is grateful to have more time to plan well for her teaching. Over the summer she became involved in a Japanese Lesson Study and although she is not currently teaching mathematics, she is certain that she will again and is happy to be able to participate in this focused discussion on how to facilitate mathematics learning that was outlined in the above section on teacher preparation and teacher retention. Marsha had watched a video that showed a typical mathematics lesson in a Japanese school and she remarked to this researcher how “different” a Japanese mathematics lesson looked when compared to one in the United States. Her remarks echoed what authors, such as House (2004), have pointed out from the results of the 1999 Third International Math and Science Study. He enumerated several student-centered teaching strategies that were found predominately in Japanese mathematics classrooms, such as

1) discussion of problem-solving strategies, including error analysis
2) availability of manipulatives
3) spending enough time on a single problem to allow students to examine and compare multiple approaches
4) emphasis on verbal explanations of problems and their solutions
5) the use of meaningful homework assignments
6) engaging students in group discussions rather than emphasizing individual work

As a result of the use of these strategies, Japanese students tended to take more risks as they invented and developed unique problem-solving strategies and they tended to use higher levels of mathematical thinking. Marsha noted, as did House, that the Japanese mathematics curriculum covered fewer topics, but covered them in greater detail, as compared to that of the United States. She expressed the hope that her continued involvement with the lesson study would prepare her for the mathematics classroom.

Apparently, the idea of the preference of depth over breadth in a mathematics curriculum has been taken to heart by the curriculum staff for John's and Veronica's district, as the researcher found out when she visited with them at their middle school. John is now in his second year of teaching sixth grade mathematics and said that his students seem better prepared for the work they need to do, while Veronica was excited about the reorganization of their curriculum. She said that they are still addressing the state mandated mathematics learning objectives, but have culled the list so as to focus on the most important ones and thus are able to spend more time on them. Unfortunately, John was in the midst of grading papers and did not seem disposed to chat, so the researcher did not ask him whether he was taking other professional education courses for his alternative certification requirements. She made a mental note to send him an email.

Jean and Kristi are still teaching math, although Jean is now on a sixth grade team. They are still using the inquiry-based mathematics curriculum, although owing to reorganization of her team, Jean's classes have more students and she now teaches one hour of geography each day. Beverly's teaching status is unchanged as well, however her (and Marsha's) school has lost some teachers so they are also experiencing larger class sizes. Beverly reported that the scores on the end-of-instruction algebra I exam were higher for the last school year and that she felt some validation of what she is doing in her classroom.

The high school into which Beverly's school feeds did not show a similar gain in test scores so there is now communication between the faculty members at the two schools to effect some changes that will result in an improvement in the scores at the high school. The most noteworthy impact of the changes on Beverly's life has been that the middle school start time is now 7:45 a.m.! She said that the high school was trying to act on results reported by authors such as Mitru, Millrood, and Mateika (2002) who explained that not only do the biological changes adolescents experience affect their outward physiology and their emotions, but also their sleep needs. Adolescents require more hours of sleep per night and their natural circadian rhythm tends to laten their sleep cycle, i.e., they prefer to go to bed later in the evening and wake up later in the morning. The same researchers reported that lack of sleep had a direct impact on attentiveness, cognitive function, retention, and ultimately academic performance of adolescents when compared to their counterparts who did manage to sleep long enough to experience the complete sleep cycle. Social opportunities, work obligations, and increased academic workload affect the amount and quality of sleep adolescents obtain, but an early start-time also interrupts the sleep cycle when it tends to begin later in the evening. Consequently researchers recommended that secondary schools would do well by their students to set back the start-time of the school day. Unfortunately for Beverly, since the elementary schools, middle schools and high school are serviced by the same buses, one population had to be pushed to the early spot, and the middle school students were placed in that position. Beverly worried that the progress that was made last year will be jeopardized by the same issues that the high school is trying to address.

The researcher was most anxious to see how Jack and Daphne were doing in their small rural elementary school. The reader might recall that Jack had discussed with the researcher the possibility of sitting in on her content/methods course in order to strengthen his mathematical content and pedagogical knowledge, but as the semester began, she did not hear from him. He had told her that scheduling such an activity would be difficult given his teaching responsibilities, but that he felt strongly enough about the benefits of the experience that he would do the best he could. When the researcher found Jack in his classroom, she noticed immediately that there were more students in Jack's classroom than there had been the previous year. The trend toward larger class sizes that the researcher observed in all of the schools was very disheartening. When she asked Jack about his school year, he informed her that his schedule had been adjusted so that he no longer had responsibility for teaching math since he was not confident in his content knowledge which, as was pointed out earlier, was exhibited in his mathematics teaching self-efficacy beliefs. Jack still has a self-contained sixth grade class, but another teacher has taken over the mathematics duties and he did not try to hide his relief over this turn of events.

Daphne is now the librarian for the elementary school. She had told the researcher during this study that she was hoping to move into the librarian's position (the previous librarian had retired) since reading and language arts were her strong teaching areas. Daphne has put the library in order after many years of inattention with regard to culling old books, purchasing contemporary books, and providing a more welcoming atmosphere. She is happy to be in the library, which is still a teaching position as far as she is concerned, since she has implemented weekly library classes for all students. The same enthusiasm and self-proclaimed silliness that she brought to the classroom will bring the library alive for her students.

If the reader has been keeping track, s/he realizes that of the eight middle school mathematics teachers who were in this study, only five are currently teaching math. The researcher was initially surprised, maybe even disappointed, by the seemingly high rate of departure of teachers from the mathematics classroom. Upon further reflection, she remembered that one of the contributors to a teachers' mathematics teacher self-efficacy beliefs was whether or not s/he was teaching in or out of his or her field of certification. In the three cases of the teachers who are not currently teaching mathematics, none of them was certified in secondary mathematics, although Marsha had taken several mathematics courses and professed to a love of math. The National Center for Education Statistics (NCES) reported in its 1993-1994 *Schools and Staffing Survey (*SASS that only 82 percent of middle school mathematics teachers had an undergraduate or graduate major or minor in mathematics. If the goal of providing highly qualified teachers for all students is to be met, certainly a major step toward accomplishing that goal is to make sure that all classroom teachers are teaching within their major or minor field. Therefore, it is not regrettable that Daphne and Jack are no longer teaching math, but rather their reassignments place them in positions where their expertise and interest will better serve their students.

Although the researcher was able to visit, albeit briefly, with each of the teachers in this study, there was something missing--she did not see any of the students who were in the study. During passing time at each of the schools, the researcher searched the faces of the students who filled the hallways for a familiar one. Of course, had any of the students seen or noticed the researcher, chances are slim that any would have remembered her. They had much more of an impact on her than she had on them. Even so, it would have been a satisfying way to close the circle of the round of visits to be able to see how the students had changed and hear about how mathematics was going for them. This admission that the students still occupy a corner of the researcher's mind is further evidence of the importance of being able to conduct a study in which a cohort of students is monitored for the entire middle school through high school period of their mathematics education. Such a study would serve to fill in the shadows that have only begun to be exposed by this study.

## Conclusion

The researcher would like to give the reader one final reminder of the research questions that motivated this study:

1) What is the relationship between a teacher's mathematics teaching self-efficacy beliefs and his or her students' dispositions toward mathematics?
2) What is the relationship between a student's disposition toward mathematics and his or her choosing to continue to study mathematics?
3) What influences middle school students' desire to continue studying mathematics?

The results of this study should serve to inform all parties with interests in the mathematics education of middle school students. Upon reflection on the significance of this study, the researcher has reached the following conclusions. First, middle school mathematics teachers are very important to their students, more so than they are aware. The teachers in this study could not cite research that suggests how students learn mathematics nor could they outline the pedagogical recommendations for the middle school classroom from professional organizations. They did know what objectives would be on the next standardized test their students would be taking and they conscientiously taught toward their students' mastery of those objectives. The students in this study were not interested in what curriculum specialists recommend, what administrators report, or what legislators mandate. They were interested only in what their teachers did in the classroom day in and day out and how the teachers treated them. Did the teacher believe in his or her students? Did the teacher treat his or her students respectfully? Did the teacher seem interested in helping his or her students learn? For the most part, the teachers enjoyed teaching and the students appreciated what their teachers were doing. This placing of value on the teacher speaks directly to the second and third research questions about what could influence students to take more mathematics. The teacher is a potentially powerful force in a student's decision as to whether s/he will take more mathematics or not.

The second major result that came from this study is that middle school teachers are not adequately prepared to teach either the content or the students they encounter. All of the teachers lamented that they had no foreknowledge of the physiological, psychological, emotional, or social issues surrounding the early adolescent. In addition, the elementary certified teachers said that they, at least initially, were not comfortable with the mathematics content they faced. The secondary certified teachers, while comfortable with the content, felt ill equipped with regard to content pedagogy, i.e. the strategies that are appropriate for the middle school level. The researcher offered the suggestion that conducting Japanese-style lesson studies would be the best attempt to facilitate the development of both content knowledge and pedagogical content knowledge. This issue of preparedness is a contributor to a teacher's mathematics teaching self-efficacy beliefs, which then influence a teacher's classroom presence. The teacher's classroom presence is one facet of the teacher's effect on a student's attitude toward mathematics, which speaks to the first research question of this study.

Regardless of the school, the class size, or the grade level, middle school teachers and students work with available resources toward accomplishing the goals set out for them by mathematics curriculum specialists who are engaged by legislators and other political entities, few of whom have recently experienced the challenges and opportunities faced by those in the public school classroom. The researcher found being in these classrooms the most fascinating part of her study. No amount of reading others' research findings can replace this experience for finding out what goes on in the middle school mathematics class room day in and day out. This exposition of the study's results has touched on those facets that were of most importance to the researcher and the researcher hopes that the community to which it is addressed will find the results as intriguing and thought provoking as she did.

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# APPENDIX A

# INTERNAL REVIEW BOARD APPROVAL

## Oklahoma State University Institutional Review Board

Date: Wednesday, September 01, 2004

IRB Application No ED04115

Proposal Title: The Effect of Middle School Teachers' Mathematics Teaching Self-Efficacy Beliefs on Their Students' Attitudes Toward Mathematics and Future Course Taking Intentions

Reviewed and Processed as: Expedited (Spec Pop)

**Approval Status Recommended by Reviewer(s): Approved** **Protocol Expires: 8/31/2005**

Principal Investigator(s):

| | |
|---|---|
| Besty Showalter | Dr. Patricia Lamphere-Jordan |
| 2402 W. 8th Ave | 247 Willard |
| Stillwater, OK 74074 | Stillwater, OK 74078 |

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The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact me in 415 Whitehurst (phone: 405-744-1676, colson@okstate.edu).

Sincerely,

Carol Olson

Carol Olson, Chair
Institutional Review Board

APPENDIX B

MTEBI IN-SERVICE SECONDARY

## MTEBI
## (Mathematics In-service Secondary)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

| **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|
| Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree |

| | | | | | |
|---|---|---|---|---|---|
| 1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort. | SD | D | N | A | SA |
| 2. I am continually finding better ways to teach mathematics. | SD | D | N | A | SA |
| 3. Even when I try very hard, I don't teach mathematics as well as I can teach other subjects. | SD | D | N | A | SA |
| 4. When the mathematics grades of students improve, it is often due to their teacher's having found a more effective teaching approach. | SD | D | N | A | SA |
| 5. I know the steps to teach mathematics concepts effectively. | SD | D | N | A | SA |
| 6. I am not very effective in monitoring mathematics activities. | SD | D | N | A | SA |
| 7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching. | SD | D | N | A | SA |
| 8. I generally teach mathematics ineffectively. | SD | D | N | A | SA |
| 9. The inadequacy of a student's mathematics background can be overcome by good teaching. | SD | D | N | A | SA |
| 10. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher. | SD | D | N | A | SA |

| | | | | | |
|---|---|---|---|---|---|
| 11. I understand mathematics concepts well enough to be effective in teaching secondary school mathematics. | SD | D | N | A | SA |
| 12. The teacher is generally responsible for the achievement of students in mathematics. | SD | D | N | A | SA |
| 13. Students' achievement in mathematics is directly related to their teachers' effectiveness in mathematics teaching. | SD | D | N | A | SA |
| 14. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher. | SD | D | N | A | SA |
| 15. I find it difficult to use manipulatives to explain to students why mathematics works. | SD | D | N | A | SA |
| 16. I am typically able to answer students' mathematics questions. | SD | D | N | A | SA |
| 17. I wonder if I have the necessary skills to teach mathematics | SD | D | N | A | SA |
| 18. Given a choice, I would not invite the principal to evaluate my mathematics teaching. | SD | D | N | A | SA |
| 19. When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better. | SD | D | N | A | SA |
| 20. When teaching mathematics, I usually welcome student questions. | SD | D | N | A | SA |
| 21. I do not know what to do to turn students on to mathematics. | SD | D | N | A | SA |

# APPENDIX C

# TEACHER QUESTIONNAIRE

Teacher Questionnaire

Please answer the following questions.

1. What is your gender? M F

2. What is your ethnicity? White (non-Hispanic) African American

   Native American Asian American Latino/Hispanic Other

3. How many years have you been teaching?

4. What was your major in college?

5. How many hours of mathematics did you have in college?

6. What stands out in your memory about the mathematics teachers you had as a student?

7. What is your area of certification? Elementary Secondary

8. Through what process were you certified? Standard Alternative

9. Do you have a middle school endorsement in mathematics?

10. Have you taken the advanced mathematics test (OSAT)?

11. Have you taken any post-college mathematics classes? If yes, please briefly describe.

12. What grade levels have you taught?

13. What subjects have you taught?

14. What is your preferred grade level and subject area? Why?

15. What prompted your decision to teach middle school mathematics?

16. Which of the following strategies do you use in the classroom to help your students learn mathematics? Circle all that apply.

Lecture Manipulatives Cooperative groups Problem posing

Projects Homework Peer teaching Other (please describe)

17. Have you participated in any professional development activities that have focused on mathematics content or teaching practices? If yes, please briefly describe.

If you would be willing to continue to participate in this study, please provide contact information below. Further participation could involve one or more of the following activities:

1. Follow-up teacher interview.
2. Survey and questionnaire administered to students by researcher.
3. Follow-up student interviews.
   (Parents and students must provide their consent/assent prior to any contact with students)
4. Observation of one or two classroom periods by researcher. No videotaping.

Name ___________________________

Preferred phone number: __________________

# APPENDIX D

# TEACHER INTERVIEW PROTOCOL

Teacher Interview Protocol

1a.. To what extent do you feel responsible for your students' learning?

b. What do you think is the relationship between effective mathematics teaching and student learning?

c. How can you tell if your students are learning?

2. How well do you think you can explain the concepts of mathematics as opposed to just the rules or procedures?

3a. You have indicated that you have also taught __________ (subject) and/or __________ (grade). How does your level of confidence about teaching middle school mathematics compare to when you taught ___________ (subject) and/or __________ (grade).

b. (If level of confidence is lower) What would you like to see in in-service workshops to help you to gain more confidence?

c. (If level of confidence is lower) If given the opportunity, would you choose to teach another grade level or another subject?

4. You have indicated that you prefer to teach _____________(grade level) and/or _____________ (subject level). Why do you feel this way?

5a. What preparation did you have for teaching middle school mathematics?

b. What would have been helpful for preparing you to teach middle school mathematics?

6a. Do you think your students are excited about mathematics?

b. (If the answer is no) What do you think you could do to excite your students about mathematics?

c. (If the answer is yes) Do you think your students' excitement about mathematics is due to something you do in the classroom?

7a. Why do you think students should take mathematics?

b. What could a student plan on doing if he or she majored in mathematics in college?

# APPENDIX E

# FENNEMA-SHERMAN
# MATHEMATICS ATTITUDE SCALES

## Fennema-Sherman Mathematics Attitudes Scales

Elizabeth Fennema and Julia A. Sherman
University of Wisconsin-Madison

In each of the following scales:

SD=strongly disagree, D=disagree, N=Neutral, A-Agree, SA=strongly agree

Circle the appropriate response for each statement.

### Confidence in Learning Mathematics Scale

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | Generally I have felt secure about attempting mathematics. | SD | D | N | A | SA |
| 2. | I am sure I could do advanced work in mathematics. | SD | D | N | A | SA |
| 3. | I am sure that I can learn mathematics. | SD | D | N | A | SA |
| 4. | I think I could handle more difficult mathematics. | SD | D | N | A | SA |
| 5. | I can get good grades in mathematics. | SD | D | N | A | SA |
| 6. | I have a lot of self-confidence when it comes to math. | SD | D | N | A | SA |
| 7. | I'm no good in math. | SD | D | N | A | SA |
| 8. | I don't think I could do advanced mathematics. | SD | D | N | A | SA |
| 9. | I'm not the type to do well in math. | SD | D | N | A | SA |
| 10. | For some reason, even though I study, math seems unusually hard for me. | SD | D | N | A | SA |
| 11. | Most subjects I can handle O.K., but I have a knack for flubbing up math. | SD | D | N | A | SA |
| 12. | Math has been my worst subject. | SD | D | N | A | SA |

Teacher Scale

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | My teachers have encouraged me to study more mathematics. | SD | D | N | A | SA |
| 2. | My teachers think I'm the kind of person who could do well in mathematics | SD | D | N | A | SA |
| 3. | Math teachers have made me feel I have the ability to go on in mathematics. | SD | D | N | A | SA |
| 4. | My math teachers would encourage me to take all the math I can. | SD | D | N | A | SA |
| 5. | My math teachers have been interested in my progress in mathematics. | SD | D | N | A | SA |
| 6. | I would talk to my math teachers about a career which uses math. | SD | D | N | A | SA |
| 7. | When it comes to anything serious I have felt ignored when talking to math teachers. | SD | D | N | A | SA |
| 8. | I have found it hard to win the respect of math teachers. | SD | D | N | A | SA |
| 9. | My teachers think advanced math is a waste of time for me. | SD | D | N | A | SA |
| 10. | Getting a mathematics teacher to take me seriously has usually been a problem. | SD | D | N | A | SA |
| 11. | My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics. | SD | D | N | A | SA |
| 12. | I have had a hard time getting teachers to talk seriously with me about mathematics. | SD | D | N | A | SA |

Usefulness of Mathematics Scale

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | I'll need mathematics for my future work. | SD | D | N | A | SA |
| 2. | I study mathematics because I know how useful it is. | SD | D | N | A | SA |
| 3. | Knowing mathematics will help me earn a living. | SD | D | N | A | SA |
| 4. | Mathematics is a worthwhile and necessary subject. | SD | D | N | A | SA |
| 5. | I'll need a firm mastery of mathematics for my future work. | SD | D | N | A | SA |
| 6. | I will use mathematics in many ways as an an adult. | SD | D | N | A | SA |
| 7. | Mathematics will not be important to me in my life's work. | SD | D | N | A | SA |
| 8. | Mathematics will be of no relevance to my life. | SD | D | N | A | SA |
| 9. | I see mathematics as a subject I will rarely use in my daily life as an adult. | SD | D | N | A | SA |
| 10. | Taking mathematics is a waste of time. | SD | D | N | A | SA |
| 11. | In terms of my adult life it is not important for me to do well in mathematics in college. | SD | D | N | A | SA |
| 12. | I expect to have little use for mathematics when I get out of school. | SD | D | N | A | SA |

# APPENDIX F

# STUDENT QUESTIONNAIRE

Student Questionnaire

Please carefully answer the following questions.

Gender (circle one)    M    F

Ethnicity (circle one):    Caucasian    African American

Native American    Latino/Hispanic

Asian American    Other

Age:    Grade:

Class you are currently taking:

1a. Do you think your teacher enjoys teaching math?

b. What makes you think the way you do?

2a. Do you think your teacher understands the math he or she is teaching?

b. What makes you think the way you do?

3a. Do you understand the math you are taking?

b. If you said yes, what does your teacher do to help you understand?

c. If you said no, do you think that your teacher knows the math but just cannot help you to understand it?

4a. Do you enjoy math?

b. If you said yes, what do you enjoy about math?

c. If you said no, why don't you like math?

5. What makes a teacher a good math teacher?

6. Finish this statement: Mathematics is like ___________________________

APPENDIX G

STUDENT INTERVIEW PROTOCOL

## Student Interview Protocol

1a. What do you do in math class each day?

b. What activities in your math class do you enjoy? Why?

c. What activities in your math class do you not enjoy? Why?

2a. What excites you about math?

b. Are there activities that you do in class that excite you about math?

c. What does your teacher do to influence how you feel about math?

d. Have there been teachers in other math classes who have influenced how you feel about math, in either a positive way or a negative way?

e. What did they do to influence how you feel about math?

3. What characteristics should a good math teacher have?

4. Is it important that your teacher understand the math or is it OK just to be able to tell you the rules and facts?

5a. Have you ever participated in informal math activities, such as an after school program or a summer program?

b. If you answered yes to part (a), what was the program and what did you like about it?

c. If you answered no to part (a), would you be interested in participating in such a program, and if so, do you have any ideas about what you would like to do?

6a. Do you think you need to take math? Why or why not?

b. Does your teacher make you think that math is important?

c. What math course(s) are you planning to take after this year?

d. Do you think you might like to take more math than what is required for high school graduation? Why or why not?

# APPENDIX H

# MTEBI RESULTS

Mathematics Teaching Efficacy Beliefs Instrument
Individual Teacher Scores
Final Sample of Eight Teachers

| Teacher # | mtebi 1 | mtebi 2 | mtebi 3 | mtebi 4 | mtebi 5 | mtebi 6 | mtebi 7 |
|---|---|---|---|---|---|---|---|
| CPS T-01 | 3 | 4 | 2 | 4 | 4 | 4 | 2 |
| CPS T-03 | 4 | 4 | 2 | 4 | 4 | 4 | 4 |
| MMS T-03 | 4 | 5 | 5 | 4 | 4 | 5 | 3 |
| MMS T-05 | 2 | 4 | 3 | 4 | 3 | 5 | 2 |
| SMS T-01 | 3 | 4 | 4 | 3 | 4 | 4 | 2 |
| SMS T-03 | 4 | 4 | 5 | 4 | 5 | 5 | 4 |
| WHMS T-01 | 4 | 4 | 4 | 4 | 4 | 4 | 2 |
| WHMS T-06 | 4 | 5 | 4 | 4 | 4 | 5 | 4 |

| Teacher # | mtebi 8 | mtebi 9 | mtebi 10 | mtebi 11 | mtebi 12 | mtebi 13 |
|---|---|---|---|---|---|---|
| CPS T-01 | 4 | 4 | 4 | 1 | 2 | 4 |
| CPS T-03 | 4 | 3 | 4 | 2 | 4 | 4 |
| MMS T-03 | 4 | 4 | 4 | 4 | 4 | 5 |
| MMS T-05 | 3 | 3 | 4 | 5 | 4 | 2 |
| SMS T-01 | 4 | 3 | 3 | 3 | 3 | 3 |
| SMS T-03 | 5 | 4 | 4 | 4 | 4 | 4 |
| WHMS T-01 | 4 | 4 | 4 | 4 | 4 | 4 |
| WHMS T-06 | 5 | 4 | 4 | 4 | 4 | 4 |

| Teacher # | mtebi 14 | mtebi 15 | mtebi 16 | mtebi 17 | mebi 18 | mtebi 19 |
|---|---|---|---|---|---|---|
| CPS T-01 | 4 | 4 | 4 | 4 | 4 | 4 |
| CPS T-03 | 3 | 4 | 4 | 4 | 4 | 4 |
| MMS T-03 | 3 | 4 | 4 | 4 | 4 | 4 |
| MMS T-05 | 4 | 4 | 5 | 4 | 4 | 4 |
| SMS T-01 | 3 | 4 | 4 | 4 | 4 | 4 |
| SMS T-03 | 4 | 4 | 5 | 5 | 5 | 5 |
| WHMS T-01 | 4 | 4 | 4 | 4 | 4 | 3 |
| WHMS T-06 | 4 | 5 | 4 | 5 | 5 | 5 |

| Teacher # | mtebi 20 | mtebi 21 | MTEBI OE | MTEBI SE | MTEBI TOTAL |
|---|---|---|---|---|---|
| CPS T-01 | 4 | 5 | 27 | 48 | 75 |
| CPS T-03 | 4 | 4 | 30 | 48 | 78 |
| | | | | | |
| MMS T-03 | 4 | 4 | 31 | 55 | 86 |
| MMS T-05 | 5 | 4 | 25 | 53 | 78 |
| | | | | | |
| SMS T-01 | 4 | 3 | 23 | 50 | 73 |
| SMS T-03 | 5 | 4 | 32 | 61 | 93 |
| | | | | | |
| WHMS T-01 | 4 | 3 | 30 | 50 | 80 |
| WHMS T-06 | 5 | 5 | 32 | 61 | 93 |
| | | mean | 28.75 | 53.25 | 82 |
| | | st. dev. | 3.37 | 5.35 | 7.78 |

# APPENDIX I

# F-S MAS SCORES

## Fennema-Sherman Mathematics Attitude Scales

Individual Student Scores (sorted by teacher)

| Teacher | Student | Confidence Scale | Usefulness Scale | Teacher Scale | F-S MAS Total |
|---|---|---|---|---|---|
| CPS T-01 | S-01 | 60 | 60 | 60 | 180 |
| CPS T-01 | S-02 | 42 | 43 | 37 | 122 |
| CPS T-01 | S-03 | 60 | 58 | 53 | 171 |
| CPS T-01 | S-04 | 46 | 52 | 47 | 145 |
| CPS T-01 | S-05 | 35 | 40 | 49 | 124 |
| CPS T-01 | S-06 | 54 | 60 | 50 | 164 |
| CPS T-01 | S-07 | 45 | 55 | 48 | 148 |
| CPS T-01 | S-08 | 35 | 51 | 37 | 123 |
| CPS T-01 | S-09 | 42 | 58 | 56 | 156 |
| CPS T-01 | S-10 | 47 | 50 | 43 | 140 |
| CPS T-01 | S-11 | 38 | 48 | 37 | 123 |
| CPS T-01 | S-12 | 36 | 40 | 45 | 121 |
| CPS T-01 | S-13 | 35 | 42 | 18 | 95 |
| CPS T-01 | S-14 | 57 | 60 | 58 | 175 |
| CPS T-01 | S-15 | 34 | 47 | 42 | 123 |
| | | | | | |
| CPS T-03 | S-02 | 60 | 60 | 55 | 175 |
| CPS T-03 | S-03 | 37 | 39 | 33 | 109 |
| | | | | | |
| MMS T-03 | S-01 | 47 | 49 | 48 | 144 |
| MMS T-03 | S-02 | 37 | 48 | 44 | 129 |
| MMS T-03 | S-03 | 54 | 60 | 57 | 171 |
| MMS T-03 | S-04 | 32 | 55 | 42 | 129 |
| MMS T-03 | S-05 | 47 | 51 | 37 | 135 |
| MMS T-03 | S-06 | 47 | 47 | 45 | 139 |
| MMS T-03 | S-07 | 48 | 42 | 45 | 135 |
| MMS T-03 | S-08 | 48 | 46 | 44 | 138 |
| MMS T-03 | S-09 | 50 | 51 | 51 | 152 |
| MMS T-03 | S-10 | 53 | 40 | 45 | 138 |
| MMS T-03 | S-11 | 50 | 47 | 58 | 155 |
| MMS T-03 | S-13 | 52 | 60 | 58 | 170 |
| MMS T-03 | S-14 | 51 | 59 | 54 | 164 |
| MMS T-03 | S-01 | 47 | 49 | 48 | 144 |
| | | | | | |
| MMS T-05 | S-01 | 55 | 60 | 55 | 170 |
| MMS T-05 | S-02 | 36 | 48 | 43 | 127 |
| MMS T-05 | S-03 | 39 | 56 | 56 | 151 |
| MMS T-05 | S-04 | 33 | 26 | 35 | 94 |
| MMS T-05 | S-05 | 43 | 50 | 47 | 140 |
| MMS T-05 | S-06 | 44 | 55 | 48 | 147 |

| Teacher | Student | Confidence Scale | Usefulness Scale | Teacher Scale | F-S MAS Total |
|---|---|---|---|---|---|
| MMS T-05 | S-07 | 38 | 36 | 37 | 111 |
| MMS T-05 | S-08 | 37 | 45 | 38 | 120 |
| MMS T-05 | S-09 | 43 | 53 | 52 | 148 |
| MMS T-05 | S-10 | 35 | 58 | 50 | 143 |
| MMS T-05 | S-11 | 44 | 51 | 53 | 148 |
| MMS T-05 | S-12 | 54 | 56 | 51 | 161 |
| MMS T-05 | S-13 | 41 | 51 | 48 | 140 |
| MMS T-05 | S-14 | 34 | 51 | 44 | 129 |
| | | | | | |
| SMS T-01 | S-01 | 37 | 45 | 41 | 123 |
| SMS T-01 | S-02 | 31 | 48 | 41 | 120 |
| SMS T-01 | S-03 | 44 | 51 | 37 | 132 |
| SMS T-01 | S-04 | 43 | 48 | 49 | 140 |
| SMS T-01 | S-06 | 40 | 37 | 29 | 106 |
| SMS T-01 | S-07 | 21 | 41 | 28 | 90 |
| SMS T-01 | S-08 | 59 | 60 | 46 | 165 |
| SMS T-01 | S-09 | 55 | 57 | 37 | 149 |
| SMS T-01 | S-10 | 42 | 52 | 45 | 139 |
| SMS T-01 | S-11 | 44 | 47 | 46 | 137 |
| SMS T-01 | S-13 | 56 | 44 | 45 | 145 |
| SMS T-01 | S-14 | 52 | 33 | 40 | 125 |
| SMS T-01 | S-15 | 53 | 54 | 48 | 155 |
| SMS T-01 | S-16 | 26 | 58 | 33 | 117 |
| SMS T-01 | S-17 | 48 | 45 | 19 | 112 |
| SMS T-01 | S-18 | 41 | 51 | 53 | 145 |
| SMS T-01 | S-20 | 18 | 42 | 26 | 86 |
| | | | | | |
| SMS T-03 | S-01 | 47 | 52 | 44 | 143 |
| SMS T-03 | S-02 | 56 | 60 | 57 | 173 |
| SMS T-03 | S-04 | 49 | 46 | 49 | 144 |
| SMS T-03 | S-05 | 36 | 42 | 40 | 118 |
| SMS T-03 | S-06 | 45 | 34 | 38 | 117 |
| SMS T-03 | S-07 | 38 | 48 | 45 | 131 |
| SMS T-03 | S-08 | 54 | 60 | 51 | 165 |
| SMS T-03 | S-09 | 33 | 34 | 40 | 107 |
| SMS T-03 | S-10 | 49 | 44 | 43 | 136 |
| SMS T-03 | S-11 | 46 | 43 | 37 | 126 |
| SMS T-03 | S-12 | 39 | 45 | 44 | 128 |
| SMS T-03 | S-13 | 53 | 60 | 51 | 164 |
| SMS T-03 | S-14 | 33 | 46 | 46 | 125 |
| SMS T-03 | S-15 | 60 | 58 | 56 | 174 |
| SMS T-03 | S-16 | 45 | 58 | 32 | 135 |
| SMS T-03 | S-17 | 47 | 48 | 44 | 139 |

| Teacher | Student | Confidence Scale | Usefulness Scale | Teacher Scale | F-S MAS Total |
|---|---|---|---|---|---|
| WHMST-1 | S-01 | 36 | 44 | 41 | 121 |
| WHMST-1 | S-02 | 30 | 41 | 39 | 110 |
| WHMST-1 | S-03 | 26 | 31 | 39 | 96 |
| WHMST-1 | S-04 | 48 | 37 | 46 | 131 |
| WHMST-1 | S-06 | 20 | 44 | 26 | 90 |
| WHMST-1 | S-07 | 38 | 52 | 42 | 132 |
| WHMST-1 | S-08 | 27 | 53 | 47 | 127 |
| WHMST-1 | S-09 | 40 | 47 | 48 | 135 |
| WHMST-1 | S-10 | 28 | 42 | 32 | 102 |
| | | | | | |
| WHMST-6 | S-01 | 41 | 29 | 38 | 108 |
| WHMST-6 | S-02 | 46 | 42 | 36 | 124 |
| WHMST-6 | S-03 | 17 | 60 | 33 | 110 |
| WHMST-6 | S-04 | 51 | 47 | 54 | 152 |
| WHMST-6 | S-05 | 51 | 52 | 39 | 142 |
| WHMST-6 | S-06 | 26 | 32 | 36 | 94 |
| WHMST-6 | S-07 | 41 | 57 | 43 | 141 |
| WHMST-6 | S-08 | 36 | 37 | 42 | 115 |
| WHMST-6 | S-09 | 53 | 56 | 51 | 160 |
| WHMST-6 | S-10 | 25 | 31 | 35 | 91 |
| WHMST-6 | S-11 | 51 | 57 | 54 | 162 |
| WHMST-6 | S-12 | 31 | 49 | 44 | 124 |
| WHMST-6 | S-13 | 50 | 55 | 54 | 159 |
| WHMST-6 | S-14 | 39 | 55 | 50 | 144 |
| WHMST-6 | S-15 | 42 | 48 | 36 | 126 |
| WHMST-6 | S-16 | 44 | 51 | 52 | 147 |
| WHMST-6 | S-17 | 39 | 40 | 44 | 123 |
| WHMST-6 | S-18 | 44 | 57 | 47 | 148 |
| WHMST-6 | S-19 | 35 | 36 | 34 | 105 |
| WHMST-6 | S-20 | 28 | 53 | 27 | 108 |
| WHMST-6 | S-21 | 27 | 41 | 46 | 114 |

VITA

Betsy Shiela Showalter

Candidate for the Degree of

Doctor of Philosophy

Dissertation: THE EFFECT OF MIDDLE SCHOOL TEACHERS' MATHEMATICS TEACHING SELF-EFFICACY BELIEFS ON THEIR STUDENTS' ATTITUDES TOWARD MATHEMATICS

Major Field: Mathematics Education

Biographical:

Education: Graduated from Midwest City High School, Midwest City, Oklahoma in May 1972; received Bachelor of Arts degree in mathematics from the University of Oklahoma, Norman, Oklahoma, in May 1976; received Master of Arts degree in mathematics from the University of Oklahoma in July 1978. Completed the requirements for the Doctor of Philosophy degree with a major in Professional Education Studies (emphasis in mathematics education) at Oklahoma State University in December 2005.

Professional Experience: Has taught both secondary and undergraduate mathematics for twenty-seven years. Has been employed at Langston University, in the Mathematics Department, since 1993.

Professional/Scholarly Memberships: National Council of Teachers of Mathematics, Phi Kappa Phi, Kappa Delta Pi.

Name: Betsy S. Showalter Date of Degree: December, 2005

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: THE EFFECT OF MIDDLE SCHOOL TEACHERS' MATHEMATICS TEACHING SELF-EFFICACY BELIEFS ON THEIR STUDENTS' ATTITUDES TOWARD MATHEMATICS

Pages in Study: 202 Candidate for the Degree of Doctor of Philosophy
Major Field: Mathematics Education

Scope and Method of Study: One purpose of this study was to determine if there was a relationship between middle school mathematics teachers' teaching self-efficacy beliefs and their students' attitudes toward mathematics. A second area of interest was to find out what aspect of a middle school student's attitude toward mathematics affected his or her plans to enroll in mathematics courses beyond those required for graduation. Participants in this study were eight middle school mathematics teachers and the students in one of each of their classes. The teachers completed the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) and a questionnaire and were interviewed by the researcher. The students completed three of the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS) and a questionnaire and two students from each class were interviewed by the researcher. Pearson's *r* was used to determine the significance of the relationship between mathematics teaching self-efficacy beliefs and attitude toward mathematics.

Findings and Conclusions: No significant relationship was found between a teacher's mathematics teaching self-efficacy beliefs and his or her students' attitudes toward mathematics. However, the Pearson's *r* of .596 indicated that there was a relationship between a student's attitude toward his or her teacher and his or her confidence about learning mathematics and the Pearson's *r* of .533 indicated that there was a relationship between a student's attitude toward his or her teacher and his or her perception of the usefulness of mathematics. Therefore, the teacher exerts a strong influence on how a student views mathematics. Data from the questionnaires and interviews further supports the conclusion that the teacher is influential in how a student views mathematics. Results from the qualitative data also indicates that middle school students are already thinking about careers and that at least half of them view knowledge of mathematics as being important to their preparations for a future career. The students credited their teachers with emphasizing the importance of mathematics.

ADVISOR'S APPROVAL: Patricia Lamphere-Jordan