EXPLORING BELIEFS AND PRACTICES OF TEACHERS OF SECONDARY MATHEMATICS WHO PARTICIPATED IN A STANDARDS-BASED PRE-SERVICE EDUCATION PROGRAM

Except where reference is made to the work of others, the work described in this dissertation is my own or was done in collaboration with my advisory committee. This dissertation does not contain any proprietary information.

Mary Alice Smeal

Certificate of Approval:

W. Gary Martin
Professor
Curriculum and Teaching

Marilyn E. Strutchens, Chair
Professor
Curriculum and Teaching

David M. Shannon
Professor
Educational Foundations, Leadership, and Technology

Dean Hoffman
Professor
Mathematics and Statistics

George T. Flowers
Dean
Graduate School

EXPLORING BELIEFS AND PRACTICES OF TEACHERS OF SECONDARY MATHEMATICS WHO PARTICIPATED IN A STANDARDS-BASED PRE-SERVICE EDUCATION PROGRAM

Mary Alice Smeal

A Dissertation

Submitted to

the Graduate Faculty of

Auburn University

in Partial Fulfillment of the

Requirements for the

Degree of

Doctor of Philosophy

Auburn, AL
December 19, 2008

EXPLORING BELIEFS AND PRACTICES OF TEACHERS OF SECONDARY

MATHEMATICS WHO PARTICIPATED IN A STANDARDS-BASED

PRE-SERVICE EDUCATION PROGRAM

Mary Alice Smeal

Signature of Author

Date of Graduation

VITA

Mary Alice Smeal, daughter of Roy and Mary Letta Shaub, was born December 15, 1958, in Nashville, Tennessee. She graduated from David Lipscomb High School in 1976. She entered David Lipscomb University in 1976 and graduated with a Bachelor of Science degree in Applied Piano in December, 1979. Upon graduation, she worked as an actuarial computer programmer/analyst at American General Insurance Company until giving birth to twins in August, 1983. In March, 1984, she moved with her husband to Southampton, New York and devoted herself to her family. While in New York, she was also elected to the Southampton Board of Education and served until moving to Florence, Alabama in 1994. After her last child began school, she entered the University of North Alabama and graduated with a Masters of Arts in Mathematics Education in 1996. She taught mathematics for the next nine years at Mars Hill Bible School. In 2004, she moved to Montgomery, Alabama. While working as a mathematics teacher at Alabama Christian Academy, she entered Graduate School at Auburn University in January, 2006. She married James Smeal on May 26, 1979. They have four children, James, Joseph, Christopher, and Nathan.

DISSERTATION ABSTRACT

EXPLORING BELIEFS AND PRACTICES OF TEACHERS OF SECONDARY MATHEMATICS WHO PARTICIPATED IN A STANDARDS-BASED PRE-SERVICE EDUCATION

Mary Alice Smeal

Doctor of Philosophy, December 19, 2008
(M.A.T., University of North Alabama, 1996)
(B.S., David Lipscomb University, 1979)

375 Typed Pages

Directed by Marilyn E. Strutchens

The National Council of Teachers of Mathematics has challenged all mathematics teachers to use the *Standards* documents (1989, 1991, 1995, & 2000) as guidelines for teaching mathematics. Many pre-service programs are now presenting curricula that are based on the *Standards* (1989, 1991, 1995, & 2000). When mathematics teachers enter their own classroom, will their teaching methods reflect the guidelines of the *Standards* that they encountered in their pre-service education?

Five case studies were used to investigate the teaching beliefs and practices of mathematics teachers who had participated in a *Standards*-based pre-service education.

The case studies were selected based on the results from a survey in order to arrive at a diverse, purposeful sample. A variety of data sources were used to develop a better understanding of teachers' beliefs and practices. The researcher used a survey, classroom observations, interviews, and an observation instrument as data sources.

One of the teachers held beliefs in alignment with the guidelines of the *Standards* and effectively implemented them in her classroom. Another teacher strongly held *Standards*-based beliefs but had difficulty incorporating these beliefs into her teaching practices due to the obstacles of curriculum, high-stakes testing, and classroom management. The third teacher incorporated some *Standards*-based teaching strategies but was heavily influenced by his administration and curriculum to follow a traditional pattern of teaching. The fourth teacher held beliefs in alignment with the *Standards* after participating in an internship with a cooperating teacher that provided positive *Standards*-based teaching experiences in a middle school setting. After she began teaching seniors, she felt that *Standards*-based strategies were more appropriate for students below the high school level. She incorporated traditional teaching practices. The fifth teacher held traditional beliefs even after the completion of his pre-service education and continued with traditional teaching strategies in his own classroom. Four of the teachers lowered their expectations of students based on the students' demographics, such as academic level and socioeconomic status.

ACKNOWLEDGEMENTS

God has been my guide throughout the many paths my life has traveled. I want to give God the glory for providing me with the opportunity and guidance to pursue my educational opportunities. Thanks also to God for blessing me with my husband Jim to be my partner. Jim daily expressed his confidence in my abilities and provided me with encouragement every step of the way. Even though my mother and father are no longer alive to celebrate my achievement with me, I want to thank them for being an example of excellence in all things. Thanks also to my children—James, Joseph, Chris, and Nathan—for their continued support and interest.

I want to give a special word of appreciation to my fellow graduate students; Lora who also had a patient and listening ear, and Carol for helping me survive all of my classes and always giving me an encouraging word when I needed it most.

Last of all, thanks to my committee for all of their time and energy. I want to acknowledge Dr. Strutchens for always guiding me in a kind and supporting manner. She shared her expertise when my knowledge needed some "scaffolding." I want to give a special word of gratitude for the encouragement that Dr. Martin provided me during research class. You helped me make my dreams become reality. I would be amiss unless I mentioned my two remaining committee members, Dr. Shannon and Dr. Hoffman. They were always so helpful and positive when the going got tough.

Style manual or journal used: Publication Manual of the American Psychological Association, Fifth Edition

Computer software used: Microsoft Excel, 2003; Atlas.ti, Version 5.2; Microsoft Word 2003

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Graduation day is here! A fresh crop of secondary mathematics teachers have completed their pre-service education and already have numerous job offers in the field of teaching secondary mathematics. How will they use their pre-service training in the classroom? How will the surrounding climate of their new school affect the implementation of the methods that they have practiced in methods courses and an internship? The entire school climate makes implementation of *Standards*-based (National Council of Teachers of Mathematics, 1989, 1991, 1995, & 2000) strategies extremely difficult. Examination of the recent history of mathematics education will provide a better understanding of the tensions that novice teachers might face.

The New Math Era to the Agenda for Action

Over time the history of mathematics education has typically depicted an “intellectual, social, and political tug-of-war in which the perspectives and theories of individuals and groups compete for influence on the goals and practices of school mathematics” (Fey & Graeber, 2003, p. 521). One such movement, the new math movement, was prompted because of criticism toward American education after World War II and the military threat posed by the launching of the Sputnik in 1957 (Fey & Graeber, 2003). The educational crisis that was created by the Cold War brought together mathematicians, educators, and psychologists to restructure the teaching of mathematics (Lambdin & Walcott, 2007). In 1959, the Commission on Mathematics of the College Entrance Examination Board (CEEB) published a key policy leadership document that defined the American new math reform agenda (Fey & Graeber, 2003). The commission report suggested that the topics of logic, modern algebra, probability, and statistics should be infused into the secondary mathematics curricula and proposed a secondary course of study that divided mathematics topics and concepts in a four-year sequence of high school courses (Algebra I, Geometry, Algebra II, Precalculus). Bruner (1960), one major influence in the new math movement, advocated the two ideas of a spiral curriculum and discovery learning (Lambdin & Walcott, 2007). A spiral curriculum characterized a curriculum that revisited mathematical concepts repeatedly in increasingly more complex and abstract forms (Lambdin & Walcott, 2007). Discovery learning incorporated the Socratic method of teaching and allowed students to discover mathematics concepts for themselves (Fey & Graeber, 2003).

A backlash against the new math occurred because parents, politicians, and even teachers viewed the movement a failure (Fey & Graeber, 2003). Beginning in the 1970s, the back-to-basics movement was born as a reaction to the new math movement (Lambdin & Walcott, 2007). The back-to-basics movement was characterized by a return to traditional instructional practices that emphasized drill-and-practice and procedural skills (Schoenfeld, 2004). Because of the ineffectiveness of the back-to-basics movement, a need for another change was voiced: “If a large proportion of K–12 students had been successful in the traditional curriculum, the impetus for change might have been muted. But that was not the case. Large numbers of students failed or left mathematics ...”

(Schoenfeld, 2002, p. 14). The back-to-basics movement did not produce mathematical performance in the United States, so the National Council of Teachers of Mathematics (NCTM) saw the need for changes to improve mathematics achievement in the United States (Schoenfeld, 2004).

The Mathematics Reform Movement

In 1980, NCTM addressed the need for improvement by publishing *An Agenda for Action* (NCTM, 1980) that had the expressed purpose of articulating a clearer focus for the future of mathematics education (Fey & Graeber, 2003). *An Agenda for Action* (NCTM, 1980) influenced numerous educational groups and NCTM publications (Fey & Graeber, 2003). The document stipulated that "problem solving must be the focus of school mathematics" (NCTM, 1980, p. 2) and called for a decreased use of drill and pencil-and-paper computations (Fey & Graeber, 2003). It was argued that problem solving benefits students because they learn best when they devise their own approaches to mathematical problems, and this leads the way to mathematical literacy (Lambdin & Walcott, 2007). Schoenfeld (2002) reported that achievement of students using reform curricula consistently surpassed those using traditional curricula on testing in the 1980s that focused on problem solving and conceptual understanding.

In 1983, the National Commission on Excellence in Education (NCEE) published *A Nation at Risk*, which revealed that the mathematics achievement gap between the United States and other countries was widening. The NCEE conveyed the urgency in education, "If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war" (NCEE, 1983, p. 5). The inadequate state of the educational system of the United States described in the report was reinforced by the results of the United States in the Second International Mathematics Study (McKnight, Travers, & Dossey, 1985). These documents set the stage for a new set of standards.

In 1989, the NCTM published the *Curriculum and Evaluation Standards for School Mathematics*, which systematically outlined reform in school mathematics. The NCTM (1989) called for teachers to teach so that:

> students are exposed to numerous and varied interrelated experiences that encourage them to value the mathematical enterprise, to develop mathematical habits of mind, and to appreciate the role of mathematics in human affairs; that they should be encouraged to explore, to guess, and even to make and correct errors so that they gain confidence in their ability to solve complex problems; that they should read, write, and discuss mathematics; and that they should conjecture, test, and build arguments about a conjecture's validity. (p. 12)

The proponents of the reform movement were trying to replace the traditional learning strategies which used rote memorization of facts and procedures. The reform movement called for major revisions to the traditional classroom (Ball, 1990). There were thirteen standards for students in grades 5–8 and fourteen standards for 9–12 students. The standards were divided into content and process standards. The content standards illustrated the subject matter all students should learn while the process standards described how students should acquire this subject matter (NCTM, 1989). The NCTM subsequently published the *Professional Standards for Teaching Mathematics* (1991) and *Assessment Standards for School Mathematics* (1995). These three documents marked the first time that any professional organization had verbalized definite goals for teachers and policymakers (NCTM, 2000). In 2000, the NCTM released *Principles and Standards for School Mathematics (PSSM*), and it was a resource and guide for educating K–12 students in mathematics. *PSSM* also provided extensive research to support its recommendations. These documents helped to define the principles and standards associated with the reform movement in mathematics education. Collectively, I will refer to this set of documents as the *Standards* (NCTM, 1989, 1991, 1995, & 2000).

Math Wars

The reform movement questioned many of the fundamental tenets of traditional teaching methods (Schoenfeld, 2004). In the 1990s, the stage for confrontation was set, and the intense debates about the teaching and learning strategies of mathematics education came to be known as the "math wars" (Lambdin & Walcott, 2007). The proponents of reform mathematics placed emphasis on students learning mathematics by constructing their own knowledge about mathematical concepts (Lambdin & Walcott, 2007). The opponents of reform focused on mathematical procedures and supported a more traditional curriculum that steered away from the "fuzzy new-new math" (Schoenfeld, 2004, p. 278).

In the late 1990s, the opponents of reform launched a large-scale effort to derail the momentum of the reform movement (Schoenfeld, 2004). The reform proponents reacted slowly to the aggressive attacks of the opponents of reform (Schoenfeld, 2004). Both viewpoints developed websites. However, the tenor of each website was completely different. The mathematicallycorrect.com website put forward by the opponents of reform exhibited a very hostile voice toward reform mathematics. For instance, the heading on the website states, "This website is devoted to the concerns raised by parents and scientists about the invasion of our schools by the New-New Math and the need to restore basic skills to math education." Website links published on mathematicallycorrect.com were mostly anonymous editorials and opinion pieces denouncing the reform movement. There were no links to articles that provided evidentiary support for the back-to-basics mindset. The mathematicallysane.com website put forward by the supporters of reform provided useful information about the reform movement and the learning of mathematics. The site had four headings with links to analysis, evidence, resources, and other useful links. Unlike mathematicallycorrect.com, mathematicallysane.com included recent research reporting on reform methods as well as findings from government panels.

In addition to the websites, numerous articles were published for both positions. For example, Quirk (2005) posted an unpublished article that pointed out the inadequacies of the NCTM *Standards.* He has also posted a number of other unpublished articles denouncing reform-based publications. Klein (2000) penned an article denouncing the U.S. Department of Education's designation of ten reform mathematics programs as "exemplary." Many research articles have been published providing examples of the effectiveness of reform-based curricula. Two examples are Riordan and Noyce (2001) and Huntley, Rasmussen, Villarubi, Sangtang, and Fey (2001). Another example of reform literature is Reyes' (2002) article explaining the positive side of reform math. Both sides have been promoting their cause but using different approaches.

On a more positive note, Schoenfeld (2004) was convinced that there was a large middle ground. The middle ground encouraged higher expectations, equity, and research to promote effective mathematics instruction. The National Science Foundation selected a panel to look for positions of agreement in teaching and learning mathematics. The panel arrived at seven areas of agreement: automatic recall of basic facts, calculators, learning algorithms, fractions, teaching mathematics in "real world" contexts, instructional methods, and teaching knowledge (Ball, Ferrini-Mundy, Kilpatrick, Milgram, Schmid, & Schaar, 2005, pp. 3–4). Although there is common ground, the debate of traditional teaching styles versus teaching based on the *Standards* continues to impact mathematics education.

Teachers Assessing Their Own Beliefs

Even though most pre-service teachers were not even aware of the math wars, their education represented a microcosm of the math wars debate. Generally, pre-service teachers had experienced a traditional high school education, and some of them participated in a pre-service education that emphasized the guidelines of the *Standards.* The resulting conflict forced mathematics teachers to assess their own beliefs and practices. The reform movement has heavily impacted mathematics education research, but the effect on mathematics instruction in the classroom has been limited (Philipp, 2007). Due to the limited implementation of reform by mathematics teachers, most pre-service teachers experienced a traditional mathematics childhood education (Brown & Borko, 1992). To complicate the conflict that apprentice teachers experience, the beliefs of mathematics teachers were heavily tied to childhood experiences.

In a pivotal article synthesizing the research on beliefs of mathematics teachers, Pajares (1992) enumerated several major points concerning teachers' beliefs that help us better understand this tension.

A. Beliefs are formed early and tend to self-perpetuate, persevering even against contradictions caused by reason, time, schooling, or experiences.

B. The earlier a belief is incorporated into the belief structure, the more difficult it is to alter. Newly acquired beliefs are the most vulnerable to change.

C. Beliefs change during adulthood is a relative rare phenomenon, the most common cause being a conversion from one authority to another or a gestalt shift. Individuals tend to hold on to beliefs based on incorrect or incomplete knowledge, even after scientifically correct explanations are presented to them.

D. Individuals' beliefs strongly affect their behavior.

E. Beliefs about teaching are well established by the time a student gets to college. (Pajares, 1992, pp. 325-326)

Pajares (1992) described the process of evolving beliefs, "knowledge and beliefs are inextricably intertwined, but the potent affective, evaluative, and episodic nature of beliefs make them a filter through which new phenomena are interpreted" (p. 325). Since these beliefs generally were unchanging, when they did modify, it was not argument or reason that altered them but rather a "conversion" (Pajares, 1992).

Some pre-service teachers spent four years totally immersed in a new approach to teaching that is drastically different from teaching mathematics traditionally (Cooney, Shealy, & Arvold, 1998; Wilkins & Brand, 2004). What effect did the methods courses, field experiences, and internships have on these pre-service teachers' beliefs? An effective pre-service secondary education may produce some mathematics teachers whose beliefs are in alignment with the *Standards*, but some teachers may continue to hold traditional beliefs about teaching mathematics (Cooney et al., 1998; Hart, 2002a; Van Zoest & Bohl, 2002; Wilkins & Brand, 2004).

Which teaching beliefs and practices will teachers choose as they transition to the classroom? Pre-service teachers may begin their careers in a variety of school climates that run the gamut from traditional to *Standards*-based. Influences in the school climate can significantly impact teachers' practices (Kitchen, 2003; LaBerge & Sons, 1999). How will these influences impact fledgling teachers' beliefs and practices? The transition from student to teacher is most assuredly a difficult one for any novice teacher (Cwikla, 2004). An inexperienced teacher must learn to be open to the voices of others and recognize their value, but a newer teacher must also listen to his or her own voice in dealing with the contexts and constraints of the classroom and in adapting to the present circumstances (Cooney, et al., 1998).

The mathematics teachers in this research study participated in a *Standards*-based mathematics education program in their pre-service coursework and exhibited a *Standards*-based teaching style in their pre-service internship. This study examined what happened to the secondary mathematics teachers' beliefs and practices during the first few years of teaching. Specifically, did their teaching beliefs and practices align with the *Standards* or did they drift back toward a traditional teaching style?

Theoretical Basis for the Study

In order to determine how a mathematics teacher's beliefs system is affected as they enter the classroom, a theoretical basis must be established that defines beliefs and beliefs systems. Leatham (2006) proposed the *sensible system* framework for systems of beliefs. To lay the groundwork, a consensus must be reached on the meaning of the terminology in the framework. Thompson (1992) and Lloyd and Wilson (1998) designated the term *conception* as a general category that included ideas such as beliefs, knowledge, understanding, preferences, meaning, and views. However, most researchers have pointed out a vast difference between the concepts of knowledge and beliefs (Furinghetti & Pehkonen, 2002; Thompson, 1992). Knowledge and beliefs must be defined to provide clarity to the discussion of the research. In the sensible system framework, the following distinction is made: "Of all the things we believe, there are some things that we 'just believe' and other things that we 'more than believe – we know.' Those things we 'more than believe' we refer to as knowledge and those things we 'just believe' we refer to as beliefs" (Leatham, 2006, p. 92). Teachers' beliefs are defined by Artzt (1999) as integrated systems of personalized assumptions about the nature of mathematics and of students, and about learning and teaching.

The sensible system of beliefs framework also presumes that teachers' beliefs influence their actions and practices. This tenet is supported by Rokeach's (1968) theory, "All beliefs are predispositions to action" (p. 113). Rokeach's statement does not guarantee that an individual holding a belief is necessarily aware that he or she is holding the belief. Pajares (1992) pointed out that "beliefs cannot be directly observed or measured but must be inferred from what people say, intend, and do – fundamental prerequisites that educational researchers have seldom followed" (p. 207). Therefore, a researcher cannot simply arrive at teachers' beliefs by asking them about their beliefs but must make inferences from a variety of sources (Leatham, 2006).

Teachers' beliefs about various facets of teaching cannot be viewed in isolation but the connection of different beliefs must be articulated. The sensible system framework assumes that individuals organize beliefs into systems that are logical to them. This tenet is supported by the coherence theory of justification as discussed by Thagard (as cited in Leatham, 2006) that compared a system of beliefs to a raft that floats on the sea with all the pieces of the raft fitting together and supporting each other. For a sensible system of beliefs to exist, an individual's beliefs must make sense with respect to his or her other beliefs (Leatham, 2006).

The strength of certain beliefs is dependent upon how strongly they fit in with the rest of the belief system (Leatham, 2006). The works of Green (1971) and Rokeach (1968) provided a clearer picture of a belief system. Green (1971) and Rokeach (1968) described the strength of certain beliefs as differing from central to peripheral. Rokeach (1968) explained that "the more central a belief, the more it will resist change" (p. 3). Another aspect of beliefs structures is that beliefs are clustered and may seem to be contradictory to observers (Green, 1971, p. 47). Belief clustering makes adjustments for contextualizing of beliefs where a teacher may believe one thing for one situation and the opposite for another (Leatham, 2006). Therefore, the sensible system framework takes for granted that a beliefs system is a sensible system that does not allow contradictions (Leatham, 2006). If a teacher's beliefs that are seemingly contradictory collide, then this person must resolve the conflict in order to make the system sensible (Leatham, 2006).

In this study, the major tenets of the sensible systems of beliefs framework were used to examine teachers' beliefs and practices. This framework was used because the existence of a sensible belief system of each participant aided in explaining the connection between teachers' beliefs and practices. A case study approach helped to provide an in-depth and detailed image of teachers' beliefs and practices using a variety of data sources. When contradictions appeared to exist in the belief system, a closer examination was made to attempt to rectify the discrepancies. Also, the alignment between teachers' beliefs and practices were studied using a number of sources to analyze how their beliefs were influencing their practices. The use of different sources provided a better picture of teachers' actual beliefs and facilitated making sense of participants' beliefs on certain concepts in light of the their entire belief system.

Purpose of the Study

The purpose of this study was to contribute to an understanding of the relationship between the beliefs and practices of secondary mathematics teachers who participated in a *Standards*-based pre-service education. The relationship was viewed using a lens based on the *Standards* guidelines about mathematics teaching and learning. To help explore this relationship, the study set out to examine other influences on teachers that affected their beliefs and practices and how teachers dealt with these influences. These influences could come from inside the classroom or outside the classroom. The study was also designed to observe student demographics, such as race, ethnicity, learning disabilities, socioeconomic status, or English as a second language, impacted the teachers' *Standards*-based beliefs and teaching strategies. Teachers often adjusted their teaching beliefs and practices for students with certain demographic characteristics (Rousseau & Tate, 2003). This study was guided by the following research questions:

1. To what extent are secondary mathematics teachers incorporating the *Standards*-based approach that was promoted in their pre-service education?

2. How consistent are the secondary teachers' beliefs with a *Standards*-based teaching framework?

3. To what extent are other factors impacting secondary mathematics teachers' beliefs and practices toward *Standards*-based mathematics?

4. To what extent do teachers change their teaching approaches based on student demographics such as socioeconomic status, race, gender, and ability level?

Significance of the Study

The results of this study will be significant in two principal areas. First of all, there is a lack of research in the area of teachers' beliefs. Studies are needed to better understand the beliefs and practices of secondary education teachers who participated in a *Standards*-based pre-service education program (Frykholm, 2004; Phillip, 2007; Thompson, 1992). This study will provide an in-depth look at the beliefs and practices of five teachers. Currently, there is also very little research on the factors that influence secondary mathematics teachers in the classroom (LaBerge & Sons, 1999). There is a limited understanding of these obstacles and their influence on instructional practices of mathematics teachers. This study will identify the factors that affected these five teachers and the influence that these factors had on their beliefs and practices.

Secondly, the study has implications for stakeholders in the education process. This study will provide insight for classroom teachers into the teaching beliefs and practices of other secondary mathematics teachers, as well as their struggles and professional needs. In addition, administrators will have a better understanding of how to support their secondary mathematics teachers. Mathematics educators whose programs are based on the guidelines of the *Standards* will be able to use the results of this study to inform their program and curricula. Finally, by providing opportunities for the teachers to participate in reflective discussions and share their beliefs and practices with me, the study has the potential to improve their teaching as well as teaching practices of fellow teachers with whom they collaborate.

Definitions

Terms used in mathematics education often convey a number of meanings. In this section, I will define several terms that occur frequently throughout this study to assure a better understanding for the reader. These terms include *Standards*-based practices, teachers' beliefs, and affect.

Standards-*based Practices*

The term "standards-based" is often used with a variety of explicit and implicit meanings (Ferrini-Mundy, 2004). Different stakeholders, such as mathematics educators, policy researchers, administrators, and teachers talk about "standards" but define "standards" very differently (Tate, 2004). For the purposes of this study, the term "*Standards*-based practices" refers to teaching practices that are based on the NCTM (1989, 1991, 1995, & 2000) *Standards* documents. The NCTM *Standards* provide a focus for mathematics teaching and learning that center around deep knowledge of mathematics, substantive conversation about mathematics, and inquiry-based thinking (Tate, 2004). Deep knowledge of mathematics encompasses exploring mathematical concepts thoroughly enough to make connections between important mathematical concepts and create complex understandings. Substantive conversation involves students talking about mathematics with their teachers and classmates to foster a shared understanding. Inquiry-based thinking includes encouraging students to be able to justify their reasoning, generate hypotheses, and present a conclusion that displays an understanding of mathematical concepts (Tate, 2004). A working definition of *Standards*-based practices is important because this study will focus on the teachers' beliefs toward *Standards*-based guidelines and how their practices align with these guidelines.

Teachers' Beliefs

Since teachers' beliefs are a central issue in this study, it is necessary to come to a consensus for the term "teachers' beliefs." There is a lack of consistency in definitions of mathematical beliefs (Philipp, 2007). In 1992, Pajares wrote a key article that examined all of the literature on teachers' beliefs and discussed the myriad of definitions dealing with teachers' beliefs. Pajares (1992) pointed out that definitions represent a consensus among researchers. When referring to teachers' beliefs, most researchers felt that beliefs included teachers' attitudes about education comprised of schools, teaching, learning, and students (Pajares, 1992).

Several current definitions of beliefs emphasize different aspects of beliefs. Philipp (2007) argued that knowledge is a kind of belief, but researchers view knowledge as "belief with certainty." Schoenfeld (1998) emphasized that personal experiences help form mental constructs that make up beliefs. Pehkonen (1998) added that beliefs can be based on subjective knowledge that may include feelings. Artzt (1999) defined teachers' beliefs as integrated systems of personalized assumptions about the nature of mathematics, of students, about learning, and teaching. This last definition closely follows Pajares' definition and will be the use of the term "teachers' beliefs" found in this study.

Affect

Most researchers agree that the affective domain can best be described as constructs that go beyond a cognitive approach (McLeod, 1992). Leder (1993) defined "affect" as a term used to "Denote a wide range of concepts and phenomena including feelings, emotions, moods, motivation and certain drives and instincts" (p. 46). McLeod (1992) and Philipp (2007) agreed that beliefs, attitudes, and emotions should be considered components of affect. Goldin (2002) added a fourth aspect that includes values, ethics, and morals to the definition of affect. McLeod (1992) divided the belief component of the affective domain into four categories: (1) beliefs about mathematics; (2) beliefs about self; (3) beliefs about mathematics teaching; and (4) beliefs about the social context. Philipp (2007) discussed the connection between beliefs and affect. He suggested that beliefs encompass the approach used when looking at the world, and affect more specifically defined the way that people deal with some aspect of their world.

Another aspect of affect to consider is that of meta-affect. Meta-affect encompasses "affect about affect, affect about and within cognition that may again be about affect, the monitoring of affect, and affect itself as monitoring" (Goldin, 2002, p. 62). Most affective occurrences are present in such a way as to add to the analysis of the total affective experience. DeBellis and Goldin (2006) developed two terms used in the domain of meta-affect. *Mathematical intimacy* relates to the vulnerable emotions that people experience when dealing with mathematics. *Mathematical integrity* conveys the meaning of an individual's dedication to mathematical truth and understanding (DeBellis & Goldin, 2006; Goldin, 2002). In the following section of the review of literature on affect, the components of the affective domain that will be explored are anxiety, efficacy, attitudes, and emotions.

II. REVIEW OF RELATED LITERATURE

In this chapter I will present a review of related literature on four areas to establish a better background to the study. The first area will look at the impact of affect on teachers' beliefs and practices. This section will first examine the research on affect of students followed by a review of research on affect of teachers. The second section will study the impact of influences that teachers face as classroom teachers. These influences include pre-service education, curriculum, content knowledge, time, classroom management, and professional development. The next section of the review of related literature will reflect on the issue of equity in the classroom. The review will look at the research on how teachers' approaches to *Standards*-based principles are influenced by the demographics of their pupils. The last area will examine the relationship of teachers' beliefs and practices and the *Standards* documents. The NCTM *Standards* (1989, 1991, 1995, & 2000) are at the heart of this investigation.

Teachers' Beliefs and Practices and Affect

The examination of affect in teachers and students is the starting point for understanding teachers' beliefs and practices toward *Standards*-based mathematics. The impact of affect adds to the understanding of why teachers hold the beliefs that they do and why they incorporate certain strategies.

Research in mathematics education has traditionally concentrated on mathematical learning and problem solving, and the affective domain and cognitive-affective interactions have taken a back seat (Battista, 1994; DeBellis & Goldin, 2006; Goldin, 2002). In mathematics education research, more emphasis has been placed on learning and achievement because most researchers did not see the connection between mathematics and emotions (Goldin, 2002). Affect in mathematics education is often manifested by teachers' equal interest in students' attitudes toward mathematics and their academic achievement (McLeod, 1992). *Standards*-based mathematics has placed a special emphasis on affect (McLeod, 1992). For example, the NCTM has endorsed the fundamental importance of affective issues in the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). Two of the five educational goals touch on the issue of affect, "that they learn to value mathematics and that they become confident in their ability to do mathematics" (p. 5). The *Professional Standards for Teaching Mathematics* (NCTM, 1991) also suggested that mathematical experiences should foster the disposition to do mathematics and the confidence to learn mathematics independently.

There is a dearth of research on the relationship between teachers' affect and the teaching and learning of mathematics (Philipp, 2007), and teachers' affect has rarely been studied in mathematics education (McLeod, 1992). In the *Handbook of Research on Mathematics Teaching and Learning* (Grouws, 1992), neither Thompson's chapter on teachers' beliefs and conceptions nor McLeod's chapter on affect included any research on teachers' affect. Goldin (2002) stressed the importance of research on the affective domain, "When individuals are doing mathematics, the affective system is not merely auxiliary to cognition—it is central" (p. 60).

Students' Affect

Before I turn to the research on teachers' affect, I want to present some findings on students' affect. I think this is important because research has shown the connection between adults' attitudes toward mathematics and their attitudes as children (Pajares, 1992; Philipp, 2007). Even though the focus of this study concerns teachers, a look at students' affect will help to paint a better picture of the construction of teachers' affect. Mathematics experiences in the early years of school can have a huge impact on teachers' feeling towards mathematics (Smith, 1996). According to Philipp (2007), research has shown that attitudes toward mathematics can change during the elementary and middle school years, but are less likely to change after that. A logical conclusion is that students' affect developed early in their mathematics education continue to influence their affect during pre-service and teaching. Teachers' practices can also be impacted by the affect of their students (Gómez-Chacón, 2000; Hannula, 2002). For example, a teacher might include more contextual word problems that were relevant to her students in order to improve students' attitudes toward mathematics. In this section, the following studies that deal with students' affect are discussed: the connection with the cognitive domain, the use of mood maps, students' changing affect, and mathematics anxiety.

The Cognitive Domain

McLeod (1992) researched the relationship between student's affect and cognitive development. McLeod (1992) emphasized the importance of integrating research of cognitive development with the affective domain in students. He illustrated this point with an example of a sixth-grade student solving a story problem. If the student held to the belief that he should be able to solve the story problem in two minutes and knew that he could not accomplish this, then he might feel a negative affect toward story problems. If this student continued to experience failure with story problems, then he might develop a negative attitude toward story problems. McLeod (1992) pointed out that this negative attitude might spread to include all areas of mathematics, and even have the far-reaching effects on students' beliefs of their ability to learn mathematics (McLeod, 1992). In a prior study on affect and cognition, McLeod, Craviotto, & Ortego, (as cited in McLeod, 1992) reported that students who were endeavoring to solve nonroutine mathematics problems often exhibited a high degree of affective responses.

Mood Maps

Gómez-Chacón (2000) also researched students' affect and realized the importance of the connection between affect and cognition in the field of mathematics education. She viewed affect as either *local affect*, the feelings of emotion that someone experiences while engaging in mathematics, or *global affect*, the construct of the beliefs held about mathematics and learning and the concept of self. Gómez-Chacón (2000) studied 23 high school students in Spain who were currently failing mathematics. She developed a *problem mood map* to study the emotions that students were feeling when participating in mathematics. The *problem mood map* contained a list of 14 emotions with their corresponding definitions, and these students selected the emotions that they were feeling. The emotions were curiosity, cheerful, despair, calm, hurry, boredom, "just great", bewilderment, brain teaser, liking, indifference, amusement, confidence, and blocked. When Gómez-Chacón (2000) asked the students to think about the emotions that they were experiencing, the students became aware of their own emotions that they were feeling and felt better able to deal with the emotions. The students filled out the mood map at the end of each mathematical activity.

Each student participating in Gómez-Chacón's study (2000) reacted to as many as 48 activities. Each session was analyzed to understand the interaction of affect and cognition. Gómez-Chacón (2000) used the mood map to answer questions about the initial affective attitude, interruptions in the affect-cognition interaction, the effect of these interruptions on the problem-solving process, the most frequent emotions, and the tendencies of cognition and affect for each session. Gómez-Chacón (2000) chose to study one student, Adrian, in depth to search for connections between cognition and affect:

> Adrian had average ability but brought an openly negative school experience to the study. Adrian exhibited highs and lows throughout the course depending on his mood and the climate of the class. Adrian intensely disliked reasoning with mathematical symbols and preferred using concrete representations, especially in geometry, but sometimes developed his own approach to solving problems. During the case study observations, Adrian also exhibited anxiety when he faced difficulties, and he often felt pressured because he worked slowly. Adrian also expressed fear of negative mathematics experiences, but he experienced satisfaction and surprise when achieving success. However, Adrian was positive toward other subjects, woodworking for instance.

Gómez-Chacón (2000) observed that Adrian held different beliefs for different forms of mathematical knowledge and was heavily influenced by a specific social group. Her study demonstrated the important connection between understanding the mathematics concepts and affect toward mathematics.

Students' Changing Affect

Students' can acquire a negative affect toward mathematics due to negative experiences, but students' affect can also change to a more positive feeling toward mathematics. Hannula (2002) investigated the concept of students changing their attitudes toward mathematics. The framework of the study was based on the theory of DeBillis and Goldin (1997) that affect was crucial for mathematical cognition. The researcher viewed emotion and cognition as two central concepts that could not be viewed separately (Hannula, 2002). Hannula (2002) illustrated an example of a student changing her attitude with the case study on his student Rita:

> Rita participated in engaging tasks in cooperative groups. There was a change in Rita's attitudes when she commented that mathematics was "more fun" because she had "been understanding more." Rita exhibited an improved attitude by observing "that must be the nicest thing exactly that one understands the topic." (pp. 41–42)

Rita's attitude showed the connection between emotions and the cognitive domain of mathematics. Even though Rita was not sure of her mathematical ability, she had the confidence to ask questions and persevere until she understood. Rita developed the belief that she could master difficult mathematical concepts. Hannula (2002) summarized that "the most important conclusion is that the proposed framework of emotions, associations, expectations, and values is useful in describing attitudes and their changes in detail" (p. 42). Even though Hannula (2002) only depicted one student's changing attitudes, the case study effectively illustrated that cooperative group activities transformed Rita's affect toward mathematics. The study underscored the malleable nature of students' affect depending on their mathematical experiences.

Mathematics Anxiety

McLeod (1992) enumerated the aspects of the affective domain: confidence, self-concept, self-efficacy, mathematics anxiety, causal attributions, effort and ability attributions, learned helplessness, and motivation. Ma (1999) conducted a meta-analysis on the relationship between anxiety toward mathematics and achievement in mathematics. She searched electronic databases using keywords and manually searched the seven leading mathematics education journals and reference lists of key articles on mathematics anxiety. Ma (1999) examined a sample of 26 studies that included 18 published articles, three unpublished articles, and five dissertations. Ma (1999) emphasized that the 26 studies were representative on the basis of qualitative and quantitative methods, gender, race, ethnicity, and sample size. Ma (1999) described the six instruments that were used to measure mathematics anxiety in the 26 studies, with the Mathematics Anxiety Rating Scale developed by Richardson and Suinn (as cited in Ma, 1999) used most frequently (in 12 of 26 studies), and 9 different instruments were used to measure achievement in mathematics (Ma, 1999). Ma reported a significant correlation of -.27 between anxiety and achievement in mathematics. Her meta-analysis showed that affect and more narrowly mathematics anxiety hindered students' mathematical learning (Ma, 1999). The research by Ma (1999) emphasized the relationship between anxiety and student achievement. The results of this quantitative study heightened the importance of improving students’ attitude toward mathematics that was described by Hannula (2002).

Connection of Students' Affect to Teachers' Efficacy

McLeod (1992), Gómez-Chacón (2000), Hannula (2002), and Ma (1999) researched various aspects of students' affect. One facet of affect was teacher efficacy which Philipp (2007) defined as the confidence to affect students' performance. A pre-service or inservice teacher's history of perceived past successes and failures were a major factor in efficacy beliefs (Smith, 1996), so their affect as students impacted their efficacy beliefs. These efficacy beliefs greatly shaped the teaching of mathematics in several ways: they influenced the use of activities, the climate of the environment, the pursuit of goals, the level of performance, and persistence when opposed by others (Phillippou & Christou, 1998). As a teacher transitions from pre-service teacher to classroom teacher, a positive affect which includes a high level of confidence is crucial to the implementation of conceptual activities that are very different from their own childhood education.

Teachers' Affect

Much of the research on teachers' affect investigates elementary teachers because many of them hold a negative affect toward mathematics (Harper & Daane, 1998). However, secondary mathematics teachers can also exhibit anxiety or discomfort concerning mathematics (Frykholm, 2004). In this section, I will discuss the efforts of mathematics educators in a pre-service methods course to reduce anxiety toward mathematics in elementary teachers. This study underscores the influence that pre-service education can hold. The second discussion centers around three studies that examined the impact of strong content knowledge on secondary teachers' affect.

The Impact of a Pre-Service Methods Course on Affect

As stated earlier, pre-service teachers' attitudes toward mathematics are impacted by their childhood education. Many elementary teachers come to their pre-service education with anxiety toward mathematics that stemmed from their childhood education (Harper & Daane, 1998). Harper and Daane (1998) researched factors that added to the mathematics anxiety of pre-service teachers and the effects of a pre-service elementary mathematics methods course on mathematics anxiety. They explained that the methods course focused on teachers modeling and students practicing effective reform teaching based on the *Professional Standards for Teaching Mathematics* (NCTM, 1991). The methods course incorporated small-group activities with manipulatives that emphasized problem solving and included 28 days of field experience. Harper and Daane (1998) studied fifty-three prospective elementary teachers who participated in the pretest and a posttest using the 98-item Mathematics Anxiety Rating Scale developed by Richardson and Suinn (as cited in Harper & Daane, 1998) to determine pretest and posttest levels of math anxiety. The Mathematics Anxiety Rating Scale was constructed to measure the anxiety associated specifically with mathematics. The investigators (Harper & Daane, 1998) designed a twenty-six item checklist that assessed the factors that had the greatest influence on mathematics anxiety (FIMA). The items on the checklist were related to experiences in mathematics or in mathematics classes. The researchers administered a 7-item methods course reflection (MCR) that was given in the last week of the course to determine what influences the methods course had on anxiety (Harper & Daane, 1998).

Harper and Daane (1998) reported that the MCR brought to light factors closely aligned with *Standards*-based mathematics that were instrumental in reducing mathematics anxiety. The teachers listed the activities of working with a peer, working in group settings using cooperative learning, using manipulatives, writing in mathematics journals, and presenting lessons in elementary school classrooms as beneficial in reducing anxiety. Harper and Daane (1998) conducted interviews with eleven of the pre-service teachers who exhibited the greatest math anxiety differences between pretest and posttest scores. Six exhibited decreased mathematics anxiety, and the remaining increased anxiety (Harper & Daane, 1998). The interviews revealed that teachers' anxiety often began in their own elementary schooling (Harper & Daane, 1998). The pre-service teachers that reported increased anxiety held the beliefs that they had a deficit in mathematics content knowledge (Harper & Daane, 1998). The researchers explained that one participant did not like writing in the mathematics journals because he could not explain the concepts in writing but could only work the problems procedurally (Harper & Daane, 1998). The research data indicated that the beliefs of the pre-service teachers with anxiety tended to be characterized by a feeling of helplessness, fearfulness, and insecurity, and a lack of trust in their mathematics ability (Harper & Daane, 1998). The research revealed that beliefs of prospective teachers portrayed the notion that they could not understand mathematics and felt that mathematics was not useful (Harper & Daane, 1998). The results of the survey indicated that the teachers' level of mathematics anxiety decreased significantly for 44 out of 53 prospective teachers after participating in the mathematics methods course (Harper & Daane, 1998).

Harper and Daane (1998) suggested some inferences from the survey and interview results. They felt that pre-service teachers’ lack of confidence toward their mathematics ability nurtured a belief about mathematics learning and teaching that promoted a traditional teaching style (Harper & Daane, 1998). Harper and Daane (1998) expressed the urgency in breaking the chain of anxiety from elementary mathematics experiences carrying over into the teachers' beliefs toward mathematics. Since the mathematics methods course is one of the last major mathematical influences on pre-service elementary teachers, the professors of the mathematics methods carry an immeasurable responsibility to allay mathematics anxiety and encourage teaching practices in alignment with *Standards*-based principles (Harper & Daane, 1998). The researchers also asserted the importance of teachers being aware of factors that cause math anxiety and trying to dissuade these factors in their students (Harper & Daane, 1998). Harper and Daane (1998) commented that mathematics anxiety factors must be abolished from the classroom if the *Standards* are to be implemented successfully.

Harper and Daane (1998) provided implications for both secondary teachers and their students. Since elementary teachers generally teach all subjects, their pre-service education must cover all core subjects. Therefore, their background in mathematics is not equivalent to secondary mathematics teachers, and their inadequate content knowledge creates more mathematics anxiety. However, a good number of secondary mathematics teachers do not have adequate mathematics content knowledge (Brown & Borko, 1992). The deficiency breeds mathematics anxiety, and this anxiety could inhibit teachers' beliefs and practices toward *Standards*-based methods (Harper & Daane, 1998). Ball (1996) agreed that these feelings of affect hindered the implementation of *Standards*-based strategies because they require a deeper content knowledge and a more conceptual understanding of mathematics than traditional methods. An effective pre-service program could address the anxiety of the prospective teachers by providing excellent content preparation, modeling of *Standards*-based methods, valuable field experiences, and an internship situation that supports the *Standards.* Harper and Daane (1998) pointed out that mathematics teachers could limit the mathematics anxiety that students acquire by engaging students in problem solving and group work that are in alignment with the NCTM *Standards* (1989, 1991, 1995, & 2000).

In summary, many of the teachers in this study initially developed anxiety toward mathematics in their elementary education (Harper & Daane, 1998). Activities such as working with a peer or in groups, using manipulatives, writing in mathematics journals, and presenting lessons in classrooms effectively reduced anxiety for the majority of these pre-service education students. Harper and Daane (1998) repeatedly made the connection between incorporating *Standards*-based practices and reducing mathematics anxiety in students.

The Expert Blind Spot in Secondary Teachers

One series of studies approached affect in secondary mathematics teachers as it related to their opinion of students’ cognition. Sometimes secondary teachers had the opposite problem of weak content knowledge. Their pre-service education included numerous upper level mathematics courses, and the new knowledge hampered their ability to understand how students think about mathematics at the secondary level. Researchers related secondary mathematics teachers' beliefs to students' mathematical thinking (Nathan & Koedinger, 2000a).

In the first study, Nathan & Koedinger (2000a) conducted a study involving 67 secondary mathematics teachers and 35 mathematics educators. The researchers asked the teachers and educators to predict the difficulty for a set of six arithmetic and algebra problems (Nathan & Koedinger, 2000a). The six problems were represented by story problems, word problems, and symbolic-equation problems. Each type of problem was divided into two categories--one had the unknown at the beginning of the problem and the other had the unknown at the end of the problem (Nathan & Koedinger, 2000a). Nathan and Koedinger (2000a) gave the teachers the six mathematics problems and asked them to rank the problems from easiest to most difficult. The results from the rankings were compared with rankings by 76 students who had completed one year of algebra. The investigators in the study also asked teachers to complete a 47-item beliefs test that was based on a 6-point Likert scale (Nathan & Koedinger, 2000a). The beliefs test was designed to assess the teachers’ views of mathematics, mathematics instruction, and student learning (Nathan & Koedinger, 2000a).

The study revealed that high school mathematics teachers held beliefs that cause them to systematically misjudge the abilities and efficacy of students' inventive solutions and tend to overestimate students’ proficiency with formally taught algebraic methods (Nathan & Koedinger, 2000a). Nathan and Koedinger (2000a) reported that secondary teachers categorically felt that the story problems and word-equation problems were more difficult than algebra equations, but this was actually the opposite of the students' rankings. Nathan and Koedinger (2000a) pointed out that these different perceptions toward types of problems had a major effect on how teachers perceive students' reasoning and learning.

Nathan and Koedinger (2000b) continued their research studying 107 different teachers across all grade bands. They asked the teachers to complete the same 47-item Likert-scale assessment and ranked the six different types of problems from the previous study (Nathan & Koedinger, 2000b). The results from the survey showed that teachers agreed that they should encourage invented solution methods (Nathan & Koedinger, 2000b). The researchers reported that secondary mathematics teachers had beliefs that were not as *Standards*-based as elementary school teachers. One finding from the survey revealed that high school teachers did not give students' invented strategies as much credit as their fellow teachers in middle and elementary school (Nathan & Koedinger, 2000b). Additionally, Nathan and Koedinger (2000b) stated that the survey also confirmed that high school teachers were more likely than elementary and middle school teachers to agree that arithmetic was always easier than algebra, and solving problems algebraically is a prerequisite to solving word problems. The survey results exposed that high school teachers were also more likely to equate inventive solutions with weak skills or poor conceptual understanding (Nathan & Koedinger, 2000b).

Nathan and Koedinger (2000b) coined the term *expert blind spot* to describe teachers with excellent content knowledge but a lack of awareness of alternate solutions to symbolic equations. Continuing research on teachers and the *expert blind spot*, Nathan and Petrosino (2003) researched 48 prospective K–12 teachers using the same 47-item Likert scale assessment and also ranking the difficulty of the six problems for beginning algebra students. Nathan and Petrosino (2003) reported that mathematics teachers with high content knowledge tended to overestimate the capabilities of their students.

These three studies illustrated differences between the attitudes of elementary and secondary teachers. These attitudes toward students’ solutions and the perception of how students view problems impacted teachers' beliefs about *Standards*-based principles like encouraging students to solve problems in a variety of ways. In these studies, the attitudes expressed by the secondary teachers were not due to a lack of content knowledge but to very high skills in mathematics content (Nathan & Petrosino, 2003). High school teachers' responses to the beliefs tests indicated a tendency to give more credence to procedural solutions which contradicted the ideals of *Standards*-based mathematics (Nathan & Petrosino, 2003). As pre-service teachers enter the classroom, they need to remember the importance placed on the advantages of multiple solutions to activities and investigative learning in the *Standards*.

Summary of Teachers' Beliefs and Practices and Affect

The above research has shown that the affective domain is heavily intertwined with the cognitive domain. The work of Hannula (2002) emphasized the connection between affective issues and cognitive issues. The research of McLeod (1992) emphasized the cumulative effect of experiencing repeated negative incidents when solving problems. The research showed that negative affect in students could impact their achievement from the cognitive viewpoint. According to Hannula (2002), students' attitudes can change if the proper support and atmosphere is created. Rita's attitude definitely improved with the use of *Standards*-based strategies and subsequently gave her the confidence to attempt higher-level mathematics courses (Hannula, 2002). Mathematics anxiety can begin early in the educational process and can influence pre-service teachers' attitudes toward mathematics teaching and learning (Harper & Daane, 1998; Ma, 1999; Philipp, 2007). Gómez-Chacón (2000) observed that emotions felt by students could be used as a starting point for developing self-efficacy for prospective teachers in the area of mathematics. As pre-service teachers became mathematics teachers, their anxiety toward mathematics influenced other areas of affect such as confidence, self-efficacy, learned helplessness, and even motivation (Ball, 1996). Other studies with secondary teachers (Nathan & Koedinger, 2000a, 2000b; Nathan & Petrosino, 2003) relayed that affect could be manifested in other ways. The secondary teachers' attitudes shaped their conception of how students think and what they are capable of achieving. Affect of both students and teachers can promote or inhibit pre-service and inservice teachers' *Standards*-based beliefs and practices (Gómez-Chacón, 2000; Hannula, 2002; McLeod, 1992).

Teachers' Beliefs and Practices and Other Influences

Mathematics teachers' affect can be influenced by conditions related to the teaching environment. The list of topics that can impede teachers' *Standards*-based beliefs and practices is lengthy (Ross, McDougall, & Hogaboam-Gray, 2002). These barriers will be different for all teachers because each mathematics teacher is in a unique teaching situation coupled with exclusive pedagogical and mathematical backgrounds. Kitchen (2003) reported that obstacles in high-poverty schools included intense workloads and difficulties with administrators, colleagues, and parents. These types of influences also occurred in schools with different socioeconomic levels. Rousseau and Powell (2005) defined the two categories of time and design as obstacles to a teachers' implementation of *Standards*-based mathematics. The time element was further subdivided to include class and planning time; standardized testing; class size; and student mobility and absenteeism (Rousseau & Powell, 2005). The design influences included quality curriculum, teacher preparation, and quality professional development (Rousseau & Powell, 2005). Two of the key quality influences were pre-service education and professional development and will be discussed later in the review of literature (Brown & Borko, 1992). The following research studies expound on how various influences affect mathematics teachers beliefs and practices.

New Teacher Concerns

New teachers are impacted more by influences than experienced teachers. Adams and Krockover (1997) conducted a study using novice science and mathematics secondary teachers. The researchers reported that the study was not investigating any particular theoretical framework such as *Standards*-based mathematics or a constructivist approach (Adams & Krockover, 1997). The twofold purpose of their study was to understand the concerns of the beginning science or mathematics teachers and their opinions of the effectiveness of their science and mathematics pre-service program (Adams & Krockover, 1997). Adams and Krockover (1997) acquired the names of prospective participants that were submitted by faculty from the School Mathematics and Science Center, and 11 former pre-service teachers agreed to participate. The study was conducted from a phenomenological perspective, and interviews were used to explore the teachers' concerns (Adams & Krockover, 1997). In addition to the interview, the data were triangulated with the secondary sources of unstructured phone conversations, the Salish Inventory for Demographic Evaluation of Schools and Teachers Education Programs that was developed by McGlamery (as cited in Adams & Krockover, 1997), and the Teachers' Pedagogical Philosophy Interview that was developed by Richardson and Simmons (as cited in Adams & Krockover, 1997).

Adams and Krockoever (1997) reported on several themes that emerged from the analysis of the data. The themes were divided into the two main categories of new teacher concerns and perceptions of the pre-service program (Adams & Krockover, 1997). The researchers wrote about one teacher's (T5) complaint about impacts on actual teaching, "I learned that teaching is the easiest thing that a teacher has to do during the day. Paperwork and classroom management far outweigh the concerns [about teaching], as far as hardness, when it comes to comparing the two" (Adams & Krockover, 1997, p. 41). The data showed that all 11 of the teachers expressed concern about the overwhelming amount of paperwork (Adams & Krockover, 1997). The research described the commonly experienced theme of classroom management that T7 expressed, "It's the discipline problems that are going to make or break you, and there is not a single way of dealing with all situations or all students" (Adams & Krockover, 1997, p. 41). Adams and Krockover (1997) showed the connection to the pre-service program when one mathematics teacher (T1) said, "My problem solving course used cooperative learning [and was] extremely helpful. [It] helped open my mind to what mathematics is really about and how to convey that to others" (p. 44).

The research conveyed that the majority of the teachers felt that there was a definite need for more field experiences in the pre-service program and more training using pedagogical content knowledge (Adams & Krockover, 1997). Adams and Krockover (1997) noted that all novice teachers experienced most of the difficulties mentioned, and the pre-service program had a huge impact on easing these concerns. The researchers did not specifically research new science and mathematics teachers through a *Standards*-based lens. Some of the comments indicated that at least some of the teachers had encountered some exposure to *Standards*-based principles (Adams & Krockover, 1997, see above comment by T1). However, many concerns of new teachers are universal whether they opt for traditional, *Standards*-based, or another method of teaching. The difficulties associated with new teaching responsibilities could severely inhibit teachers' implementation of any method of teaching, including *Standards*-based strategies. Pre-service teachers who have experienced *Standards*-based preparation are not immune to the induction pains of novice teachers.

Professional Development

From the research of Adams and Krockover (1997), it is apparent that novice teachers can use any support available. The opportunity for professional development in alignment with the *Standards* provides positive reinforcement for those teachers still transitioning from their pre-service education. However, newer teachers participating in professional development do not guarantee that their beliefs and practices will remain loyal to the *Standards.* The following studies illustrate both positive and negative outcomes of professional development.

Inexperienced Teachers

Another study researched inexperienced teachers' reactions to professional development and professional support. Cwikla (2004) studied middle-school mathematics teachers with less than seven years of teaching experience, and these teachers participated in a systemic project involving a professional development program. The ten volunteers in the study were participating in some phase of the professional development program. Cwikla (2004) noted that each teacher was being prepared to implement methods based on the NCTM *Standards.* Most of the teachers' schools were using the same *Standards*-based curriculum (Cwikla, 2004). The professional development consisted of a two-week summer program and a one-week program for teachers who were returning for their second and third year of participation (Cwikla, 2004). Cwikla (2004) reported that the participating teachers also attended professional development training that was presented on-site at each of their respective districts. The researcher administered a written survey that investigated the participants' reactions to the professional development project (Cwikla, 2004). The researcher also conducted a 90-minute interview with each teacher (Cwikla, 2004).

The analysis of the data produced four emergent influences: mentoring, collaboration, content knowledge, and classroom observations (Cwikla, 2004). The research indicated that the mentoring process produced only negative attitudes toward the more experienced mathematics teachers and had no affect on these teachers' beliefs toward the *Standards* (Cwikla, 2004). Cwikla (2004) described the example of Patsy who enumerated some barriers to her relationship with her mentor: difference in age, feelings of incompetence, and her feeling of helplessness. The data conveyed that all of the participants discussed the need for some sort of collaboration, and none of them received it at their school (Cwikla, 2004). Cwikla (2004) pointed out that two of these new teachers sought out peer teachers in different school districts and created their own mentoring system by meeting on the weekends and keeping in touch by e-mail. The researcher described another beginning teacher who established a support system with a new teacher in a different building (Cwikla, 2004). The research showed that teachers expressed a vital need for collaboration in order to support their *Standards*-based beliefs and improve their skills that are in alignment with their beliefs (Cwikla, 2004).

From the data collected, a lack of content knowledge of experienced teachers was a concern to inexperienced teachers. Cwikla (2004) reported that eight of the interviewees felt that they had a more solid background in mathematics content than their more experienced colleagues. The interviews brought to light the emotion of irritation that the participants commonly expressed toward the more experienced teachers (Cwikla, 2004). The newer teachers were frustrated because their colleagues needed to spend a significant amount of the professional development sessions focusing on basic mathematics. For example, Ella, a sixth-grade teacher with a degree in middle-school mathematics education, commented about how time was spent during the professional development activity on basic mathematics, "There was a lot more time spent doing, you know, catching up the non-math people" (Cwikla, 2004, p. 190). Cwikla (2004) demonstrated how teachers felt that adequate content knowledge was a necessity when incorporating *Standards*-based mathematics. She quoted Patsy, a seventh-grade teacher with a bachelor's degree in mathematics and elementary education:

> I mean, these people can barely learn the math for themselves. And until they're tested on whether or not they can actually reason through it, they're not going to care ... If you can't explain your answer, if showing your work is the extent of what you can do, you're not going to be able to teach my children. (p. 190)

The research indicated that the newer teachers preferred to spend more time on the teaching strategies and the curriculum rather than focusing on only the basic mathematics content because the participants were dedicated to honing their *Standards*-based strategies (Cwikla, 2004).

Cwikla (2004) also reported that teachers felt the need for more collaborative classroom observations. According to Cwikla (2004), the observations should take place in non-threatening atmosphere to help the teachers improve their own *Standards*-based teaching methods (Cwikla, 2004). Mark, one of the participants, pointed out that it should not be an administrator but “somebody who’s not in the pressure cooker” (Cwikla, 2004, p. 191). The researcher reported that Wanda had opportunities to participate in collaborative observations and commented on its merits for *Standards*-based mathematics:

> You learn so many subtle things ... questioning techniques, wait time ... how much time to give the kids to work on a problem. How to start off the problem. How to engage the kids in critical conversation ... Just even subtle mundane things. Like where to position yourself in the room. Letting the kids take over . . . and they debate a question, defend something. Just things like that. (Cwikla, 2004, p. 192)

Cwikla (2004) noted that opportunities for observations by like-minded peers can only enhance teachers’ *Standards*-based teaching and solidify *Standards*-based beliefs as well. Cwikla’s (2004) study included only 10 teachers who volunteered for the study, so the willing participants were more likely to hold beliefs consistent with the *Standards.* Also, the data were self-reported, so reliability was limited.

Summarizing briefly, the research in this study indicated that less experienced teachers tend to be more open to the *Standards*-based principles and usually have already experienced exposure to *Standards*-based methods in their pre-service education (Cwikla, 2004). Problems can arise when less experienced teachers who held *Standards*-based beliefs attempt to participate in a professional support system with more experienced teachers who held traditional beliefs. On a more positive note, the use of collaborative observations encouraged the use of the *Standards*-based beliefs and practices held by the novice teachers. Using collaborative observations with peers supporting the *Standards* promotes improved beliefs and practices in any climate that novice teachers may encounter (Cwikla, 2004).

Barriers in High-Poverty Schools

Schools characterized with a student population of low SES experience a lot of teacher turnover (Kitchen, 2003). Due to the high turnover, often pre-service teachers find their first job in a classroom full of students who come from a background of poverty. To this end, a professional development project attempted to address the barriers faced by teachers implementing the *Standards* in schools that were considered high-poverty (Kitchen, 2003). In order to research and improve this problem, the University of New Mexico established four professional development “academies” (Kitchen, 2003). Twenty-eight secondary mathematics teachers in high-poverty schools participated in the project. Kitchen (2003) served as the coordinator of one of the academies. Each academy lasted for three weeks in the summer and emphasized engaging teachers in a problem-solving curriculum to enhance secondary teachers' conceptual understanding of mathematical content (Kitchen, 2003).

The researcher asked the teachers to identify and follow the barriers that they identified. The sources of data used in the study were surveys, journals, and written reports (Kitchen, 2003). Over half of the participants in the study represented minority populations, and, due to high recruitment, over half of the participants were teachers with less than six years of experience (Kitchen, 2003). Several themes emerged when the data were analyzed. Kitchen (2003) conveyed that the most significant influence voiced by the teachers was their intense workload. “Too much paperwork, too much grading, ... no prep time, parent conferences make it difficult to want to change. I'm just too tired!" (Kitchen, 2003, p. 20). Another major obstacle that emerged was the unwelcoming climate from administrators, fellow teachers, and parents (Kitchen, 2003). Kitchen (2003) relayed one teacher's comments about the lack of support, "I don't feel that I am supported by administration and the veteran teachers ... Parents want their kids to do math traditionally also ... not just playing" (p. 21). The research data indicated that most of these teachers were the only participants from their school that attended the academy, and they felt a sense of isolation and a lack of support when trying to implement the *Standards*-based strategies (Kitchen, 2003). The researcher reported that the final theme that emerged was the resistance felt from the students (Kitchen, 2003). Kitchen (2003) quoted one teacher in a school with a majority of African American students:

> I tried groups, they only chat and play ... They wait for someone to do 'it', so they can copy. If no one does it in the group for the group, they just sit. Most of my 8th graders received an F the last 5 years in math. [They say] 'What's one more F?' (p. 21)

One of the main barriers that emerged was that all problems did not have easy solutions. The hindrances were intensified because of the lack of resources and teachers' low expectations that accompanied high-poverty schools. Also, *Standards*-based strategies were much more difficult to implement in a school with very little or no support from colleagues and administrators. One drawback of the study was that the data were self-reported and were only collected during the summer. The use of observations the following school year provided more information on the impact of the summer institute on the teachers' beliefs and practices in relation to the *Standards*. High-poverty schools similar to those in this study could benefit immensely from novice teachers with high expectations to implement the *Standards* to *all* students. However, pre-service students leaving the "nest" for the first time must be aware that attitudes and resources at poverty schools can make their goals more difficult to reach than schools with students of higher socioeconomic levels.

The Transition from Pre-service to Experienced Teacher

The relationship between pre-service education and teaching in the classroom is very important to this research study. In a National Science Foundation (NSF) project, a longitudinal study reported on mathematics teachers before they began their pre-service program and during their sixth year of teaching (Cady, Meier, & Lubinski, 2006). Cady et al. (2006) noted that the NSF project researched collaborative learning environments that were established during field experiences to prepare pre-service teachers to implement effective classroom practices based on the NCTM *Standards*. Twelve of the initial 22 pre-service K–8 teachers were still available and willing to participate in the study. The study used a mixed methodology with a combination of surveys and an interview (Cady et al., 2006). One survey, the Mathematics Belief Scale (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989), identified the beliefs about the teaching and learning of mathematics. A second survey, the Learning Context Questionnaire, was developed by Griffith and Chapman (as cited in Cady et al., 2006), and classified a student's level of intellectual development where low scores signified that the student depended on sources such as the textbook or the teacher to arrive at the correct answer.

The researchers analyzed the surveys and the interviews separately (Cady et al., 2006). The Friedman test (Green, Salkind, & Akey, 2000) was used for the surveys because it utilized repeated measures analyses over an extended period of time (Cady et al., 2006). The repeated-measures experiment matched each teacher's survey scores that were taken before entering the pre-service program, after completion of the program, one year after leaving the program, and six years after leaving the program (Cady et al., 2006). The interviews were analyzed using codes created by the cognitively guided instruction (Carpenter & Fennema, 1988) tenets, traditional principles, and *Standards*-based principles (Cady et al., 2006). Follow-up interviews in the study identified that five of the participants exhibited beliefs and practices that were in alignment with *Standards*-based principles (Cady et al., 2006). Conversely, the research results indicated that two of the teachers still presented the procedural skills necessary to perform a problem-solving task and viewed problem solving as if it were not related to mathematics (Cady et al., 2006).

The data showed that teachers listed several influences that impacted their beliefs and practices toward *Standards*-based mathematics (Cady et al., 2006). Practicing *Standards*-based principles during the teachers' pre-service experiences had the most impact on their transformation of classroom practices (Cady et al., 2006). Cady et al. (2006) shared a comment from the participant Rachel that encapsulated the process:

> I think the project had some influence on me, but I didn't know that until I got in my classroom and started teaching mathematics. It was very difficult at the time to understand how everything was going to fit in.... When I think back, I go "oh yeah, that was why." I remember why this works best. (p. 301)

Attending professional development opportunities was another positive influence that participants agreed led to the increased use of *Standards*-based methods in teachers' practices (Cady et al., 2006).

On the negative side, the researchers also reported that teachers also did not realize how much time *Standards*-based teaching required until they left their pre-service environment (Cady et al., 2006). This caused the teachers in the study to voice a need for additional class time for mathematics during the day (Cady et al., 2006). Cady et al. (2006) noted that Vicky, one of the participants, often mentioned that high-stakes testing also influenced her practices. Vicky also felt pressured to sequence her curriculum and used procedural tasks to prepare students for achievement tests. In the study, two other teachers, Hannah and Sam, expressed similar pressures to a lesser degree, but they used students' understanding to guide their *Standards*-based instructional decisions (Cady et al., 2006). Cady et al. (2006) gave numerous examples of barriers to *Standards*-based teaching. Almost half of the teachers were able to overcome the obstacles and continued to use *Standards*-based strategies. However, the two teachers who still leaned toward traditional methods were affected adversely by the obstacles. Cady et al. (2006) provided more research in the study supporting the importance of an effective *Standards*-based pre-service education as preparation for teachers.

One Teacher's Story

Cady (2006) continued her research efforts by returning to the middle-school mathematics classroom. She described the difficulties that she encountered as a veteran teacher reentering the classroom after graduate school (Cady, 2006). Cady (2006) held beliefs that were consistent with the NCTM *Standards*, and she assumed that her practices would be implemented easily into the classroom. However, as she reflected on her actual teaching practices during the first few months, she portrayed herself as the epitome of traditional teaching—a routine of checking homework, presenting the lesson, checking for comprehension, assigning homework, and assessing with close-ended tests (Cady, 2006). Cady (2006) cited meetings, new-teacher orientations, and paperwork as barriers to implementing her *Standards*-based practices.

Cady (2006) prioritized problem solving as the biggest challenge. She noted that her textbook did not support *Standards*-based teaching strategies (Cady, 2006), so she chose to find some help. Cady (2006) supplemented her textbook with NCTM's *Making Sense of Fractions, Ratios, and Proportions* (Lutwiller, 2002) and *Navigating through Algebra in Grades 6-8* (Friel, Rachlin, & Doyle, 2001). She worked diligently on changing her teaching practices over the next two years. She indicated that some days were very difficult, but confidence came with experience. Cady (2006) reported that her questioning techniques became more probing and less revealing. She also admitted that time was always an issue for implementing worthwhile tasks, but her determined spirit helped her resolve this problem. Cady (2006) began to feel comfortable continuing discussions on a specific mathematics topic until the next day, and she included the concepts to be discussed with the ensuing tasks to reduce nonproductive discussion time. She witnessed a new level of engaging discourse from students, and an added plus was a reduction in discipline problems. Cady's story provided valuable insight into difficulties faced even by experienced teachers. Cady (2006) made no mention of any support from professional development opportunities, administrators, or colleagues. However, she demonstrated that teachers who hold *Standards*-based beliefs can overcome obstacles to implement *Standards*-based practices by setting goals and priorities and exhibiting patience (Cady, 2006). The limitation of this study was that all of the data were self-reported by Cady. Cady (2006) articulated hindrances that she faced as an experienced teacher with strong *Standards*-based beliefs, and her experiences magnified the negative impact that a curriculum can have on new teachers entering the classroom. She also proved that evolving teachers can retain their *Standards* beliefs and practices among adversity.

A Study of First-Year Teachers

Another study expanded the research on first-year teachers (FYTs) by looking at 12 secondary mathematics teachers who had participated in the same pre-service education (LaBerge & Sons, 1999). LaBerge and Sons (1999) reported that *Standards*-based mathematics teachers encountered a variety of influences that affected their beliefs and practices. In the study, the FYTs completed an 18-item survey, so the data were basically self-reported (LaBerge & Sons, 1999). The FYTs in the study also participated in an on-campus seminar discussion (LaBerge & Sons, 1999). The results from the survey indicated that four of the respondents reported very limited success implementing the *Standards*-based principles, three reported some success, and three reported moderate success (LaBerge & Sons, 1999). Two of the FYTs did not respond to the items on the survey pertaining to *Standards*-based principles (LaBerge & Sons, 1999). Seven of the FYTs participating in the survey listed time constraints and a lack of resources as barriers to implementing the NCTM *Standards* (LaBerge & Sons, 1999). The resources cited by the participants were calculators and computers (LaBerge & Sons, 1999). According to LaBerge and Sons (1999), two other obstacles mentioned were curriculum difficulties (4 of 12) and discipline problems (3 of 12). The researchers quoted one of the FYTs comments concerning the time barrier and the *Standards*, “If I do [try to implement the *Standards]*, I'll be further behind” (LaBerge & Sons, 1999, p. 144).

LaBerge and Sons (1999) pointed out that another viewpoint of time constraints dealt with the extra planning needed to integrate *Standards*-based lessons. Similarly from the discussion group, LaBerge and Sons (1999) shared that one FYT expressed a desire to implement *Standards*-based activities, but the element of time prohibited her from consulting with colleagues or planning the lessons. The researchers reported that the factors that supported the FYTs’ beliefs and practices included administration, their colleagues, and professional development activities (LaBerge & Sons, 1999). In the study, six of the FYTs listed the most significant factor that enhanced their *Standards*-based practices was their mathematics methods course (LaBerge & Sons, 1999). Interestingly enough, none of the FYTs in the study mentioned their former cooperating teacher as a help or a hindrance (LaBerge & Sons, 1999).

Since the data were mostly self-reported and not triangulated, the results had severe limitations. However, LaBerge and Sons's (1999) study has similarities to this research study. The research project described paralleled LaBerge and Sons (1999) in that all of the teachers completed the same secondary pre-service education, and the study investigated barriers that teachers experienced as they attempted to implement the *Standards.* This study delved more deeply into the barriers cited in the study by LaBerge and Sons (1999) by conducting individual interviews and observations.

Summary of Teachers' Beliefs and Practices and Other Influences

The studies examined in this section have shown that climate and circumstances surrounding a *Standards*-based mathematics teacher served as a profound influence (Van Zoest & Bohl, 2002). The curriculum provided a daily source of influence. In some cases the curriculum supported the *Standards*-based practices (Frykholm, 2004; LaBerge & Sons, 1999). However, the absence of a *Standards*-based curriculum can severely hamper the implementation of a teacher's *Standards*-based practices (Cady, 2006). The proper curriculum usually acted as a leavening agent to enhance the *Standards*-based practices of teachers, but sometimes teachers were determined to remain traditional teachers (Frykholm, 2004). For pre-service teachers entering the teaching profession, the availability of a *Standards*-based curriculum provided the advantages of more *Standards*-based lessons and activities for new teachers and a curriculum that is similar to their pre-service education. A common theme for the engrained traditional teacher was a weak content background (Frykholm, 2004). Cwikla (2004) pointed out that most of her participants graduated from their secondary mathematics program with a stronger mathematics background than some of their more experienced coworkers.

In addition to providing a strong mathematics background, mathematics teachers' pre-service preparation has a strong impact on their beliefs and practices (Adams & Krockover, 1997; Brown & Borko, 1992; Cady et al., 2006; Van Zoest & Bohl, 2002). Most teachers entering the classroom today explored mathematical concepts and skills in pre-service programs in ways that were conceptually and strategically different from their pre-college education (Ball, 1996; Pajares, 1992). The major components identified by research that impacted a teachers' beliefs and practices were mathematics methods courses (LaBerge & Sons, 1999; Wilkins & Brand, 2004) and fieldwork (Adams & Krockover, 1997; Brown & Borko, 1992). In the study by Adams and Krockover (1997), teachers reported that more fieldwork was needed to better prepare teachers for a reform classroom, but the influence of the cooperating teacher was not mentioned. The impact of pre-service teachers' internship (Van Zoest & Bohl, 2002) will be discussed later in the review of literature.

As teachers in the research studies tried to implement *Standards*-based principles that they had embraced, other influences impacted their practices (Ball, 1996; Kitchen, 2003). The issue of time emerged in some of the studies (Adams & Krockover, 1997; Cady, 2006; Cady et al., 2006; Kitchen, 2003; LaBerge & Sons, 1999). *Standards*-based mathematics concepts often took longer to discover, and less experienced teachers had to find techniques that improved their time management in the classroom (Cady, 2006; Keiser & Lambdin, 1996). Teachers in the studies recounted that preparation for *Standards*-based tasks took a significant amount of planning time (Cady, 2006; Cady et al., 2006; LaBerge & Sons, 1999). LaBerge and Sons (1999) reported that teachers did not have enough time to collaborate with colleagues (LaBerge & Sons, 1999). Generic teaching duties also required a lot of time for mathematics teachers (Adams & Krockover, 1997; Cady, 2006).

Mechanisms used to address the issue of time and other problems were providing mentors, encouraging teacher collaboration, and instituting peer observations (Cwikla, 2004). Another timesaver was the implementation of a *Standards*-based curriculum that had excellent lesson plans, effective questions, and activities for every lesson (Cady, 2006). Kitchen (2003) addressed the barriers of administrators, colleagues, and parents who did not hold beliefs in alignment with the *Standards*-based principles. On the other side of the spectrum, a well-designed mentoring program was used to improve teachers' attitudes, feelings of efficacy, and instructional skills in light of *Standards*-based mathematics (Darling-Hammond, 2003). The mentoring process worked especially well if the mentors were experienced teachers who had received training in *Standards*-based mathematics and used the strategies in their classrooms (Darling-Hammond, 2003). Cwikla (2004) found that mentors did not necessarily diminish the needs of novice mathematics teachers incorporating *Standards*-based practices. Cwikla (2004) noted that participants felt that a spirit of collaboration was important to help support their beliefs. The tactic of observing each other's classroom and discussing these examples helped gain insight to more productive *Standards*-based practices (Cwikla, 2004). The collaboration and mentoring of teachers can help them align their beliefs and practices with the guidelines of the NCTM *Standards* (Cwikla, 2004). Learning to teach in harmony with *Standards*-based ideals is an intricate and lengthy process (Feiman-Nemser, 2001). From the research in this section, we can see that the influences of curriculum, professional development, and collaboration with colleagues can provide a much needed boost to encourage transitioning teachers' beliefs and practices while other negative influences can whittle away at their beliefs and practices.

The influences discussed in the preceding paragraphs impacted secondary teachers' beliefs and practices to some degree. In this section, some teachers were able to cope with the negative influences and maintain their implementation of the *Standards,* and other teachers reverted toward a more traditional teaching style. Some teachers were so determined to overcome the negative influences that their affect toward the *Standards*-

based teaching was even stronger. The next section continues the discussion of research about influences through an equity lens.

Teachers' Beliefs and Practices and Equity

The influences discussed in the previous section are all external factors that help work together to comprise mathematics teachers' classroom climates. Other influences can come from within mathematics teachers' personal biases. These biases can also impact the teaching and learning of *Standards*-based mathematics teachers, and equity is a key concern to all of the stakeholders. NCTM (2000) designated equity as one of its basic principles. The document explained that "equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students" (p. 12). A key player in achieving equity for *all* students is the classroom teacher. NCTM (2000) charged teachers with a responsibility to understand and address cultural differences in the classroom:

> Teachers need help to understand the strengths and needs of students who come from diverse linguistic and cultural backgrounds, who have specific disabilities, or who possess a special talent and interest in mathematics. To accommodate differences among students effectively and sensitively, teachers also need to understand and confront their own beliefs and biases. (p. 14)

Teachers must have a thorough content knowledge and pedagogical content knowledge as well as an appreciation for diverse needs and cultures. NCTM (2000) painted a picture of the equitable teacher as one who teaches with "big expectations and worthwhile opportunities for all” (p. 12). According to the *Professional Standards for Teaching Mathematics* (NCTM, 1991), teachers should afford an appropriate context for *all* students and acknowledge the merit in *all* students’ ways of thinking. Mathematics teachers should ensure that *all* students are learning important mathematics, and the affect of students is positive (NCTM, 1991). Teachers value students' diverse backgrounds, including linguistic, cultural, and socioeconomic, and consider these backgrounds when designing their teaching strategies (NCTM, 1991). The NCTM position statement (2008) on equity defines equity as “high expectations, respect, understanding, and strong support for all students.” The statement continues to say that teachers’ beliefs and practices must be constantly examined to make sure that all students are receiving the accommodations that they need to achieve their maximum potential.

Teaching Styles and Socioeconomic Status of Students

Unfortunately, not all teachers value diverse student populations. Boaler (2002) illustrated the issue of equity in reform mathematics with a three-year study in England that compared two low SES secondary schools that were comparable demographically. Boaler (2002) described the climates of both schools involved in the study. Amber Hill teachers approached mathematics more traditionally using ability grouping and procedural methodology. Phoenix Park teachers used an open-ended approach in their mixed ability mathematics classes. The Phoenix Park teachers and collaborators from the Association of Teachers of Mathematics in England developed the curriculum which was in alignment with *Standards*-based principles (Boaler, 2002). The Association of Teachers of Mathematics in England is equivalent to the NCTM in the United States (Boaler, 2002). Boaler (2002) reported that at the conclusion of the study, Phoenix Park far outscored Amber Hill on all assessments, including the national examination given to English students. The researcher included the fact that students at Phoenix Park scored above the national average even though the school was located in one of the poorest parts of England (Boaler, 2002). The achievement outcomes were not distinguishable by SES class, but those who exhibited improved achievement were split equally among middle and lower class (Boaler, 2002).

Boaler (2002) pointed out that "research has found that some reform approaches do promote equity and high achievement, and it is important to understand the conditions that supported such achievements and to examine the ways in which these reform approaches differed from others" (p. 240). The teachers at Phoenix Park did not adjust their teaching styles for students based on SES, and the achievement gap between middle and lower class was reduced (Boaler, 2002).

Improving Achievement for Low-Attaining Students in England

In another study conducted in England, the implementation of the revised curriculum and teaching suggestions made by the Department for Education (1995) was researched. Watson and de Geest (2005) conducted the Improving Attainment in Mathematics Project (IAMP) in England using a collaborative effort among teachers and other stakeholders to improve achievement in low-achieving secondary students. IAMP involved participants from the University of Oxford, the University of Birmingham, and ten classroom teachers (Watson & de Geest, 2005). The researchers reported that IAMP brought together a team of teachers that wanted to improve students' mathematical thinking and shared the belief that all children could learn (Watson & de Geest, 2005). Watson and de Geest (2005) stated that the main purpose of the research was to study the practices of the participating teachers and identify common principles that led to improved mathematical learning. The researchers pointed out that England has an established tradition of tracking students in mathematics classes according to past achievement (Watson & de Geest, 2005). Recent English curriculum goals encouraged teachers to promote discourse, presentation of findings by students, visual representation, explicit correction of errors, and the incorporation of technology (Department for Education and Employment, 2001). Watson and de Geest (2005) pointed out that the new national development in England was very similar to the reform curricula around the world. In 2001, the new national initiative provided mathematics teachers with materials for low-achieving students that helped structure their teaching, and all schools were given worksheets, plans, and lesson ideas that included a few key specific lesson plans (Watson & de Geest, 2005). The researchers discovered that experienced teachers felt a high level of frustration with the new materials and expressed a desire to try different approaches (Watson & de Geest, 2005). The Esmee Fairbairn Foundation funded the IAMP and allowed teachers to explore supplementary ways to teach low-achieving target students (Watson & de Geest, 2005). Watson and de Geest (2005) added that the targeted students were not included in the national system of assessment and accreditation because their achievement scores were so low.

Eight teachers remained throughout the duration of the study, and they all volunteered to participate in IAMP (Watson & de Geest, 2005). The researchers recognized the teachers as co-researchers, and the teachers chose strategies from a variety of reform-based research suggestions and evaluated the effects on students' learning (Watson & de Geest, 2005). The data included audio tapes of group discussions, audio tapes of interviews with researchers, video tapes of lessons, students' work and tests, field notes of discussions, and teachers' notes (Watson & de Geest, 2005). The data from the study were analyzed using a grounded theory approach that searched for the relationship of practices that led to improvements in achievement (Watson & de Geest, 2005). One of the limiting obstacles that Watson and de Geest (2005) encountered included a self-selected participant pool who the researchers already knew due to lack of volunteers. Another complication arose when some teachers used the suggested strategies while others chose alternative methods (Watson & de Geest, 2005). The researchers also reported that some teachers were able to provide very little data, and the information from the meetings, discussions, and observers' notes was used to generate the data common to all participants (Watson & de Geest, 2005). Watson and de Geest (2005) also described a lack of consensus among the teachers about the appropriate types of teaching strategies and mathematical definitions. The focus of the first part of the study emerged as a process for defining improvement and an avenue for coming to agreement about profitable activities in the classroom (Watson & de Geest, 2005).

According to Watson and de Geest (2005), there were no common methods or materials that connected the study. The researchers reported that some teachers exhibited strategies in alignment with reform principles while others matched a traditional style of teaching that relied heavily on the textbook (Watson & de Geest, 2005). Watson and de Geest (2005) constructed a set of mathematical actions from the teachers' data that indicated that learners are thinking about mathematics. The activities listed that were in alignment with the *Standards*-based principles included:

- describing connections with prior knowledge
- generalizing structure from diagrams or examples
- generating own inquiry
- predicting problems
- giving reasons
- working on extended tasks over time
- creating and sharing own methods
- making comparisons
- posing own questions
- dealing with unfamiliar problems
- initiating their own mathematics (Watson & de Geest, 2005, pp. 223–224).

Watson and de Geest (2005) pointed out that not all, but most teachers were incorporating most of the activities listed above, and some had modified their teaching practices to include these activities. Watson and de Geest (2005) reported that the data indicated a shift in teaching style from prompted lessons to use of nontraditional strategies that were first used by teachers and were later adopted by learners. The researchers also discussed the significant findings from the analysis of the data (Watson & de Geest, 2005). The analysis showed results that were in direct opposition to the standard customary practices for students labeled as low-achieving. The results were so startling that Watson and de Geest (2005) discussed the findings several times with the teachers for clarification and assurance of accuracy. The common beliefs that emerged were that teachers communicated shared beliefs that "all students could learn mathematics, that mathematics is intrinsically interesting, and that it is the teacher's job to support learner's approaches to mathematics as it is, with all its complexities" (Watson & de Geest, 2005, p. 225).

Watson and de Geest (2005) summarized that the most common concept was the "creation of space and time for learning through extended thinking time and extended tasks" (p. 230). The results showed that the extra time and extended tasks enabled low-attaining, discouraged students to gain recognizable, testable skills. These beliefs *arose from their own shared principles,* and these teachers *freely innovated for themselves* using a variety of methods (Watson & de Geest, 2005, p. 230). Watson and de Geest (2005) interpreted the teachers' commitment to the project, the opportunity to have discussions about their activities and learn from each other and the researchers, and their use of unconventional methods as a positive influence for achievement for low-attaining students.

Watson and de Geest's (2005) study was not intended to study the implementation of the NCTM *Standards* but was investigating improving achievement for low-attaining secondary students. The new initiatives for England are loosely related to the NCTM *Standards* (Watson & de Geest, 2005). Many of the teaching activities agreed upon to enhance mathematical thinking represented tenets of *Standards*-based mathematics (listed in a preceding paragraph). The participants were not focusing on a particular teaching method or curriculum, but they developed a list of principles with accompanying actions that Watson and de Geest (2005) described as successful mathematical teaching. The importance of high expectations for all students and the emphasis on students' understanding and explanations (Watson & de Geest, 2005) corresponded to *Standards*-based mathematics. The researchers admitted that the data collection was not rigorous due to the limited number of participants and their other commitments (Watson & de Geest, 2005). Also, the discussions of analysis (Watson and de Geest, 2005) did not provide any representative quotations from the participant teachers which would have provided a better understanding of teachers' beliefs and practices.

In summary, researchers in this study set out to improve students' mathematical thinking by implementing a curriculum that was in alignment with the guidelines of the *Standards.* The students in the study were considered extremely low achievers. Most of the teachers who volunteered for this research project shifted to practices that were consistent with the *Standards*, and the results were startling (Watson & DeGeest, 2005). At the conclusion of the study, the beliefs and practices of these teachers displayed many similarities to the focus of *Standards*-based mathematics. The teachers shared the emerging belief that all children can learn (Watson & DeGeest, 2005). This study showed the importance of mathematics teachers confidently holding the belief that all students can learn using *Standards*-based strategies.

Assessment Inequities

Sometimes teachers' beliefs about the ability of SES students affect their assessment decisions. Thomas, Madaus, Raczek, and Smees (1998) collected data from the National Curriculum of England assessment results from 17,718 seven-year-olds and compared the results from the performance-based standard tasks (STs) with the teacher assessments (TAs).

Thomas et al.'s comparison (1998) of the STs and the TAs showed that inclusion students, low-SES students, and English-as-a-second-language students were not assessed fairly due to teachers' biases (Thomas et al., 1998). The researchers conveyed that teachers' beliefs about students were influencing the TAs, and teachers were not assessing students equitably during subjective "authentic" assessments. Instead they were adding to the achievement gap with unsubstantiated lower assessments (Thomas et al., 1998). Similarly, Reeves, Boyle, and Christie (2001) used data from nationally representative samples of schools in England and Wales. The purpose of their study was to explore relationships among pupil performance in Key Stage 2 standard tests, TAs for these students during the same timeframe, and variables with regard to gender, language, and special education needs (Reeves et al., 2001). The results showed that teachers held beliefs that demonstrated bias by underestimating the ability of inclusion students (Reeves et al., 2001). The study also reported that as many as one fourth of the inclusion students performed above the level that their teacher reported (Reeves et al., 2001). The researchers noted that some students were probably denied access to attempt certain level tests simply because of teacher expectations (Thomas et al., 1998).

These two studies represented large amounts of quantitative data from England and Wales, but neither of the studies were viewed from a specific teaching philosophy. Also, the students that were researched were much younger than secondary students. The results, however, illustrated that teachers displayed biases due to students' abilities, SES, and language barriers. Teachers entering the classroom must closely examine their own biases and address them.

Teaching Based on Socioeconomic Status

What do mathematics teachers consider equitable situations in *Standards*-based classrooms? Often teachers adjust learning strategies depending upon the socioeconomic makeup of the students (Lubienski, 2002; Sztajn, 2003). Sztajn (2003) conducted research on the relationship between equity and *Standards*-based teaching practices in mathematics. The researcher noted that participation in the project required knowledge of the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and none of the selected teachers could be involved in any long-term, professional development program (Sztajn, 2003). Sztajn (2003) reported on two case studies of elementary school teachers. She described research on Teresa Walker, a third-grade teacher who categorized herself as a "language arts person." Teresa had recently participated in a three-week intensive course that emphasized problem solving and the use of manipulatives in the mathematics classroom. Sztajn (2003) also studied Julie Farnsworth who taught fourth grade and was also a doctoral student in elementary education. Julie was more of a "mathematics and science person" and was aware of the principles in the NCTM *Standards.* Sztajn (2003) reported that both teachers were conscientiously trying to implement *Standards*-based principles individually in their classroom. The purpose of the study was to discover factors that caused teachers to modify *Standards*-based ideals apart from mathematics teaching and learning (Sztajn, 2003).

The study examined Teresa and Julie who both taught in public schools that were composed of all White students (Sztajn, 2003). The socioeconomic background of the two schools were very different, 40% of the students at Teresa's school received free or reduced lunches while only 10% of the students at Julie's school qualified (Sztajn, 2003). According to Szatjn (2003), Teresa and Julie reported that the educational level of the parents was also divided. The parents at Teresa's school were mostly blue-collar workers and low income, but the parents at Julie's school were made up of doctors, lawyers, and university professors (Sztajn, 2003). The researcher spent four weeks in each teacher's classroom observing and conducted five semi-structured interviews with each teacher. The researcher observed all day, every day of the week, to construct a more complete picture of the teacher and her practice (Sztajn, 2003). Sztajn (2003) also interviewed the principals involved, other teachers in the schools, and some parents of the students.

Sztajn (2003) viewed data collection and analysis from a progressive problem-solving standpoint. After each week of observation, Sztajn (2003) interviewed the teachers and used all pertinent information to guide the next round of observations. After the data collection phase was complete, Sztajn (2003) triangulated all of the data and looked for evidence of beliefs beyond mathematics that influenced the teachers' implementation of *Standards*-based methods. According to Sztajn (2003), the data analysis results revealed that teachers interpreted reform differently depending on the socioeconomic status (SES) of the students in their classroom. The theme of *students' needs* surfaced as an important consideration in the teaching of mathematics. The analysis by Sztajn (2003) disclosed that teachers were influenced by beliefs about children, society, and education in general, and these beliefs impacted their expectations of students. Sztajn (2003) also reported that teachers considered students' needs when adapting their mathematics teaching strategies, and these ideas went beyond mathematics.

Sztajn (2003) used the case study of Teresa to describe the implementation of *Standards*-based mathematics through the lens of *students' needs*:

> Teresa thought that structure and order were especially important for her students because 'their community' lacked organization. Additionally, Teresa described the society as 'mobile and transient' because most of the students came from

> 'unstable families'. Teresa agreed that higher-order thinking and problem-solving skills were critical in mathematical learning. However, she expressed doubt in being able to teach critical thinking skills and still maintain discipline in the room. Teresa summarized her feelings, 'I don't want school to be like home for them. (...) I want my class to be pleasant. I want it to be safe, organized.' A key word in Teresa's classroom was that she must always help her students 'remember.' (Sztajn, 2003, p. 62)

Teresa's comments conveyed that she thought she was implementing equitable teaching that had to be "adjusted" for socioeconomic status (Sztajn, 2003).

Sztajn (2003) presented an example of a mathematics teacher with similar views as Teresa. The two teachers differed not in their attitudes but in their current teaching situations:

> Julie felt that she was already teaching mathematics in a *Standards*-based manner but wanted to improve her implementation of the NCTM *Standards.* Julie incorporated manipulatives, problem solving, and projects into her daily routine. Julie felt that students needed exposure to ongoing problem solving with the quote, 'they need more things that are not just one-shot deals' (p. 65). Julie revealed her way of thinking when she admitted that she had to deal with fewer remedial problems because her students come to her with a lot of knowledge such as basic facts that they have learned at home. Julie formerly taught at a school where the majority of students were low SES before coming to her current school. Julie's attitude explained the need to use different teaching approaches based on students' SES:

> When I taught at a school where children were poorer, [the kids] needed to become literate and numerate. I mean, really, that was a goal for me to, for them to be literate and numerate because their low socioeconomic background went hand in hand with their skills. So I had to work on all these things with those low kids. With wealthier students it's different because they have that background before school. (Sztajn, 2003, p. 67)

Sztajn (2003) examined Teresa's and Julie's beliefs and practices in connection with the SES of students. Julie's teaching methods were more student-centered while Teresa employed more traditional methods because of her students' SES (Sztajn, 2003). Teresa's and Julie's beliefs held about low-SES students' learning abilities that emerged from the study were not in alignment with the *Standards.* Sztajn's (2003) discussion further revealed that both teachers had the same beliefs about students' ability to learn based on their SES but were currently teaching differently because of the dissimilar demographics of the students. Therefore, their *Standards*-based practices were influenced by their beliefs about certain students' ability to learn.

Equity Studies in Secondary Schools

In the following paragraphs are two equity studies in secondary schools. One investigated secondary mathematics teachers who felt that equality and "color blindness" was the same as equity. The second study examined the problems teachers' encountered with the context of word problems.

Equality and Color Blindness

Mathematics teachers also may display a lack of understanding of equity in secondary schools. Secondary teachers equated equality and "color blindness" with equity (Rosseau & Tate, 2003). Rousseau and Tate (2003) conducted a study that involved seven mathematics teachers of low-tract students at the same high school. The researchers approached the study from a social reconstructionist viewpoint (Rousseau & Tate, 2003). The social reconstructionist approach uses reflection to concentrate specifically on implications for teaching that promotes equity and justice. Rousseau and Tate (2003) connected social reconstructionism to two recommendations in the *Professional Standards for Teaching Mathematics* (NCTM, 1991). The recommendations focused on teacher reflection of the influence of the students' demographics on their learning and the role of mathematics in society and culture (NCTM, 1991). The majority of the students at the school were White (74%), 12% were African American, and 4% were Latino, but the minority students were overrepresented in the low-tract mathematics classes (Rousseau & Tate, 2003). All of the mathematics teachers were White. Rousseau and Tate (2003) gathered data using individual teacher interviews and weekly observations. The purpose of the study was to examine teachers' beliefs related to equity and the effect of those beliefs on their teaching practices. Their study reported two pervasive beliefs of teachers that promoted inequitable practices for students of color (Rousseau & Tate, 2003). First of all, Rousseau and Tate (2003) reported that teachers believed that equity meant equal treatment for all students. One teacher expressed his belief that he was treating all students equitably, "I try to make sure that I am working with all of my students equally, or I am responding to my students equally ... treating them equally is probably the biggest diversity issue as far as I am concerned" (Rousseau & Tate, 2003, p. 213). Secondly, according to Rousseau and Tate (2003), none of the teachers expressed an emphasis on the students' learning outcomes in connection with equity but only on the learning process.

The researchers also stated that teachers felt color blindness was the politically correct stance toward equity (Rousseau & Tate, 2003). Rousseau and Tate (2003) noted that the teachers did not purposefully refuse to recognize the students' race but saw the connection between students' race and achievement. Consequently, the teachers did not view teaching strategies as possible reasons for the gap in achievement based on race. The researchers additionally reported that the teachers frequently blamed the achievement gap on SES, thereby placing the blame for underachievement on the home situations of the students (Rousseau & Tate, 2003). The study showed that the teachers' color blindness caused them not to examine themselves or the school to see if they were contributing to the reproduction of unequal educational outcomes (Rousseau & Tate, 2003). In the end of the year interview, one teacher's comment underscored the lack of understanding of the concept of inequity. "I don't think that [equity] has really come up. I mean, I have never, I don't feel like I have ever been faced with any kind of issues based on equity or diversity" (Rousseau & Tate, 2003, p. 214).

The classroom example that the researchers had observed depicted Ms. Smith, the mathematics teacher, essentially sitting at her desk the entire class period (Rousseau & Tate, 2003). The researchers further explained that Ms. Smith did not "give help until the students took the initiative to ask for it" (Rousseau & Tate, 2003, p. 214). This example was representative of the mindset and teaching style of teachers of low-tract mathematics classes (Rousseau & Tate, 2003). Rousseau and Tate (2003) noted that the lack of reflection by teachers in the study perpetuated a teaching style that was influenced by the beliefs about the achievement capability of students of color.

The study had several limitations but also provided valuable insight into teachers' attitudes regarding equity. Rousseau and Tate (2003) did not discuss the methods of data analysis. The focus of the study emphasized the importance of reflection, but no specific methods of reflection were discussed. The researchers did not dwell on specific teaching strategies when discussing the data, so the study did not specifically apply to *Standards*-based beliefs and practices through the equity lens. However, the researchers' implications about teachers' views of equality and color blindness added to the knowledge base of equity. Rousseau and Tate (2003) showed that the concept of equity is often confused with equality.

Student's Attitudes toward Problem Solving

Other teachers recognized the differences in the learning styles higher-SES and lower-SES students (Lubienski, 2000). Lubienski (2000) directly researched problem-solving attitudes of seventh-grade students through the lens of SES. She studied 12 target students that included six boys and six girls (Lubienski, 2000). The boys and girls in her study were distributed equally by SES. Lubienski (2002) reported students' differences of beliefs occurred in their experiences with whole-class discussions and open-ended problems. Lubienski (2002) brought to light that higher-SES students had a more positive attitude toward open-ended problems. For example, Guinevere, a seventh-grade student, represented the general tenor of the higher-SES students in the study by commenting, "I guess our family's just—we are word problem kind of people" (Lubienski, 2002, p. 115). According to Lubienski (2002), lower-SES students expressed confusion related to various ideas in discussions and just wanted to be told "the rules." She further explained that lower-SES students tended to become so engrossed in the context of the problem that they missed the intended mathematical point (Lubienski, 2000, 2002). Lubienski (2002) concluded that teachers needed to identify and find strategies to dissipate the difficulties the lower-SES children experience. From her personal research, Lubienski (2000, 2002) felt that teachers must continue to have high expectations and not give in to adjusting problems to fit the comfort zone of lower-SES students.

Lubienski's (2000) study has been misinterpreted by a number of researchers. Numerous studies have cited that Lubienski (2000) was implying that *Standards*-based approaches with lower-achieving students actually promoted more inequity (Gutstein, 2003; Irwin, 2001). A limitation was that Lubienski (2000) conducted self-directed research, so the data were self-reported. The study provided insight about the importance of context when selecting engaging tasks. The study also expanded the research data on students' approaches to nonroutine problems based on their SES. Lubienski (2000) pointed out the need for teachers to be aware of the difficulties that contextual problems pose for students of low-SES. Less-experienced teachers need to maintain high expectations for students of all demographic backgrounds and carefully take into account the context of activities and tasks to uphold an atmosphere of equity for *all* students.

Secondary Schools with a Majority of English Language Learners

Context, among other concerns, is also important when studying equity for English language learners (ELL). As the number of Hispanic immigrants increases in the United States, the number of English language learners becomes more prominent in our school systems. In some cases, there are areas of the country in which a majority of the students in the school system are ELL (Gutierrez, 1999). As pre-service teachers enter the work force, they may find themselves in a school that contains a significant percentage of students with a language barrier. Most pre-service teachers have very little exposure to school systems with a majority of ELL (Gutstein, Lipman, Hernandez, & de los Reyes, 1997). A placement in a classroom with this environment could impact teachers' beliefs and practices. The next two studies look at different examples of equitable teaching practices in schools with a majority of Latino students.

A Culturally Relevant Approach

One of the studies investigated the implementation of a culturally relevant curriculum teaching approach (Gutstein, et al., 1997). The training that most pre-service and inservice mathematics teachers receive does not usually include exposure to cultural issues in any depth (Gutstein et al., 1997). The purpose of Gustein et al.'s (1997) study was to research the relationship between *Standards*-based mathematics and culturally relevant teaching in a Mexican American community. A secondary goal of the study was to examine how teachers integrated the Mexican American culture into mathematics lessons. Gutstein trained eight mathematics teachers who were fluently bilingual using the *Mathematics in Context* (MiC) middle school curriculum (National Center for Research in Mathematical Sciences Education & Freudenthal Institute, 1995). Gutstein and Lipman worked directly with the project and introduced a local university student and the principal into the second phase of the project. The teachers were chosen because of their strong stances of four criteria: (1) they believed all children could learn; (2) they saw the importance of the Mexican culture and language; (3) they were interested in all children; (4) they were convinced that they could impact all of their students (Gutstein, et al., 1997).

In the study, teachers encouraged students to explore mathematical concepts and come up with an explanation that they understood (Gutstein, et al., 1997). The teachers used effective questioning and expected the students to present and justify their reasoning. For example, Ms. Herrera, a Mexican American teacher, pushed her students to become critical thinkers and “stand up for what they think is right.” As an educator she also felt the need to foster leadership skills in her students. Mr. Simkin often used Spanish in his classroom to produce camaraderie with his students, and sometimes he even digressed into Spanish only with students who were recent immigrants (Gutstein, et al., 1997).

The study emphasized the importance of a collaborative group effort that involved numerous stakeholders—teachers, a principal, and community members (Gutstein, et al., 1997). The fact that the players involved represented Mexican American, Peruvian, Columbian, and White backgrounds provided the added benefit of cultural diversity. The teachers in the study infused culture into their teaching styles and continued to incorporate *Standards*-based strategies into their classroom. The study provided an excellent example of *Standards*-based teaching and culturally relevant teaching working together harmoniously.

Union High School

Other teachers used a proactive approach to produce equity for mathematics students because they believed that all students could be successful. Gutierrez (1999) reported on research conducted at a school using an organized-for-advancement (OFA) framework, which called for teachers to work together collectively. Gutierrez (1999) described the demographic makeup of the faculty and students. The study took place at Union High School in Chicago at a high school with a primarily Latino (67%) population and the remaining students consisted of African-Americans (15%), Whites (13%), and Asian-Americans (5%). The native languages of the students of Union High represented 42 different languages. The majority of the mathematics teachers were White and middle class. Gutierrez (1999) also reported that the head of the mathematics department, a self-claimed social activist, strongly supported the teachers' right to choose the appropriate curriculum and strategies to achieve their goals.

The researcher noted that the key to Union's success in mathematics was the OFA framework that promoted solidarity of the teachers' goals and determination (Gutierrez, 1999). Gutierrez (1999) described the communication among the three core teachers in the OFA mathematics department as positive, reflective, and continuous. She further explained that another important component was the mathematics department's partnership with a local university that provided professional development in cooperative learning and supporting students. Gutierrez (1999) emphasized the importance of teaching via problem solving and other *Standards*-based principles, but she never actually addressed the actual teaching practices that the teachers used.

Gutierrez (1999) focused on the equity issue for minority students and the beliefs of Union's mathematics faculty. She explained that instead of lowering expectations for minority students, the teachers "convinced" the students to take an extra intensified summer course and take a double-period of calculus to prepare for the AP exam. According to Gutierrez (1999), the number of students taking calculus jumped from 30 to

61 in two years. The researcher pointed out that teachers were not just lucky in promoting more participation in higher-level mathematics courses, but they took energetic steps to develop meaningful relationships with the students (Gutierrez, 1999). The teachers were devoted to out-of-classroom activities such as advanced placement (AP) review sessions, tutoring at lunch or after school, talking with the students outside of class, and attending a variety of extracurricular activities. The teachers used these opportunities to get to know their students personally, socially, mathematically, and pedagogically. Gutierrez (1999) added that another important piece of the puzzle included the administrator providing time to meet together and also release time for personal development.

The goal for Union High mathematics department was to expand the participation of upper level mathematics courses for all students, specifically calculus (Gutierrez, 1999). Gutierrez (1999) praised the accomplishments of teachers who collectively set goals and went the extra mile for the students to accomplish those goals. The researcher in this study did not discuss particular teaching styles but concentrated on the importance of the Equity Principle that *all* students can learn (NCTM, 2000) and the need for teachers to understand how students' demographics influence their learning (NCTM, 1991). Both of these studies involving English language learners added to the base of knowledge concerning the use of equitable teaching practices for *all* students.

Systemic Urban Projects

The concept of learning for *all* was also demonstrated in two systemic urban projects. Both the Algebra Project (Silva & Moses, 1990) and the Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project (Silver & Stein, 1996) reported on systemic urban projects that promoted equitable teaching of mathematics that was in alignment with the NCTM *Standards*. Both of these projects provided encouraging results for low-SES schools.

The Algebra Project

Recognizing the need for more equitable representation in higher-level mathematics classes, Robert Moses visited his daughter's sixth-grade mathematics classroom, and he was convinced that all students should be able to master algebra and qualify for honor mathematics and sciences classes in high school (Silva & Moses, 1990). The Algebra Project, a systemic urban project, was born with three broad goals. The Algebra Project sought to develop mathematically literate and confident middle school students who were prepared for upper level mathematics and science classes (Silva & Moses, 1990). Another goal was to prepare teachers to serve as facilitators to learn mathematics using real life experiences and supporting students in the social construction of mathematics. The Algebra Project hoped to incorporate more stakeholders in the *effective effort* and include parents, community volunteers, and school administrators to support the teachers (Silva & Moses, 1990). Moses recognized the students' barrier to transition from concrete representation to the abstract nature of algebra. Moses created the Transition Curriculum, a five-step process to cross the symbolic barrier (Silva & Moses, 1990). During this process, students understand the mathematical concepts and devise explanations in their own words as a beginning stage. At the first stage, the students must be allowed to use "their" language and are not required to use Standard English. This language could be a dialect of English, such as Black English, or the students' native language. In the next phase teachers lead the students from their subconscious language to regimented (structured) English (Silva & Moses, 1990).

West and Davis (2005) reported that this process creates social support for proficiency and sense of community among students, no matter what the cultural makeup.

The Algebra Project teachers had common beliefs about the achievement of all students and were committed to the concept of group work, cooperation, and taking risks (Silva & Moses, 1990). Silva and Moses (1990) noted that the teachers volunteered to be involved in the Algebra Project and participated in an intense training program. The teachers did not seek to weed out marginal students but cultivated all students' minds. Both students and teachers in the Algebra Project encouraged positive patterns of behavior and discouraged negative destructive attitudes or actions (Silva & Moses, 1990). The teachers in the Algebra Project adjusted their teaching styles due to the ethnic makeup of their students. They still utilized reform strategies but allowed students to use "their language" at appropriate times.

Quantitative Understanding: Amplifying Student Achievement and Reasoning Project

Another systemic urban project, the QUASAR Project, also sought to increase achievement of low-SES students. The QUASAR Project (Silver & Stein, 1996) was developed with the belief that students of low SES had the ability to learn mathematics conceptually. Silver and Stein (1996) described how QUASAR began in 1990 with an emphasis on incorporating a collaborative effort among teachers, administrators, and mathematics educators (Silver & Stein, 1996). The researchers reported that QUASAR focused on students learning mathematics by engaging in activities that are embedded in the students' social and cultural context (Silver & Stein, 1996). Four schools were initially involved with the project, but two schools were added later. The student population was one half African American, one third Latino, and one eighth White.

Two of the schools in QUASAR served a majority of students that did not use English as their first language at home. Seventy-five percent of all the QUASAR students lived in households with an income of less than $20,000 per year (Silver & Stein, 1996).

Silver and Stein (1996) described the QUASAR classroom teachers as having a positive belief in *all* of the students' abilities to learn conceptually even though they were aware of the many adversities that existed in the student population. These teachers had confidence that the students were able to understand the mathematics (Silver & Stein, 1996). They agreed with the incorporation of learning strategies that constructed the students' mathematical understanding and employed the use of engaging tasks that challenged students (Silver & Stein, 1996). Silver and Stein's research (1996) revealed that one school reported a 400% increase in placement to the ninth-grade algebra track (from 8% to more than 40%). The researchers also reported that a QUASAR school had the second-highest passing rate, outperforming more than 20 other schools in the district (Silver & Stein, 1996).

Silver and Stein (1996) noted that the beliefs of the teachers in this study contributed heavily to the success of this program and helped to dispel the myth that high-order critical thinking and high expectations were not appropriate for low-SES students. The teaching styles of the QUASAR teachers were not altered for low-SES students, and they maintained high expectations for *all* students to participate in challenging activities. The results of the QUASAR project added to the growing body of success stories for students of low SES. The Algebra Project and QUASAR are very relevant to the geographic location of this research study. The teachers in this study were exposed to equitable teaching practices for *all* students in their pre-service education.

A significant number of the schools in our surrounding area contain a majority of students with low SES, minority populations, or both. Transitioning teachers in this study must believe in *all* of their students and maintain high expectations for *all* students regardless of SES, race, or any factors that could be perceived as obstacles.

Summary of Teachers' Beliefs, Practices, and Equity

The preceding review of related literature illustrated the diversity of the approaches of teachers toward students with needs based on their culture or SES. Some teachers lowered their expectations in an effort to "help" students (Lubienski, 2002; Szatjn, 2003). These students were not receiving the accommodations to produce an equitable education, but actually the teaching strategies only decreased the significant mathematics that the students were learning. The research by Rousseau and Tate (2003) also showed that teachers believed that they were "helping" students by their color blindness and equal treatment of students. In a Mexican American school setting, the teachers believed that students could learn more equitably by incorporating a curriculum that matched their cultural background (Gutstein et al., 1997). Culturally relevant teaching agreed with NCTM *Standards* about teachers utilizing children's existing knowledge. These students not only received a *Standards*-based teaching approach, but they also developed a sense of pride in their culture and leadership skills. The teaching approaches tapped into students' cultural and mathematical knowledge and developed students' critical thinking skills (Gutstein et al., 1997). The project at Union High School (Gutierrez, 1999), the Algebra Project (Silva & Moses, 1990), and the QUASAR project (Silver & Stein, 1996) also promoted a more equitable education for diverse students by using a collaborative effort to cultivate the expectation that *all* students can be successful in higher-level mathematics courses. The Algebra Project and these other projects successfully helped students “escape the parking lot” of the basic mathematics track (Silva & Moses, 1990). These projects negated the assumption that algebra should only be offered to certain students. They also repudiated the assumption that inner-city and minority students should be steered away from upper level science and mathematics courses (Silva & Moses, 1990). The results from Boaler's (2002) research emphasized that all students can learn equitably using *Standards*-based methods.

Teachers’ beliefs play a significant role in their approaches to address the issues of diversity. They must start with the strong belief that children come to school from a variety of cultures with their own impressive academic achievements (Means & Knapp, 1991). They must determine the best teaching approaches given the circumstances, and these strategies may take many forms as long as the teachers do not lower their expectations of any of the students. As teachers enter their own classroom, they must closely examine their beliefs to ensure that they are convinced that they can provide equitable teaching practices for *all* students.

Teachers’ Beliefs and Practices and *Standards*-based Principles

The three previous sections focusing on affect, other influences, and equity dealt with various issues that affected teachers’ beliefs and practices of secondary mathematics that related to *Standards*-based methods. These issues are heavily interwoven with beliefs and practices and have contributed to the formation of teachers’ beliefs and practices. The final review of literature on teachers’ beliefs and practices and their connection to the NCTM *Standards* will look at studies from other countries, studies about pre-service teachers, studies based on curriculum, a study looking at teachers changing independently, and a study dealing with a professional development model.

Secondary Mathematics Teachers in Tasmania

One foreign study conducted in Tasmania focused on the beliefs of individual teachers. Beswick (2007) researched and identified specific beliefs of secondary mathematics teachers that are the underpinnings of the constructivist philosophy. Beswick's view of constructivism was based on von Glasersfeld's (1990) writings that suggested that learning builds on prior knowledge that has been constructed in the context of past experience. Therefore von Glaserfeld (1990) indicated that learning is a purposeful progression where students align their constructed knowledge so that it fits optimally with experience.

In the study, Beswick (2007) researched an initial sample of 25 teachers that was made up of mathematics teachers in grades 7–10 in a rural area of Tasmania. The researcher selected eight of these teachers for case studies. The teachers administered the Constructivist Learning Environment Survey (CLES) that was developed by Taylor, Fraser, and Fisher (as cited in Beswick, 2007) to one or two of their classes. The researcher stated that a total of 39 classes participated in the survey portion of the study (Beswick, 2007). The CLES used in the study contained 28 items that examined the frequency of learning events in their classroom. The CLES items were divided into four categories of *Standards*-based teaching: autonomy, prior-knowledge, negotiation, and student-centeredness. In the study, the teachers completed a beliefs survey about the nature of mathematics, mathematics teaching, and mathematics learning; responded to a semi-structured interview; and were observed as well (Beswick, 2007). The researcher purposely selected eight teachers from the beliefs survey based on compliance to participate and the diversity of the beliefs and classroom practices (Beswick, 2007). Beswick (2007) analyzed the data by closely examining the surveys, interview transcripts and observation notes to understand each teacher’s beliefs, as well as conflicting statements about beliefs. In a meeting with each teacher, the researcher presented her findings and discussed each teacher’s analysis for clarification and consensus (Beswick, 2007). Beswick (2007) reported the findings on the two teachers who demonstrated belief systems that most closely matched constructivist ideals. She found that classroom practices were driven by beliefs of mathematics teachers rather than the methods or curriculum, and this observation matched the basic premise of Watson and de Geest (2005).

Jim, one of the teachers participating in the study, had taught for 29 years, and the scores from his belief survey and CLES consistently showed that Jim was very much in agreement with constructivist mathematics (Beswick, 2007). The researcher’s observations in Jim’s classroom paralleled his beliefs of coherent problem-solving and student-centered learning. A second teacher in the study, Andrew, had been teaching secondary mathematics and science for 25 years. According to Beswick (2007), Andrew's beliefs were not “strong” on the Likert scale, but the CLES data from his students were almost identical to Jim’s (Beswick, 2007). The observations by Beswick (2007) in Jim's classroom revealed a lot of effective questioning and students justifying their work either verbally or by written communication. Beswick (2007) framed Jim’s beliefs with the quote “... Mathematics to me is for exploring, conjecturing ... well, there’s probably no such thing as right answers to any problem ...” (p. 110). The purpose of

Beswick's study (2007) was to identify the beliefs that were fundamental to the individual characteristics of each teacher's classroom. Eight of these nine beliefs related specifically to the basic ideas of *Standards*-based mathematics:

> A. Mathematics is about connecting ideas and sense-making.
>
> B. Students' learning is unpredictable.
>
> C. All students can learn mathematics.
>
> D. The teacher has a responsibility to actively facilitate and guide students' construction of mathematical knowledge.
>
> E. The teacher has a responsibility to maintain ultimate control of the classroom discourse.
>
> F. The teacher has a responsibility to induct students into widely accepted ways of thinking and communicating in mathematics.
>
> G. The teacher is the authority with respect to the social norms that operate in the classroom.
>
> H. Teachers have a professional responsibility to engage in ongoing learning.
>
> (pp. 114–115)

Beswick (2007) noted that "ultimate control" in belief statement E carried the meaning that the teachers have an accountability to see that the classroom is productive and effective. The remaining belief statement "Mathematics is fun" implied that teachers enjoy mathematics and possess a certain degree of confidence and playfulness toward mathematics (Beswick, 2007).

Beswick (2007) viewed this study from a constructivist perspective and emphasized that no teachers' beliefs were related to any specific teaching method.

However, the beliefs listed above are in alignment with guidelines of the *Standards.* Belief A is covered in the Curriculum Principle that “a mathematics curriculum should be coherent” (NCTM, 2000, p. 15). Belief B touches on discussion in the Learning Principle that students are “flexible in exploring mathematical ideas and trying alternative solution paths” (NCTM, 2000, p. 21). Belief C matches the Equity Principle that “mathematics can and must be learned by all students” (NCTM, 2000, p. 13). Beliefs D, E, F, G, and H are all encompassed in the Teaching Principle (NCTM, 2000, pp. 16–18).

The Effects of Pre-service Education on Teachers' Beliefs

This section will examine the effects of different components of the pre-service education on teachers' beliefs. The NCTM called for change in pre-service mathematics education (NCTM, 1991, 2000). The National Science Foundation (National Research Council [NRC], 1989) called for changes in the pre-service secondary mathematics and science educational practices. These changes required incorporating *Standards*-based practices by educators within the undergraduate mathematics content and education courses that make up the curriculum for secondary teaching programs (NRC, 1989). *Standards*-based teacher education programs and extensive professional development have been designed to help mathematics teachers become comfortable with the *Standards*-based view of teaching and learning mathematics (Battista, 1994). Research has indicated that teachers' beliefs about mathematics are heavily influenced by their own experiences with education before they enter their pre-service education program (Brown & Borko, 1992; Pajares, 1992; Philipp, 2007). Teacher education programs must incorporate strategies that help pre-service teachers develop an internal belief system that is aligned with *Standards*-based mathematics (Cady et al., 2006). Pajares (1992) summed up his analysis of changes in beliefs, “if conceptual change takes place, newly acquired beliefs must be tested and found effective, or they risk being discarded” (p. 321). It is important that the limited number of experiences that a pre-service education can provide must be effective to alter pre-service teachers’ beliefs to align with the *Standards*.

The Effects of a Mathematics Methods Course

One source of effective experiences is the mathematics methods course. Wilkins and Brand (2004) studied the effects of a mathematics methods course that provided meaningful opportunities for prospective teachers to shift their beliefs toward the NCTM *Standards*. The research basis of this study was founded on the concept that teachers’ beliefs about teaching and learning mathematics influenced instructional practices (Wilkins & Brand, 2004). Wilkins and Brand (2004) studied 89 participating graduate students that were enrolled in a graduate-level mathematics methods course. The participants had already graduated but had elected to continue to work on their master’s degree before entering the teaching profession (Wilkins & Brand, 2004). Seventy-four of the prospective teachers were working on a master’s degree in elementary education, seven in special education, and five in secondary mathematics education (Wilkins & Brand, 2004).

In the study, Wilkins and Brand (2004) looked at the effect of a mathematics methods course on the teachers’ beliefs about the NCTM *Standards*. Wilkins and Brand (2004) explained that the methods course focused on the investigative approach to teaching mathematics. The investigative approach is “based on the recognition of mathematics as more than a collection of concepts and skills to be mastered; it includes methods of investigating and reasoning, means of communication, and notions of context” (NCTM, 1989, p. 5). The researchers reported that the methods course textbook was *Fostering Children’s Mathematical Power: An Investigative Approach to K–8 Mathematics Instruction* (Baroody & Coslick, 1998). The graduate students also explored the major ideas from the *Principles and Standards for School Mathematics* (NCTM, 2000).

Wilkins and Brand (2004) explained that the investigative approaches encompassed the future teachers modeling the exploration of mathematical content through the hands-on use of manipulatives and activity-based lessons. The soon-to-be teachers also were required to design and present investigative lessons and complete assignments using cooperative-group techniques (Wilkins & Brand, 2004). The researchers used the Mathematics Belief Instrument (MBI: Hart, 2002a), an instrument created by Hart for evaluating the effectiveness of teacher education program in promoting teacher beliefs and attitudes that are consistent with the underlying philosophy of *Standards*-based principles aligned with NCTM. The MBI (Hart 2002a) used in the study was divided into three sections: the first section was a form of the Standards Belief Instrument (Zollman & Mason, 1992) that measured the consistency of a person’s beliefs about mathematics teaching and learning with the NCTM *Standards*; the second section investigated the change in teachers’ beliefs about teaching and learning mathematics; and the third section contain two items that measured self-efficacy (Wilkins & Brand, 2004).

In the study, the participants took a pretest and posttest survey (Wilkins & Brand, 2004). The researchers reported a statistically significant positive difference on the SBI and teacher beliefs portion of the survey. However, the study stated that the section surveying teacher efficacy was less consistent after taking the methods course (Wilkins &

Brand, 2004). Wilkins and Brand (2004) explained that this could be due to missing data. The results after the methods course showed that twenty-one of the future teachers felt that they were not very good at learning mathematics, but sixteen of them believed they were very good at teaching mathematics (Wilkins & Brand, 2004). Overall, the findings from the study suggested that the teachers' beliefs were more in alignment with the NCTM *Standards* and their sense of self-efficacy was much improved after participating in the mathematics methods course (Wilkins & Brand, 2004).

The actual experience of creating investigative lessons and also engaging in actual activities helped the prospective teachers put concrete experiences with the principles in *Standards*-based mathematics. However, these graduate students had not practiced *Standards*-based strategies in their own classroom, so it was difficult for them to know how they will deal with the everyday situations that occurred in teaching. Other drawbacks of Wilkins and Brand's (2004) study were that all of the data were based on self-reported surveys and involved mostly prospective elementary teachers. On a positive note, the methods course and survey were based on NCTM (2000) and produced positive beliefs changes that aligned with the *Standards.*

The Effects of an Alternate Certification Pre-service Program

A similar study researched teachers' beliefs before and after the completion of an alternate certification pre-service program. The Urban Alternative Preparation Program (UAPP) examined several important aspects of teachers' beliefs in an elementary pre-service program (Hart, 2002a). All of the courses offered in the program were viewed through the constructivist lens (Hart, 2002a). First, the professors modeled constructivist teaching, and then the pre-service teachers planned and modeled constructivist lessons themselves (Hart, 2002a). Hart (2002a) noted that the teachers were asked to reflect after each field experience.

Fourteen teachers participated in the UAPP. The UAPP was an alternative certification teaching pre-service program that had two phases (Hart, 2002a). The first phase of UAPP was comprised of one 3-week minimester and two full semesters. The first phase of UAPP was completed by a semester of student teaching in an urban setting. The program placed an emphasis on field experiences. Phase II of UAPP occurred when the students actually became teachers in low socioeconomic schools (Hart, 2002a). The teachers participating in UAPP simultaneously taught and worked on a master's degree for four semesters. Hart (2002a) noted that teachers' prior beliefs were difficult to change, and the change was limited when pre-service teachers learned mathematics content differently than they learned mathematical methods. To avoid being exposed to mixed teaching philosophies and to provide consistency for UAPP, the mathematics content courses and the pedagogy courses were all taught by the same professor throughout the program (Hart, 2002a). Hart (2002a) constructed and used the MBI as the instrument to measure change in student/teacher beliefs. Hart (2002a) also collected qualitative data in the form of a weekly log. Unfortunately, the data collection did not extend into Phase II of the project (Hart, 2002a). Hart (2002a) reported that both quantitative and qualitative data indicated a positive improvement in teachers' beliefs toward *Standards*-based mathematics. The researcher illustrated the improvement with a statement from Rosa, one of the participants (Hart, 2002a). Rosa initially described her experience with mathematics as "bad, very bad, horrible" and arithmetic should be taught with lots of “drill and practice” (Hart, 2002a, p. 9). In her post survey Rosa shared that “the students were thinking and doing almost all of the talking by now” (p. 9).

One unique feature of Hart’s (2002a) study was that the same professor taught both the content and methods courses. Often disparity occured in the teaching approaches of the mathematics professors and the mathematics educators (Brown & Borko, 1992). Hart’s (2002a) study only involved 14 students so only limited analyses could be performed on the data from the surveys. Like Wilkins and Brand’s (2004) study, all of the data in Hart’s (2002b) were self-reported, and the pre-service teachers kept a weekly log to provide some qualitative data.

Hart’s (2002a) research studied elementary pre-service teachers, and the data only added limited information to this research study on secondary mathematics teachers. Even though Phase II of the program extended into actual teaching experiences in urban schools, the data collection did not continue into Phase II (Hart, 2002a), so no knowledge was gained about the teachers’ actual teaching styles. The teacher educators modeled effective activities, and pre-service teachers had the opportunity to practice the techniques themselves. The newly acquired *Standards* beliefs were “tested” and solidified by the pre-service teachers. The pre-service education program at Southern State University used a similar approach. Teacher educators modeled the *Standards*-based methods for the students, and then pre-service teachers incorporated the strategies into their own practice lessons.

Belief Structures of Pre-service Teachers

Another study of pre-service teachers illustrated that the process of developing beliefs represents a complex metamorphosis. Cooney, Shealy, and Arvold (1998) looked at pre-service teachers' beliefs from a *Standards*-based viewpoint that included the psychological and social construction of knowledge. The study promoted the use of reflection to aid the teachers in developing as autonomous teachers within a community of learners (Cooney et al., 1998). The researchers used Green's (1971) belief structure as the basis for analysis. Green's (1971) three different facets of belief structures have already been discussed earlier. According to Cooney et al. (1998), the use of evidence was an important part of Green's (1971) analysis. The meaning of beliefs held in a quasi-logical relationship based on evidence could be defined by a situation where "a person may hold a belief because it is supported by the evidence, or he may accept the evident because it happens to support a belief he already holds" (Green, 1971, p. 49).

The study employed a purposeful selection of participants and analyzed data in a search for supporting evidence as well as evidence that refuted the framework. In the study, 15 secondary mathematics education students formed a cohort for the progression of mathematics education courses, which included a curriculum course, a methods course, an internship, and a final seminar (Cooney et al., 1998). A survey was administered to the 15 pre-service secondary mathematics undergraduates during the curriculum course, and four participants were selected (Cooney et al., 1998). In the study, each prospective teacher was interviewed four times and field notes were taken on classroom observations (Cooney et al., 1998). The research team in the study met weekly to discuss the field notes. The researchers were interested in capturing the beliefs that were exhibited in the pre-service teachers' field experiences (Cooney et al., 1998). Cooney et al. (1998) told the story of one teacher Greg who exhibited a change in his *Standards*-based beliefs and practices:

> Greg believed that learning mathematics meant learning how to follow a mathematical procedure with common sense. Greg felt that teaching was a 'calling, something I've got to do,' and he wanted to 'prepare people for life' (p. 316). Greg was stringently opposed to using technology in the classroom, but his beliefs changed drastically over the course of his teacher education preparation. Greg's participation in technologically rich activities in the context of teaching caused him to reverse his viewpoint on the use of technology in his classroom. At the beginning of the study, Greg felt that open-ended tasks, especially using manipulatives, served the purpose of making the class more exciting, but he altered his beliefs to value technology in mathematics as an important and contextual setting for developing reasoning skills and higher-order thinking. Greg reconsidered his beliefs because of the evidences that emerged (Green, 1971). Greg attributed his change in beliefs to the open-ended investigations and collaboration with mathematics educators and peers. (Cooney et al., 1998)

Cooney et al. (1998) shared the account of another pre-service teacher who was unaffected by her pre-service education:

> Sally was also a 'people' person and thought that she should be told how to teach mathematics. At the beginning of the study, Sally viewed mathematics as a set of facts and algorithms where the authority for mathematical concepts was attributed to teachers and textbooks. Throughout the study that followed her internship, she began to see students as complex people with a variety of needs but expressed a lack of confidence in her ability while being overwhelmed in the process. Sally held the central belief (Green, 1971) that all children can learn and felt that the

teacher had the responsibility for student learning. The research report noted that Sally decided not to continue her profession as a teacher (Cooney et al., 1998).

A third pre-service participant Henry agreed with Sally that mathematics was a set of rules and procedures that were passed on by teachers and textbooks (Cooney et al., 1998). The study showed that Henry rarely saw the relationship between student learning and teaching and rejected the various methods of teaching presented in his pre-service education and strongly held onto his initial beliefs (Cooney et al., 1998). The researchers noted that the context of mathematics problems separated the meanings of the word *function* for Henry into different belief clusters (Green, 1971). The study pointed out that Henry's cooperating teacher shared his traditional viewpoints and only increased Henry's confidence. The interviews revealed that Henry's belief system remained essentially unchanged by his entire education process (Cooney et al., 1998).

The research by Cooney et al. (1998) added much more to the base of information presented so far, and the case studies provided a more complete picture of pre-service teachers. Only Greg changed his beliefs and practices, and the change was precipitated by the technology activities that he experienced during his methods course. His technology experiences represented his "conversion" to beliefs aligned to the *Standards*. Unfortunately, the dichotomy between Sally's preexisting beliefs and the *Standards*-based practices presented during her pre-service education could not be reconciled. Henry's prior beliefs were so engrained that none of his exposure to *Standards*-based teaching had any impact on his beliefs. A *Standards*-based pre-service education called for the examination of prior traditional beliefs, but there were no guarantees that the beliefs would be altered. For our purposes, a limitation of the study was that the research ended with the pre-service education, and no knowledge could be gained about the teachers as they entered their own classroom.

The Influence of the Internship

The impact of internship, another crucial component of the pre-service mathematics education, was examined by Van Zoest and Bohl (2002). Overwhelming evidence has shown that fieldwork was the most important component of the pre-service education process (Brown & Borko, 1992) and could have a positive or negative effect on the beliefs toward the NCTM *Standards*. Van Zoest and Bohl (2002) purposely chose to research a case study of an intern whose cooperating teacher's philosophy was in alignment with *Standards*-based mathematics. The case study that they conducted followed Alice, a secondary mathematics pre-service teacher, during her internship and researched the effects that the internship had on her beliefs (Van Zoest & Bohl, 2002). Alice's internship took place at a high school of about 1000 students that had just switched to block scheduling and the Core-Plus Mathematics Program (CPMP; Coxford, Fey, Hirsch, Schoen, Burrill, Hart, et al., 1997). Gregory, Alice's cooperating teacher with 31 years of teaching experience, felt traditional approaches to teaching were not effective and was in agreement with the philosophy of the NCTM *Standards* (Van Zoest & Bohl, 2002). Van Zoest and Bohl (2002) discussed Alice's beliefs regarding *Standards*-based mathematics:

> Prior to her internship, Alice had taken three mathematics education courses that stressed *Standards*-based principles based on the NCTM *Standards.* The goal of the mathematics methods courses was to groom *Standards*-based teachers to act as catalysts for the *Standards*-based effort in their new schools. Alice was always

> an excellent mathematics student throughout her schooling and really loved mathematics. However, she knew that she had learned mathematics procedurally and did not really have a deep understanding of most mathematical concepts. Alice had a strong belief in *Standards*-based mathematics and had committed herself to teach her own students in such a way as to promote conceptual learning using the NCTM S*tandards*. (Van Zoest & Bohl, 2002)

Van Zoest and Bohl (2002) collected data from interviews with Alice, 25 reflective journals, planning sessions between Alice and Gregory, and four observations. The study reported that Alice's beliefs on *Standards*-based mathematics became more engrained as a result of her supportive experience in a positive *Standards*-based climate (Van Zoest & Bohl, 2002). The data indicated that Alice's beliefs were well-articulated when she emphasized that she wanted students to be thinking about mathematics, using such terms as "conceptualizing rules," getting "at the heart of the concept," "conceptualizing" what symbols represent, and "grasping the ideas of the problems" (Van Zoest & Bohl, 2002, p. 278).

The research on Alice did not stop with her internship. Van Zoest and Bohl (2002) continued to study Alice in her first teaching position where she taught in a school with a very traditional mindset toward *Standards*-based mathematics. The researchers received Alice's audio-taped reflections throughout the first few months of her teaching and interviewed Alice during the fourth month of her first year of teaching (Van Zoest & Bohl, 2002). Alice worked very hard to supplement the curriculum so that her teaching was still in alignment with the NCTM *Standards* even though she was heavily pressured by her peers to promote traditional teaching (Van Zoest & Bohl, 2002). The research indicated that a determined Alice rewrote the curriculum using CPMP as a guide (Van Zoest & Bohl, 2002). Consequently the school adopted the Connected Mathematics Project (CMP; Michigan State University, 2006) for their curriculum. According to Van Zoest and Bohl (2002), Alice was the pivotal teacher that convinced the administration to switch to a curriculum more in alignment with the *Standards*-based approach. In her closing interview with the researchers, Alice attributed her intern experience to her belief that "opinions [about *Standards*-based mathematics instructions] are worth something" (Van Zoest & Bohl, 2002, p. 281).

Van Zoest and Bohl's (2002) study painted an excellent picture of the beliefs and practice of Alice using a variety of data sources. They also provided follow-up into Alice's teaching career. This study showed that *Standards*-based curriculum coupled with a cooperating teacher who supported the NCTM *Standards* (1989, 1991, 1995, & 2000) was an effective combination for producing a grounded teacher that supports *Standards*-based mathematics. The question is how many Alice's are our secondary mathematics education programs turning out?

These studies researching belief changes during the pre-service education looked at various aspects of the pre-service education including field experiences, methods courses, mathematics courses, and internships. In all of the studies, the pre-service teachers presented lessons or activities that supported the *Standards.* Ambrose (2004) highlighted that the path for changing existing beliefs in pre-service teachers comprised "emotion-packed, vivid experiences that leave an impression" (p. 95). The engaging activities modeled by prospective teachers provided them opportunities to construct new beliefs about the effectiveness of the *Standards.*

The Effects of Curriculum on Teachers' Beliefs and Practices

The powerful influence of time discussed in the previous section can be alleviated somewhat with the aid of an effective *Standards*-based curriculum. *Standards*-based materials do not provide scripted instructions for mathematics teachers, but they offer opportunities for "orienting individuals and institutions toward collectively valued goals" (Shulman & Sykes, 1983, p. 501). A *Standards*-based curriculum can provide novice teachers with a "leg up" when trying to implement *Standards*-based principles. The following studies investigated the effects of curriculum on teachers' beliefs and practices.

An Inquiry-Based Science Curriculum

Some studies related to *Standards*-based principles can be found in the discipline of science. Roehrig and Kruse (2005) based their study on the premise that science should be presented in an inquiry-based learning atmosphere. Inquiry-based instruction encompasses utilizing investigative teaching strategies and activities not only to teach content but also to develop students' abilities to both do and understand inquiry. The purpose of Roehrig and Kruse's study (2005) was to examine the impact of a inquiry-based chemistry curriculum, Living By Chemistry (LBC: Biological Science Curriculum Study, 2005), on teachers' beliefs and practices when using a inquiry-based curriculum. Roehrig and Kruse (2005) pointed out that the LBC curriculum was developed for a more diverse student population and covered all of the national and California state standards for chemistry. The two curriculum units used in the study, Alchemy and Smells, incorporated investigative tasks to learn content such as the structure of the atom, the periodic table, ionic bonding, and nuclear chemistry in real-world contexts (Roehrig & Kruse, 2005). The researchers added that the lesson plans encouraged active student-to-student and student-to-teacher discourse where the teacher's role was described as the facilitator and provided an extensive teacher's guide (Roehrig & Kruse, 2005).

The study was conducted in an ethnically and linguistically diverse school district (Roehrig & Kruse, 2005). The researchers studied a large urban school district that was committed to use a framework of teaching that supported inquiry-based instruction (Roehrig & Kruse, 2005). Roehrig and Kruse (2005) administered a pre- and post-test to high school chemistry students in the study. The study reported that all students showed significant achievement gains, and the lower-achieving students showed the most gain (Roehrig & Kruse, 2005). The test used in the research contained open-ended questions that required conceptual understanding of the key ideas.

The study explained that the role of the school district was to provide professional development to prepare the teachers to implement the LBC curriculum (Roehrig & Kruse, 2005). The teachers had attended a week-long institute the previous summer that emphasized general inquiry-based instruction, and they attended four in-service days specifically targeted at implementing the LBC curriculum (Roehrig & Kruse, 2005). During the study, twelve teachers completed semi-structured interviews at the beginning and end of the study (Roehrig & Kruse, 2005). These teachers were also observed four to seven times throughout the duration of the study (Roehrig & Kruse, 2005). The results of the study showed that teachers adjusted their beliefs and their classroom practices to agree with the investigative principles exhibited in the LBC curriculum (Roehrig & Kruse, 2005). The research reported that four teachers demonstrated small to moderate changes in their classroom practices, but seven of the teachers exhibited large classroom changes (Roehrig & Kruse, 2005).

Even though this study investigated science teachers, it provided an excellent example of an inquiry-based curriculum supported by professional development training to incorporate the curriculum. The results showed that the combination of curriculum and professional development promoted significant changes in the teachers' classroom practices. The results provided valuable information concerning *Standards*-based curricula because of the similarities between inquiry-based instruction and *Standards*-based teaching principles.

Mathematics in Context

A similar study investigated changes in teachers' beliefs and practices that were influenced by the school's new *Standards*-based curriculum. Frykholm (2004) conducted a study to examine the impact of a *Standards*-based curriculum on the beliefs and practices of teachers using the *Mathematics in Context* (National Center for Research in Mathematical Sciences Education and Freudenthal Institute, 1995). The conceptual teaching strategies used in *Standards*-based mathematics often created varying degrees of discomfort for mathematics teachers (Frykholm, 2004). The purpose of the study was to begin articulating a theoretical framework on the concept of *teacher discomfort* (Frykholm, 2004). Another purpose of the study was to explore teachers' discomfort and its impact on teachers' beliefs and pedagogical practices (Frykholm, 2004). The research was conducted in seven schools in Colorado, Minnesota, and Wisconsin (Frykholm, 2004). Eight of the teachers who volunteered for the study were selected for detailed case studies. The data from the case studies included classroom observations, post-lesson conferences, audiotaped lesson presentations, teachers' reflections while they listened to the tapes of their lessons, and informal sources of information (Frykholm, 2004).

Frykholm (2004) identified four types of teacher discomfort when he outlined his teacher discomfort framework. The four domains he listed included cognitive discomfort, beliefs-driven discomfort, pedagogical discomfort, and emotional discomfort (Frykholm, 2004). He defined the cognitive discomfort of mathematics teachers as showing doubt about their mathematical content knowledge, about their ability to make connections about mathematical concepts, and about teaching in a way that promoted conceptual mathematical connections (Frykholm, 2004). The research brought out a beliefs-driven discomfort that emerged when inconsistencies appeared between beliefs about the nature of mathematics, beliefs about how students best learn mathematics, beliefs about how and what mathematics should be taught, and beliefs about the role of mathematics (Frykholm, 2004, p. 133). Frykholm (2004) noted pedagogical discomfort surfaced most frequently when teachers struggled with the changing roles required of both teachers and students in *Standards*-based teaching. He categorized the fourth component of the framework as the emotional discomfort that occured with the emotions associated with the first three discomforts (Frykholm, 2004).

Frykholm (2004) reported on the case studies as they related to the beliefs and practices in light of *Standards*-based mathematics. Frykholm (2004) observed Mr. Daniels who had been teaching elementary students for 20 years and was currently teaching mathematics to sixth graders. The data indicated that Mr. Daniels openly admitted that he was a traditional teacher who had weak mathematical content knowledge and his beliefs about teaching and learning mathematics showed more consistency than any of the other case studies (Frykholm, 2004). Mr. Daniels was observed by the researchers as being heavily dependent on the textbook and did not have the confidence to implement the supplemental materials from MiC (Frykholm, 2004). Frykholm (2004) surmised that Mr. Daniel's beliefs in traditional teaching and his weak mathematics background probably caused his discomfort with the MiC curriculum and *Standards*-based strategies (Frykholm, 2004).

The second case study examined the beliefs and practices of Ms. Compton who had a bachelor's degree in mathematics and had been teaching five years (Frykholm, 2004). Frykholm (2004) pointed out that Ms. Compton did not hold beliefs that were in agreement with the NCTM *Standards* and repeatedly commented that her beliefs were not in alignment with the conceptual ideas of the MiC curriculum. This dichotomy as reported by the researcher made it difficult for Ms. Compton to regularly implement the curriculum using *Standards*-based methods (Frykholm, 2004).

The researcher described Ms. Wheaton as a 7th grade teacher who had been teaching for four years and had not earned a degree in mathematics (Frykholm, 2004). Frykholm (2004) noted that even though her content knowledge was not strong, and she felt discomfort when trying to implement the MiC curriculum, Ms. Wheaton wanted to teach in a way that was consistent with the NCTM *Standards.* The data showed that her desire to teach using *Standards*-based principles helped her overcome the discomfort with the MiC curriculum (Frykholm, 2004). The researcher indicated that Ms. Wheaton was very open with her students about her own difficulties in using the new curriculum, and her candidness helped her students feel safe to attempt higher-level tasks (Frykholm, 2004).

In the last case study, Frykholm (2004) portrayed Ms. Moore as having a strong background in mathematics and as embracing the philosophy of the NCTM *Standards*

(Frykholm, 2004). Her lesson that was observed by the researcher was a model lesson in teaching *Standards*-based mathematics (Frykholm, 2004). Frykholm (2004) did not observe any level of discomfort in Ms. Moore's beliefs and practices, but she felt that her students should struggle to gain ownership of their mathematics. Ms. Moore explained her views on discomfort to Frykholm (2004) during her post-lesson conference, “The only way that they are going to understand math is if they wrestle with it. I like to push them like this as much as possible” (p. 144).

The four teachers expressed different types of discomfort for a number of underlying reasons. Frykholm (2004) pointed out that the possible causes of these four teachers’ discomfort stemmed from the MiC curriculum and their own beliefs about the curriculum. The researcher surmised that the teachers’ beliefs about the MiC curriculum along with the teachers’ ability to resolve the discomfort shaped their beliefs about *Standards*-based principles and the level of implementation of the *Standards*-based curriculum (Frykholm, 2004). Several implications have emerged from the research on the case studies. Mr. Daniels and Ms. Compton provided examples of teachers whose beliefs and practices were not changed by the addition of the *Standards*-based MiC curriculum. Interestingly enough, they represented opposite ends of the spectrum with respect to mathematical content knowledge, Mr. Daniels with weak and Ms. Compton with strong. Ms. Wheaton and Ms. Moore held very positive beliefs and practices with respect to *Standards*-based mathematics. These two teachers also had diverse content knowledge, Ms. Wheaton with weak and Ms. Moore with strong.

Frykholm (2004) pointed out that knowledge about the pre-service education of these four teachers provided invaluable introspection into these teachers’ beliefs.

Teachers whose pre-service education supported the NCTM *Standards* had an easier transition into teaching if their new school used a *Standards*-based curriculum like MiC. The new teachers had ready-made *Standards*-based lessons that lessened their level of discomfort in the classroom and eased time pressures.

The Core-Plus Curriculum

In continuing with the theme of the effects of curriculum on teachers' beliefs and practices, two studies used the Core-Plus curriculum as their *Standards*-based curriculum. The first study looked at the different impact of the Core-Plus curriculum on the teaching beliefs and practices of two teachers at the same school. The second study investigated the beliefs and practices of 26 teachers who had been using Core-Plus for four years or less.

Two teachers at the same school. Another study investigated the affects of another *Standards*-based curriculum on teachers' beliefs and practices. Lloyd (1999) examined the beliefs of two experienced secondary mathematics teachers as they switched to the Core-Plus *Standards*-based curriculum. The Core-Plus curriculum (Hirsch, Coxford, Fey, & Schoen, 1995) promoted the themes of cooperation and exploration and was created to provide teachers with a curriculum that supported the principles of the NCTM *Standards* (1989). The study followed these teachers over the course of three years. The data were triangulated using interviews, classroom observations, and fieldnotes (Lloyd, 1999). Lloyd (1999) selected the two teachers in the study because they volunteered to implement Core-Plus, they wanted to incorporate more cooperative and investigative strategies promoted by Core-Plus in their classroom, and the two teachers exhibited different features to be studied.

The research project studied Mr. Allen who had 14 years of teaching experience that promoted traditional methods of teaching mathematics (Lloyd, 1999). Lloyd (1999) interviewed Mr. Allen 17 times, observed him 73 times, and noted that Mr. Allen began using Core-Plus I in a class of 32 ninth-grade students. During the study, Mr. Allen illustrated his beliefs in *Standards*-based tenets by his comment, “thinking about situations but not necessarily have the answer be the major outcome—it’s the process that’s important” (Lloyd, 1999, p. 233). Similarly, Mr. Allen also expressed his *Standards*-based beliefs by identifying the importance of student learning in a student-centered environment. “The teacher wasn’t going to be the focus anymore,” and the groups’ work gave students “more ownership” of the mathematics (Lloyd, 1999, p. 234). However, there were aspects of the Core-Plus curriculum that Mr. Allen did not implement as he wanted. Lloyd (1999) commented that Mr. Allen felt more comfortable providing his students with scaffolding and teacher-directed assistance in whole-class discussions. The observations by the researcher also found that Mr. Allen was very concerned with staying on track and limiting the students’ opportunities by doing most of the work himself (Lloyd, 1999). Lloyd (1999) pointed out that Mr. Allen expressed frustration with his practices that were contradictory with the Core-Plus tenets, “to be the opposite of what [Core-Plus is] really trying to emphasize” (p. 237).

The second teacher in the study, Mrs. Fay, had similar beliefs in *Standards*-based mathematics. She had ten years of teaching experience and had moved to teach at this school because of a desire to implement *Standards*-based strategies using the Core-Plus curriculum (Lloyd, 1999). She liked the “really rich problems” that incorporated real-life contexts (Lloyd, 1999, p. 238). Lloyd (1999) reported that Mrs. Fay believed that students learned important mathematics without procedural explanations from the teacher. However, the research showed that she often gave the correct explanations when asked by students instead of facilitating them to the solution with effective questioning (Lloyd, 1999). The data from the study showed that Mrs. Fay was still struggling with her role as a facilitator and was uncertain how to successfully align her use of discourse with *Standards*-based beliefs (Lloyd, 1999).

Lloyd (1999) pointed out that both teachers felt that the emphasis on the Core-Plus curriculum of cooperative activities and investigative learning was beneficial, but they interpreted the implementation of the curriculum’s tasks very differently. The analysis by the researcher highlighted three main themes surrounding both teachers (Lloyd, 1999). First, Lloyd (1999) discussed the theme of teacher control of student learning explaining that Mr. Allen and Ms. Fay dealt with the control issue differently. The researcher described Mr. Allen’s belief that students benefited from investigative activities but was convinced that students learned best when the mathematics content was explicitly outlined, and the teacher controlled the pace (Lloyd, 1999). Ms. Fay, on the other hand, believed that students learned without explicit instruction but often gave specific answers to her students rather than making them dig for the answers to their questions (Lloyd, 1999). Lloyd (1999) commented that the issue of teachers’ efficacy should be considered as the teachers’ role in the classroom adapts to *Standards*-based principles.

Lloyd (1999) described the second theme as the opportunity to personalize instruction. The researcher discussed the difficulties that both Mr. Allen and Ms. Fay faced with the exploration and group activities (Lloyd, 1999). Neither of the teachers chose to deviate from the curriculum and indicated that they were not able to personalize the instruction to fit their needs (Lloyd, 1999).

Lloyd (1999) voiced the third theme as the tensions between a curriculum's philosophy and teachers' visions. The conflict in Lloyd's (1999) study presented an unusual type of conflict because the two teachers wanted activities that required more cooperation among students than was provided in the materials. Even though Lloyd (1999) observed that the teachers had placed the students in groups, a good number of the students were working individually and not investigating cooperatively. Lloyd (1999) noted that in Mr. Allen's second year he sometimes directed the students to work activities individually that were intended for cooperative discussions. Lloyd (1999) pointed out that the tensions between the curriculum and the teacher occured through complex interfacing between teachers' goals and the curriculum's layout. Lloyd (1999) concluded that researching the connections between teachers and curriculum can be very advantageous for teachers.

One of the important aspects of Lloyd's (1999) study is that both Mr. Allen and Ms. Fay were interested in incorporating the Core-Plus curriculum. The study covered three years, and an abundance of data was also collected. The study reported that Mr. Allen and Ms. Fay made significant changes in both their beliefs and practices that were more consistent with *Standards*-based principles. The results showed that a *Standards*-based curriculum without the aid of professional development could mar the desired teaching practices. Mr. Allen and Ms. Fay would have probably implemented the Core-Plus curriculum more effectively if professional development opportunities were offered in conjunction with the implementation of Core-Plus. Mr. Allen and Ms. Fay illustrated that teachers are rarely going to completely replace all of their existing beliefs. Usually, teachers are more likely to make sense of new information by using the existing beliefs as "filters and intuitive screens through which new information and perceptions are sifted" (Pajares, 1992, p. 324).

Twenty-six teachers in the Dickinson School System. In a larger study of teachers using Core-Plus, Arbaugh, Lannin, Jones, and Park-Rogers (2006) researched 26 teachers who had been using Core-Plus Mathematics Program (Coxford et al., 1997, 1998, 1999, 2001; McGlamery, 1993) four years or less. The research indicated that the impact of curriculum on *Standards*-based beliefs and practices is powerful (Arbaugh et al., 2006). The study involved voluntary teachers who were all employed by Dickinson Public Schools, a large mid-western school district (Arbaugh et al., 2006). The purpose of this study was to investigate the instructional practices of these 26 teachers and examine the connection between their beliefs and practices (Arbaugh et al., 2006). The researchers used classroom observations and teacher interviews as sources of data (Arbaugh et al., 2006). The purpose of the one-hour interviews was to explore the teachers' beliefs and practices regarding teaching with Core-Plus (Arbaugh et al., 2006). Arbaugh et al. (2006) observed each teacher once, and the lessons that were observed were categorized into three different descriptions as defined by Weiss, Pasley, Smith, Banilower, and Heck (2003). The three classifications were low-lesson quality (LLQ), medium-lesson quality (MLQ), and high-lesson quality (HLQ) where the HLQ lesson most closely resembled *Standards*-based teaching (Weiss et al., 2003). The researchers observed 11, 8, and 7 lessons that were categorized as LLQ, MLQ, and HLQ respectively (Arbaugh et al., 2006).

Two vignettes, one LLQ and one HLQ, were discussed by the researchers in detail (Arbaugh et al., 2006). In the LLQ lesson presented in the study, Ms. Taylor constantly shifted the intent of the curriculum from learning conceptually to the importance of the correct solution (Arbaugh et al., 2006). Similarly, Arbaugh et al. (2006) pointed out that other LLQ lessons were altered to fit the paradigm of more traditional lessons.

Arbaugh et al. (2006) stated that two consistent beliefs about learning and teaching mathematics emerged from the interviews with teachers whose lessons were categorized as LLQ. The study brought out that the teachers exhibited low expectations about their students' capability to succeed using the Core-Plus curriculum (Arbaugh et al., 2006). Ms. Martin illustrated:

> I think it is material that they are expected to do what they have no background on. They are supposed to discover things, but they are clueless. They plug everything into a calculator but they don't know what anything means or how to find it on their own ... I'm bogged down by kids who know nothing about what they should know. (Arbaugh et al., 2006, p. 535)

The researchers in the study described the teachers' abilities to facilitate the appropriate learning environment for Core-Plus activities as the second area of beliefs (Arbaugh et al., 2006). Ms. Tanner provided an example statement, "A weakness I feel I have in Core-Plus is the use of group work" (Arbaugh et al., 2006, p. 535). The research indicated that these teachers demonstrated a lack of pedagogical content knowledge (Arbaugh et al., 2006).

The study described a vignette of the HLQ lesson that demonstrated the use of scaffolding, effective questioning, and justification of answers by Ms. Andrews (Arbaugh et al., 2006). In the vignette, the students were allowed to use their own strategy, and the teacher did not comment on the correctness of the solution. However, the researcher observed the shift from student-centered to teacher-centered discussion occurred during whole class discussions (Arbaugh et al., 2006). The following statement from the study illustrated the difference in the HLQ teachers' beliefs from the LLQ teachers' beliefs, "... the textbook is excellent. It gives them a chance to work through problems on their own" (Arbaugh et al., 2006, p. 540). A similar comment in the instance by Ms. Byers echoed other teachers' high expectations of their students, "[When problems are put] in context, I haven't seen anything come their way that they couldn't do" (Arbaugh et al., 2006, p. 540). The researchers noted that the teachers with the HLQ lessons also expressed concern about their ability to promote effective classroom discourse and manage group work (Arbaugh et al., 2006).

Arbaugh et al. (2006) complemented the research by Lloyd (1999) by including a much larger number of participants. Both studies illustrated the varying degrees to which mathematics teachers implemented the *Standards*-based principles that Core-Plus promoted. Arbaugh et al. (2006) presented some examples of Core-Plus being the catalyst for changing the beliefs and practices of secondary mathematics teachers. The study showed that an effective curriculum does not guarantee that all teachers will conform their beliefs and practices to align with *Standards*-based guidelines. However, as pre-service teachers make the change to their own classrooms, a supportive, *Standards*-based curriculum could help to reinforce *Standards* beliefs and practices developed during the pre-service experiences. Both Arbaugh et al. (2006) and Lloyd (1999) surmised that professional development needed to be combined with the implementation of a *Standards*-based curriculum to ensure more effective execution of the *Standards*-based ideals. The combination of *Standards*-based curriculum and professional development provided even more support for novice teachers trying to implement *Standards*-based strategies.

Teachers' Evolutionary Change

Some teachers gradually change their beliefs toward *Standards*-based mathematics without participating in an organized professional development project. (Chapman, 2002) conducted a study using four experienced secondary mathematics teachers. The purpose of Chapman's study (2002) was to examine the change in those teachers' beliefs over a period of time without external interventions. The data collection and analysis by Chapman (2002) centered around thought processes that teachers used when teaching mathematical word problems. Chapman (2002) used interviews, role-play, and classroom observations as the sources of data. The interviews with Chapman (2002) probed into the mathematics teachers' past, present, and probable future teaching strategies with an emphasis on "word problems." Chapman (2002) reported that the classroom observations and follow-up discussions took place as the teachers taught one unit that included word problems. Chapman (2002) studied the data looking for instances that indicated changes in teaching or teachers' beliefs related to mathematics. Chapman (2002) did not specifically attribute any of his findings to a connection with *Standards*-based mathematics and was not using the *Standards*-based principles as a framework.

Chapman (2002) described the changing beliefs of one of the participants Elise in detail:

> Elise held the dominant belief that 'mathematics is play/game,' and her teaching style was primarily traditional (p. 181). Elise wanted to resolve the conflict in her beliefs and practices and began to incorporate activities so students could experience mathematics as a game. Elise's teaching evolved to concentrate on problem solving, and soon she saw the connection between games and problem solving. Elise's teaching style became more student-centered, but then Elise voiced the problem of her students' poor performance on the graduation exam. Elise again had to adjust her practices to include critical thinking and reflective practices for the students. Elise illustrated her shift in beliefs, 'They [students] get to discover for themselves or try things or take risks ... I like the kids to do more play than me giving them the process.' (Chapman, 2002, p. 184)

Even though Chapman (2002) was concerned primarily with looking at the change in teachers' beliefs, he illustrated that Elise's beliefs and practices began as very traditional and shifted to a more student-centered, investigative teaching process. These changes reflected that Elise's mindset became very much aligned with *Standards*-based principles.

Chapman (2002) described another teacher's beliefs that evolved as his teaching assignment changed:

> In Mark's early teaching career, he was a very traditional teacher who believed that direct teaching was the best method to teach mathematics. Mark began to teach grades four and six several years later. His new situation challenged his

> beliefs of mathematics as experience. Mark saw the need to change the students' role in the learning process, so his teaching shifted to be more student-centered utilizing small-group work. Mark still recognized tension between his practices and his changing beliefs and realized the need to involve the students more in the discovery process of the content. Mark included real-world contexts and making connections among the mathematical topics. Mark's primary belief began as 'mathematics is experience' and shifted to 'math is hands-on, communication, connection, problem solving.' (Chapman, 2002, p. 188)

Like Elise, Mark's beliefs and practices had changed from a very traditional mindset to a belief system that was in agreement with the NCTM *Standards*. The experiences and influences that less experienced mathematics teachers encounter in their daily teaching will continue to impact their beliefs and practices. For *Standards*-based beliefs that were developed during pre-service education, these changes are more likely to gravitate toward stronger and stronger *Standards*-based beliefs and practices when the climate, curriculum, and opportunities for professional development promote it.

The Effects of a Professional Development Model

Four years after its implementation, a longitudinal study of a professional development model was studied to determine what curriculum changes had been put into practice by teachers (Hart, 2002b). The reinforcement of *Standards*-based effects using the right professional development model is essential to success (Clarke, 1997). The professional model used in this study was the Reflective Teaching Model (RTM: Hart & Najee-ullah, 1997) and was based on constructivist principles and metacognition. Hart (2002b) explained that teachers within the model were involved in both individual and group activities that caused the teachers to confront their current beliefs. She continued that teachers were asked to give reasons for their beliefs, construct new knowledge and reflect on their experiences (Hart, 2002b). All of the activities in the study used a model/experience/reflect framework. The Atlanta Math Project (AMP) began working with 13 teachers in 1990, and by 1994, 98 teachers were involved in the project (Hart, 2002b). Georgia State University first implemented the AMP with 13 school systems in the metropolitan Atlanta area (Thomas, 1994). AMP sought to change teachers' beliefs and practices by providing teachers with teaching and learning experiences that were consistent with the *Standards*-based mathematics. The activities of AMP included summer professional development, on-site support for planning and teaching, and peer mentoring (Thomas, 1994). Hart (2002b) examined AMP teachers four years later to determine how their beliefs had changed in respect to *Standards*-based mathematics. The study asked teachers to participate in a survey adapted from Clarke's instrument (Clarke, 1997). According to Hart (2002b), thirty-seven of the teachers responded to the survey, and 14 were interviewed.

The results of the data showed that these teachers had changed their beliefs and ultimately changed their teaching practices as well (Hart, 2002b). Hart (2002b) identified five factors that were identified as very helpful in influencing the change in beliefs about the *Standards*-based movement. These factors were the following items on the survey: colleagues in the AMP, modeling of strategies in the AMP, collaboration in AMP, the *Standards*-based movement, and innovative curriculum materials (Hart, 2002b, p. 169). In the RTM, the teacher educator and secondary mathematics teacher collaboratively planned lessons with the teacher leading the process (Clarke, 1997). Concerning the impact of colleagues, one participant explained, “The collegiality allowed me to see outside the loneliness of the ‘one teacher’ classroom” (Hart, 2002b, p. 170). The researcher conveyed the impact of the modeling of strategies with a comment from one participant, “I think it was important for me to watch other teachers and be able to talk to them about what they were thinking” (Hart, 2002b, p. 171). Hart (2002b) reported that one teacher in her interview commented, “I believe my students understand math better and enjoy it more because of my experience in AMP” (p. 170). Hart (2002b) quoted another teacher who eloquently described changes promoting NCTM *Standards*, “I have always taught with manipulatives, hands-on, but more teacher-directed. Now my questioning strategies have become better. My questions are more open-ended” (p. 170). Another comment from the study also illustrated the incorporation of more *Standards*-based ideals:

> The major differences I see in my teaching deal with the open communication in the classroom. I elicit student responses in a much more open-ended way than I did when I first began teaching. I accept a wide range of responses and deliberately ask questions that elicit varying responses in order to facilitate conversation. (Hart, 2002b, p. 170)

The comments listed above showed the connections between the constructivist approach and the NCTM *Standards*. The data from the study supported the research that colleagues were crucial to the change in beliefs through interaction and reflection (Hargreaves & Fullan, 1992; Schubert & Ayers, 1992). The results from Hart’s (2002b) study implied the lasting and powerful effect that the combination of collaboration, professional development support, and curriculum can have on teachers’ beliefs and practices. The fact that results of a systemic project were still impacting teachers in favor of *Standards*-based practices four years later provided encouraging news to the *Standards*-based movement. Hart's (2002b) study demonstrated that transitioning teachers who valued the concepts of the *Standards* felt much more comfortable in a supportive school. As mathematics teachers exit a *Standards*-based education, entering a school with *Standards*-based professional development can make implementation of their newfound beliefs much easier.

Summary of Teachers' Beliefs and Practices and Standards*-based Principles*

Most of the preceding research revealed success stories. The qualitative researchers generally selected to describe purposefully one or two of the cases that they had studied (Beswick, 2007; Chapman, 2002; Lloyd, 1999; Van Zoest & Bohl, 2002). Cooney et al. (1998) elaborated on four teachers' changing beliefs that illustrated various ends of the spectrum, and Frykholm (2004) eight. Specifically, Harry did not change his traditional beliefs, but only solidified them (Cooney et al., 1998). Sometimes teachers' current beliefs blocked their understanding and approval of *Standards*-based mathematics (Battista, 1994). The acknowledgement of the *Standards*-based philosophy carries with it an enormous responsibility to learn to guide students' constructive activities to help them "discover" important mathematical concepts. These changes require extensive knowledge of mathematical concepts and pedagogical content knowledge (Battista, 1994). Were most mathematics teachers permanently changing their beliefs and practices?

The impact of pre-service education is very influential on teachers' beliefs and practices (Brown & Borko, 1992). The research in the previous section suggested that fieldwork and internships provide opportunities to put learning into practice that may affect teachers' beliefs (Cooney et al., 1998; Hart, 2002a; Van Zoest & Bohl, 2002). Alice (Van Zoest & Bohl, 2002) and Henry (Cooney et al., 1998) provided examples of the impact that cooperating teachers have on pre-service teachers' beliefs. As Hart (2002a) suggested, consistency is also vital to the development of teachers' beliefs in pre-service education.

From the research in this section on inservice teachers, we see that professional development and *Standards*-based curricula are two approaches to effect change in teachers' beliefs and practices (Arbaugh et al., 2006; Frykholm, 2004; Hart, 2002b; Lloyd, 1999; Roehrig & Kruse, 2005). The AMP (Hart, 2002b) implemented professional development support that combined collaboration among colleagues, curriculum, and effective modeling to bring about change in teachers' beliefs and practices that were in alignment with the guidelines of the *Standards*. Roehrig and Kruse (2005) suggested that teachers who were given curricula guidance using *Standards*-based practices were more likely to shift their beliefs to be in alignment with the guidelines of the *Standards*. Lloyd (1999) reported on teachers who were interested in *Standards*-based principles and volunteered to try out a new curriculum. The end result produced well-grounded beliefs and practices. Arbaugh et al. (2006) reported conflicting results with the Core-Plus curriculum. Their study also included voluntary participants, but the outcome produced a mixture of implementation of *Standards*-based practices. Arbaugh et al. (2006) identified a weakness in pedagogical content knowledge as a contributing factor. In addition some teachers felt uncomfortable trying to manage group work (Arbaugh et al., 2006). Chapman (2002) described two teachers whose beliefs changed during the course of teaching mathematical word problems. The change in beliefs created a tension that precipitated in a change to teaching practices characterized by student-centered, problem-solving methods. These two teachers incorporated *Standards*-based teaching practices without access to a collaborative effort through a professional development model or a curricular change. Elise and Mark both came from a traditional background, and their journey through the experience of teaching mathematics led them to new-found beliefs and practices that were very much in alignment with the NCTM *Standards* (Chapman, 2002).

Many approaches can be used to impact teachers' beliefs toward the *Standards*-based movement. A *Standards*-based pre-service education is significantly enhanced by supportive professional development and curriculum alignment. One key element of the research was that many of the teachers saw the need for a change in their beliefs and practices (Chapman, 2002; Cooney et al., 1998; Hart, 2002a, 2002b; Lloyd, 1999; Watson & de Geest, 2005; Van Zoest & Bohl, 2002). Romberg (1992) summed up the importance of a shift in teachers' beliefs, "The single most compelling issue in improving school mathematics is to change the epistemology of mathematics in schools, the sense on the part of teachers and students of what the mathematical enterprise is all about" (p. 433).

Summary of the Review of Literature

The review of literature surveyed four topics related to teachers' beliefs and practices: affect, influences, equity, and the *Standards.* Research showed that mathematics anxiety often begins during the elementary years and a negative affect could impact students' achievement (Harper & Daane, 1998; Ma, 1999; Philipp, 2007).

Affect of both students and teachers impacts pre-service and inservice teachers' beliefs and practices (Hannula, 2002; McLeod, 1992).

In addition to the affect of mathematics teachers, the school climate heavily influences teachers' beliefs and practices (Van Zoest & Bohl, 2002). Some of the influences that impact teachers' practices include curriculum (Cady, 2006; Frykholm, 2004), a lack of time (Adams & Krockover, 1997; Cady et al., 2006; Kitchen, 2003; LaBerge & Sons, 1999), administrators (Kitchen, 2003), professional development (Adams & Krockover, 1997; Cwikla, 2004), and colleagues (Cwikla, 2004; Kitchen, 2003).

Teachers' equitable or inequitable attitudes toward students are another consideration affecting teachers' practices. Some teachers lowered their expectations to "help" students (Lubienski, 2002; Szatjn, 2003), and others believed they were "helping" students by treating all students the same (Rousseau & Tate, 2003). Effective efforts that promote equitable teaching include culturally relevant teaching (Gutstein et al., 1997) and incorporating a collaborative effort of administrators, teachers, parents, and students to instill high expectations for all students (Gutierrez, 1999; Silva & Moses, 1990; Silver & Stein, 1996).

The final section in the review of literature examined the connection between teachers' beliefs and practices and NCTM *Standards.* A *Standards*-based pre-service education can have a significant impact on teachers' beliefs and practices (Cooney et al., 1998; Hart, 2002a; Wilkins & Brand, 2004; Van Zoest & Bohl, 2002). Inservice teachers were more likely to shift their beliefs and practices toward the *Standards* if they participated in *Standards*-based professional development (Hart, 2002b) and used

Standards-based curricula (Arbaugh et al., 2006; Frykholm, 2004; Lloyd, 1999; Roehrig & Kruse, 2005).

Research Questions

In this study, the research questions stemmed directly from the theoretical basis for the study, literature review, and purpose of the study. The research questions were all exploratory. According to Yin (2003), exploratory questions often lead to additional paths of inquiry. My exploration of the beliefs, practices, and participants' other influences led me to examine factors shaping the secondary mathematics teachers' practices and questions to consider in future research. The purpose of this study was to contribute to an understanding of the relationship between the beliefs and practices of secondary mathematics teachers who participated in a *Standards*-based pre-service education. The relationship was viewed using a lens based on the *Standards* (NCTM, 1989, 1991, 1995, & 2000) guidelines about mathematics teaching and learning. This study was guided by the following research questions:

1. To what extent are secondary mathematics teachers incorporating the *Standards*-based approach that was promoted in their pre-service education program?
2. How consistent are the secondary teachers' beliefs with a *Standards*-based teaching framework?
3. To what extent are other factors impacting secondary mathematics teachers' beliefs and practices toward *Standards*-based mathematics?
4. To what extent do teachers change their teaching approaches based on student demographics such as socioeconomic status, race, gender, and ability level?

III. DESIGN OF THE STUDY

Chapter III presents the methodology for this study, including researcher biases, settings for the study, instrumentation, participant selection, the data collection and analysis, and methods for ensuring validity and reliability. When choosing the design of a study, the plan must be carefully considered. In this study, my interpretations of teachers' beliefs and practices and the explanations of the participants themselves guided the exploration of the research questions.

Researcher Biases

Before proceeding further into the methodology, I would like to explain my own personal biases and beliefs towards the teaching and learning of mathematics. It is easiest to understand my beliefs in light of my own experiences. My high school education was traditional and teacher-centered. During my pre-service education, I was exposed to cooperative learning and some techniques to incorporate group activities. However, when I entered the classroom, my teaching practices resembled a traditional, teacher-centered format because my administrator strongly encouraged an "orderly" classroom and discouraged the use of group activities. My first administrator left the school, and a more flexible administrator took his place. I attended professional development activities that promoted inquiry-based learning, and I attempted to infuse investigative activities into my methods.

After nine years of teaching, I moved to a different town, and the administrator at my new school encouraged me to take courses at the university. I took a mathematics education research course that introduced me to the *Standards* documents and to many research studies promoting the incorporation of the *Standards.* I felt that this course provided the guidelines to teaching that I had been searching for since I entered my own classroom. After that class, I entered the doctoral program and took numerous classes that stressed mathematics teaching and learning based on the guidelines of the *Standards.* Therefore, I hold beliefs that align with *Standards*-based teaching practices. As a result, I view teachers' practices in light of the guidelines of the *Standards.* Also, I may have been more observant of certain aspects of the teachers' scenarios as opposed to others. For example, when observing teachers in the classroom, I may have concentrated on the teachers' questioning, causing me to overlook the overall impact of the lesson. Because I already reviewed the research literature before conducting the research, I may have had preconceived ideas about the outcome of the study.

Research Procedures

This study incorporated a mixed methodology that incorporated the use of both quantitative and qualitative research. Mixed methods research can be defined as "collecting and analyzing quantitative and qualitative data within either a single study or multiple studies" (Creswell & Plano Clark, 2007, p. 5). Qualitative data can be used to reinforce or develop quantitative research and vice versa (Strauss & Corbin, 1998). The qualitative research complements the quantitative research by following up and helping to explain the quantitative results (Cresswell, 2007). The quantitative method was used because I wanted to get an overall image of the beliefs and teaching practices of mathematics teachers who graduated from Southern State University. Although the main purpose of the quantitative survey was to provide data to select the case studies, the results of the survey were also analyzed quantitatively. By using qualitative methods, I was able to explore the beliefs and practices of teachers more thoroughly and examine the image with a magnifying glass to discover details that influenced teachers' beliefs and practices. The in-depth look at teachers qualitatively could also help to provide some explanations for the results of the quantitative portion.

Context of the Study

Before turning to the specifics of the methodology of this study, I will provide a context for the discussion of the participant selection process. In this study, all of the mathematics teachers experienced a traditional high school education while they all participated in a pre-service education at Southern State University, a public university in a southern state that stressed *Standards*-based teaching practices. In this section, I will describe the secondary mathematics education program at Southern State University and the Communicating Through Mathematics (CTM) systemic project to set the stage for the discussion on participant selection.

Secondary Mathematics Pre-service Education Program at Southern State

The secondary mathematics education program at Southern State University was based on teaching principles that were in alignment with the NCTM *Standards* (1989, 1991, 1995, & 2000). All of the teachers in this study completed a traditional bachelor's degree or an alternative master's degree from the secondary mathematics education program at Southern State University.

First, I will discuss the course requirements for the bachelor's degree. To earn a bachelor's degree, each pre-service mathematics teacher was required to complete methods courses in teaching middle school mathematics, teaching high school mathematics, and technology and applications in secondary mathematics. These courses concentrated on immersing pre-service teachers with *Standards*-based experiences that included modeling of effective teaching by teacher educators, observation of *Standards*-based teaching in local middle and high schools, and teaching model lessons using *Standards*-based strategies in middle and high school classrooms and their methods class. Additionally in the mathematics department, the mathematics education curriculum required 13 mathematics courses: a three-semester calculus sequence, differential equations, linear algebra, history of mathematics, introduction to advanced mathematics, abstract algebra, geometry I, mathematics statistics, a senior-level discrete mathematics course, and another senior-level mathematics course. The culmination of the pre-service education was a semester-long internship with a classroom management class taken concurrently.

A closer look at the curricula studied in the methods classes provided insight into the actual teaching practices that secondary mathematics education graduates from Southern State experienced. The middle school methods course used *Elementary and Middle School Mathematics: Teaching Developmentally* (Van de Walle, 2007) as the primary text and was supplemented with relevant articles. Students were also required to prepare other written assignments, including numerous activities that promoted their development as reflective practitioners. Additionally, groups of students were required to prepare and teach four lessons from the Connected Mathematics Project (CMP: Michigan State University, 2006). CMP is a middle school mathematics curriculum that is organized around important mathematical ideas to develop a deep understanding of important ideas and makes rich connections with investigations across grades. The prospective teachers also spent time observing middle school classrooms, and teaching the CMP lessons to small groups of students in the classroom.

The technology course focused on acquiring basic know of calculators and computers to aid in exploring and solving mathematical problems within the high school mathematics curriculum. Specifically, pre-service teachers learned about dynamic geometry software, spreadsheets, designing websites, statistical software, and graphing calculators. Pre-service teachers demonstrated their knowledge by preparing computer laboratory activities, making a presentation to the class about integrating technology into instruction for a particular mathematical topic, and presenting a lesson to a secondary mathematics classroom using technology.

The high school methods course also offered numerous opportunities for field experiences. Each pre-service teacher helped with seatwork, led discussions of homework, and organized and led lessons during field experiences. Portions of *Principles and Standards for School Mathematics* (NCTM, 2000) and related articles were surveyed during each class meeting. Class time was also spent discussing and working lessons from a unit from the Interactive Mathematics Program (IMP; Alper, Fendel, Fraser, & Resek, 2003). IMP units are generally structured around a complex central problem, and other topics were brought in as needed to solve the central problem, rather than restricting the mathematical concepts (Key Curriculum Press, 2007). Both CMP and IMP incorporated *Standards*-based teaching practices characterized by:

- worthwhile tasks that engage *all* students
- effective questioning
- teacher as facilitator
- students working collaboratively to explore and grapple with significant mathematics
- students presenting and writing justifications and explanations for their solutions
- the use of technology as a tool
- teachers' respect for students' ideas and ways of thinking (NCTM, 1991)

Each mathematics education student culminated his or her pre-service preparation with a semester-long internship in a secondary mathematics classroom. At the beginning of the internship, pre-service teachers observed their cooperating teachers and became acclimated to their new school environment. After a few weeks, the interns began teaching one class each day and increased their teaching load each week. The interns were required to teach their cooperating teacher's full class load for four consecutive weeks. To reinforce *Standards*-based teaching practices, priority was given to placing interns with cooperating teachers whose beliefs and practices were in alignment with *Standards*-based principles.

There was a somewhat different regimen of coursework for an alternative masters degree in secondary mathematics. Alternative masters students must complete the same methods courses as the undergraduate students. In the mathematics department, 15 hours of coursework were required at the graduate level beyond an undergraduate degree in mathematics. The equivalent of an undergraduate mathematics degree was mandatory for admission to the program. It was compulsory that students in the alternative masters program complete three mathematics education graduate courses: one investigating research in mathematics education, one that studied the evaluation of teaching and learning mathematics, and one that examined mathematics program models, components, and standards. Additionally, alternative masters students participated in a specified number of hours of fieldwork in secondary schools. The number of fieldwork hours required by the state has been increased several times in the past few years. Pre-service teachers completed their coursework for the alternative masters with a semester-long internship and the same classroom management class taken by the undergraduates.

Communicating Through Mathematics Project

Communicating Through Mathematics (CTM) is a systemic project funded by the National Science Foundation and seeks to improve mathematics teaching and learning. CTM is comprised of a partnership among Southern State University's College of Education and College of Sciences and Mathematics, Waterton University, and fifteen school districts located in the Eastern portion of the state. The mission statement of CTM emphasizes that all students understand, utilize, and communicate mathematics. The students use this knowledge to become lifelong learners of mathematics and productive citizens.

CTM contains four components—professional development, teacher education, curriculum alignment, and stakeholder involvement. CTM provides effective professional development that aids teachers with their curriculum alignment. The professional development also offers presentations that help teachers improve their *Standards*-based pedagogical skills. In order to promote *Standards*-based pre-service education, teachers educators involved with CTM attempt to match interns with teachers who are active in CTM. Teachers in schools that join the program are encouraged to attend professional development opportunities geared for their grade level. The professional development activities include a two-week summer institute and a follow-up one-week institute the next summer, quarterly meetings, and numerous workshops throughout the year. Some teachers are chosen to take on enhanced roles, such as a presenter, a school teacher leader, or a district teacher leader. A CTM presenter organizes and leads sessions at CTM's summer institute and quarterly meetings throughout the year. The presenters must attend numerous training sessions as well as planning meetings throughout the year. The principal of a school selects the school teacher leader for CTM. A school teacher leader is responsible for coordinating activities at the school and encouraging teachers to incorporate *Standards*-based practices in their classroom. The district teacher leaders are nominated by a representative from their school district. The responsibilities of a district teacher leader are the same as school teacher leaders, but they are carried out at the district level.

Instrumentation

This study used four primary instruments. The first, the Teacher's Practices and Beliefs Survey, was used in the quantitative study. The remaining three—interview protocols, Reformed Teaching Observation Protocol, and field notes—were used in the qualitative study.

Teacher's Practices and Beliefs Surveys (TPBS)

The Teacher's Practices and Beliefs Survey (TPBS) was adapted from the beliefs and attitudes survey developed by the Evaluation Planning Team of CTM. A copy of the TPBS can be found in Appendix A. Sources used by the evaluation committee in developing the instrument included the RAND report (Ball, 2003), the National Assessment of Educational Practices (National Center for Educational Statistics, 2003), and several other federal projects. The TPBS was field-tested in the spring of 2007. The participants consisted of five pre-service teachers in their final semester and three graduate students. Those who participated in the field test of the survey were also asked for suggestions to clarify ambiguous or biased wording.

The TPBS contained several sections. The first section explored the teachers' beliefs about teaching and learning mathematics, and the options available were "Strongly Agree," "Agree," "Neutral," "Disagree," and "Strongly Disagree." The second section investigated the alignment of teachers' practices with their beliefs by reflecting on their first class of the day, and the options available were "All or Almost All," "Often," "Sometimes," "Rarely," and "Never."

Certain portions of the beliefs section and question #13 on the influence that teachers have on student learning were relevant to teachers' expectations of students based on the students' background and socioeconomic status. These statements were combined to arrive at each teacher's beliefs and practices toward equity.

In order to help understand the factors that affected teachers' practices, the survey asked teachers to rate eight potential factors based on the following options: guides my teaching practices; significantly influences; influences only slightly; or not at all.

The final section of the survey asked background questions like years taught, level of education, gender, ethnic background, and amount of professional development that they have participated in within the last year.

Interview Protocols

Two semi-structured interview protocols were developed for use with the case studies. Related research with similar interviews (Adams & Krockover, 1997; Peterson, Fennema, Carpenter, & Loef, 1989; Roehrig & Kruse, 2005) was examined to develop the interview questions. A predetermined list of questions was asked of each secondary mathematics teacher in the first interview to ensure all of the planned topics were covered. Further explanation on questions was explored if the participant's answer called for clarification. A copy of the initial interview can be found in Appendix B. The participants were also asked to respond to specific teaching events that took place during the follow-up observations. The questions in the closing interview also investigated the teachers' beliefs and practices as they pertained to specific events witnessed during the second observation period. The structured portion of the interview was field-tested in July, 2007 at a professional development workshop for *Standards*-based mathematics. Ten teachers participated in the field test.

Reformed Teaching Observation Protocol (RTOP)

The Reformed Teaching Observation Protocol (RTOP) was used to guide classroom observations. The RTOP was developed to provide a reliable method for determining the degree to which reform methods were being implemented by mathematics and science teachers. A copy of the RTOP can be found in Appendix C. The RTOP was selected for use in this study because of the alignment of the RTOP objectives with those of *Standards*-based teaching practices. The instrument was created by the Evaluation Facilitation Group (EFG) of the Arizona Collaborative for the Excellence in the Preparation of Teachers (ACEPT) from two instruments: the Horizon Research Inc. instrument and a classroom observation instrument developed locally by ACEPT's Dr. Anton Lawson of the Arizona State University Biology Department (AzTEC, 2002). Because of the RTOP objectives' alignment with *Standards*-based teaching practices, the instrument provided an excellent method of consistently analyzing teachers' practices.

During each class observation, an RTOP was completed to provide a standardized means of determining to what degree *Standards*-based mathematics instruction had taken place. The RTOP was divided into five different sections. The first section called for basic background information on the teacher and class. The second section examined contextual background and activities. In this section, I included information such as a description of the lesson observed, the seating arrangements, relevant details about the student population and teacher, and any observational notes about happenings in the classroom. The observational notes were transcribed and coded with all of the other transcribed data.

The next three sections consisted of categories of statements using Likert-scale ratings. Each question was scored on a five point Likert scale where 0 represents "Never Occurred" and 4 represents "Very Descriptive" (AzTEC, 2002). A higher score indicated teaching practices that were more in alignment with *Standards*-based practices. A neutral score was represented by a 2. The third section, Lesson Design and Implementation,

contained five statements. The statements examined to what extent the teachers' design and implementation of lessons were student-centered. The fourth section, Content, included five statements on propositional knowledge and five statements on procedural knowledge.
A lesson was propositional through a *Standards*-based lens if the lesson used fundamental mathematics concepts, promoted conceptual understanding, and made connections with the real world. A lesson was procedural from a *Standards*-based point-of-view if the students used a variety of representations, devised hypotheses, thought critically, and reflected on their learning. The fifth section, Classroom Culture, was comprised of five items about communicative interactions and five items describing student/teacher relationships (AzTEC, 2002). A classroom was deemed to have *Standards*-based communicative interactions if students felt comfortable communicating with each other and contributed significantly to the focus of the lesson. The student/teacher relationship was *Standards*-based if the teacher encouraged active participation and was a patient listener. The RTOP helped provide a better understanding of each teacher's practices in light of the *Standards.*

Field Notes

I took field notes during each observation to get a better of picture of each classroom environment. These notes included incidents of students getting out of their seats, passing notes, not on task, texting, listening to music, and communicating across the room to their friends. I also looked for any information that could not be heard on the tape, such as facial expressions of students and teachers, students' and teachers' attitudes, the pattern of students' hands raised, and the atmosphere created by the décor of the classroom. Although I was especially attentive to certain aspects of teaching, my mind also was open to other unanticipated phenomena that emerged.

Participant Selection

The context and the instrumentation descriptions have set the stage for the participant selection. The task of selecting participants involved an arduous process that began with 95 prospective candidates and ended with five teachers who agreed to participate in a case study. In the following paragraphs, I will describe the actions taken with an accompanying timeline for the participant selection process.

Initial Participant Selection

The pool of participants was all former secondary mathematics education students who graduated from Southern State University from 2001 to 2007. These students were selected because I wanted to research a group of teachers who had experienced a similar *Standards*-based pre-service education program. The students included both bachelors and alternative master's students. The alternative master's students were included because they are required to complete a one-semester internship which is a very crucial component of the pre-service education. Prior to any contact with the secondary mathematics graduates, permission was obtained from the Internal Review Board (IRB) of Southern State University to conduct the study. A copy of the IRB approval letter can be found in Appendix D.

In September and October of 2007 continuing efforts were made to locate all available names, addresses, and emails of the potential participants. The university was able to provide the names of all students who had received a degree in mathematics education during the years 2002 to present. Some of the prospective names contained current emails and/or mailing addresses. The 2001 data had to be retrieved from old graduation programs. The total number of graduates from both sources totaled 95. Next, came the task of discovering if and where these graduates were teaching mathematics, as well as obtaining their current emails and mailing addresses.

I used numerous techniques to locate missing or inaccurate information. These included emailing teachers to request information concerning other teachers, searching school websites for matching names, and calling numbers provided by the university to verify the teacher's information. The extended search confirmed that only 15 graduates had definitely left the teaching profession. One of the graduates had moved into administration at the secondary level. I was able to validate that 54 of the graduates were currently teaching secondary mathematics. The remaining twenty-six graduates either did not respond to any of my correspondence or their addresses could not be confirmed.

In the fourth week of October, 2007, a preliminary email was sent to all qualifying teachers explaining the purpose and significance of the study and asking for their participation in the survey. A letter was sent with the same information to all prospective participants who did not have accurate emails. The email/letter also served the purpose of alerting teachers of the arrival of the survey. The survey was sent out by email/letter the first week of November, 2007. The participants were asked to return the survey by November 21, 2007. A reminder was sent on November 14, 2007 to encourage participants who had not returned their surveys to complete the survey. In accordance with my IRB protocol, each possible participant was assigned a number and assured of their anonymity and privacy if they completed the survey. The surveys contained the participants' assigned number, and their name was not included on the survey anywhere. I was the only person who had access to the list that connected the participants' name with their assigned number.

Since less than thirty surveys had been returned, I decided to send all of the non-responding teachers a letter via postal mail that contained the link to the survey and a physical copy of the survey with a self-addressed stamped envelope. Only two surveys were returned by postal mail. Another follow-up email was sent during the first month of December, 2007. Continued efforts were made by email, postal mail, phone calls, and personal solicitation for graduates to complete the survey. After the collection of surveys was completed, 42 surveys were returned, 15 of the possible candidates were no longer teaching mathematics, contact was never made with 26 candidates, and 12 who had been confirmed as teachers did not complete the survey.

Selection of the Case Study Participants

During the month of December, 2007, possible candidates for the case studies were selected. The responses to the TPBS in the areas of teachers' beliefs, teachers' practices, and teachers' beliefs and practices toward equitable teaching were used to narrow the field of possible case study participants. My goal was to select case study participants who would represent a maximal, purposeful sample that represented diversity in teachers' beliefs and practices.

The responses used for selection criteria were divided into three categories. The first category included the responses to questions from the TPBS that probed teachers' beliefs. The second category contained responses to questions from the TPBS that investigated teachers' practices. The third category consisted of items from the TPBS that explored teachers' equitable beliefs and practices. More details about the scoring of the three categories can be found in the qualitative data analysis section.

I ranked the scores from all of the responses in each of the three categories and divided the scores into quartiles. After the survey scores were tallied, the task of choosing the participants began. To ensure an extreme range of beliefs, I selected ten teachers with the following rankings: two teachers' scores placed in the highest quartile in all three categories, five teachers’ scores placed in the bottom quartile in all three categories, and three had beliefs and practices that conflicted where beliefs fell in one extreme quartile and practices fell in the other. I looked for a sample that varied under the following factors: years of teaching, level of education (bachelor’s degree vs. master’s degree), perceived ability level of classes, teaching at schools that participated in the CTM systemic project, geographic location of the school where they were teaching, and diversity of classes taught. Six teachers were selected, but one later elected to withdraw. An attempt was made to select teachers of diverse racial and ethnic backgrounds. However, only two current teachers were identified as non-White, and the only African American still teaching chose not to return the survey even though I made a personal telephone call to encourage her participation. The remaining teacher was chosen as one of the case study participants.

One facet of this study included the observation of how student demographics impacted the implementation of teachers' *Standards*-based teaching strategies. Student demographics include factors such as race, ethnicity, socioeconomic status, ability level, and students who use English as a second language. I expected to find some emerging data relevant to the demographics of students and *Standards*-based beliefs and practices of teachers. Most of these former mathematics education students taught within a relatively small geographic radius of the university. Pseudonyms have been used for all teachers and schools included in this study. A summary of the teachers' years of experience, level of education, and beliefs and practices are reflected in Table 1.

A purposeful, diverse sample was chosen so that more implications could be made from the data gathered. One of the teachers was in his first year of teaching while two of the teachers were in the spring of their second year. However, one of these teachers had 11 years of teaching experience in the Middle East. The remaining two teachers were more established and had already taught four years. The level of education was divided among two teachers holding bachelor's degrees, two holding alternative masters degrees, and one teacher with both a bachelors and masters from Southern State University. Two of the teachers were not affiliated with the CTM Project, but the other three all participated to some degree. One teacher was highly involved, and the other two were moderately involved.

The responses from the TPBS were used to categorize the teacher in relation to their beliefs and practices. Three teachers had high rankings in the beliefs category, two teachers had high rankings in the practices category, and three teachers had high rankings in the equitable expectations category. A high ranking would be associated with a teacher in alignment with *Standards*-based teaching practices. One teacher had high rankings in all three categories, and one teacher had low rankings in all three categories. The diversity in all of these factors was sought to provide a means to compare teachers and draw implications from the different situations. Similarities and differences were noted to find patterns and commonalities that led to teaching practices that were traditional or *Standards*-based.

Table 1

Summary of Teacher Factors

Teacher	Years Taught	Level of Education	CTM School	Grades Taught	Level of Class	SB* Beliefs	SB* Practices	Expectations in Light of Equity
Mr. Easterly	5	Bachelors Degree	No	9-12	Different	Low	Low	Low
Ms. Danforth	2 in US 11 in another country	Alternative Masters	Yes	12	Same	Low	High	Low
Mr. Barry	1	Bachelors Degree	No	7-8	Different	High	Low	High
Ms. Anthony	2	Alternative Masters	Yes	7-8	Different	High	High	High
Ms. Chandler	5	Masters Degree	Yes	10-12	Same	High	Low	High

*SB stands for *Standards*-based

Methodology

This section will describe the methodology used in the study. First of all, a sketch will be given of both the quantitative and qualitative methodologies used in the study. The data collection methods used for the quantitative and the qualitative are explained in the next section. Then, the analysis of the data collected is described in the final section. A detailed explanation of the coding process is given in the data analysis section.

Quantitative Methodology

The purpose of quantitative research is defined as "reducing characteristics to a form that could readily be described with numbers, and using the numbers to identify relationships among the characteristics" (Jones & Kottler, 2006, p. 9). Quantitative research focuses on the deductive component in order to test hypotheses or theory (Johnson & Christensen, 2004). Educational quantitative research usually entails collecting data from surveys, achievement tests, and other collection instruments using precise data (Johnson & Christensen, 2004).

The quantitative portion of this study was based on the responses from the Teachers' Beliefs and Practices Survey (TBPS). The teachers who were contacted to complete the TPBS were graduates from the secondary mathematics education program at Southern State. To recap the response from the 95 graduates, 42 returned the survey, 15 were no longer teaching mathematics, 12 did not complete the survey, and contact was never made with 26 candidates. The survey was based on a Likert scale of 1 to 5 where 5 indicates teaching beliefs or practices aligned with the guidelines of the *Standards*. The data provided a means to represent the relationships between teachers' beliefs and practices numerically from a larger number of respondents (*n* = 42). The results of the quantitative data were compared with the qualitative data.

Qualitative Methodology

Qualitative research can be defined as "any type of research that produces findings not arrived at by statistical procedures of other means of qualification" (Strauss & Corbin, 1998, pp. 10-11). Qualitative research is naturalistic which means that it has "actual settings as the direct source of data, and the researcher is the key instrument" (Bogdan & Biklan, 1998, p. 4). Researchers are the vehicle for gathering qualitative data, and their efforts should be spent collecting detailed data (Bogdan & Biklan, 1998). Qualitative research incorporates the "presence of voice and the use of expressive language" to create *einfuhlung* or "empathy" (Eisner, 1998, pp. 36–37) that gives a complex, detailed understanding of the topic (Cresswell, 2007). The qualitative researcher should so skillfully describe the environment that the reader actually experiences the feeling of "being there" (Cresswell, 2007).

One specific approach to qualitative research is the case study. Cresswell (2007) described the focus of case studies as an in-depth analysis of "an issue explored through one or more cases with a bounded system" (p. 73). Merriam (1998) and Stake (2006) defined the case as a unit that has boundaries making it different or unique in some way from other cases. The case study approach investigates detailed, thorough data collection from numerous sources of data that usually include interviews, observations, documents, and transcribed information (Cresswell, 2007). A case study approach was chosen as the methodology to investigate teachers' beliefs and practices in order to obtain a "rich, 'thick' description of the phenomenon under study" (Merriam, 1998, p. 29). In this study, the five teachers were selected as “cases” or units of analysis in order to gather a purposeful, maximal sample. The Teacher’s Practices and Beliefs Survey (TPBS) was the instrument used to find cases that were unique and diverse.

Five individual case studies comprised the qualitative element of the study. Southern State University provided an opportunity to research secondary mathematics teachers who had participated in a *Standards*-based pre-service education. In 2000, the secondary mathematics education program hired two new professors who were very knowledgeable of *Standards*-based teaching strategies. They implemented a curriculum (see p. 119 for description) that promoted the *Standards*-based concepts. The professors also served as the director and co-director of the CTM systemic project.

Data sources included in this study consisted of multiple sources: the TBPS; classroom observations; Reformed Teaching Observation Protocol (RTOP) instrument (AzTEC, 2002); two observation periods of five consecutive days; observation notes taken during each observation period; and post-observation interviews. An explanation of the instruments is provided in the previous instrumentation section.

Observations in a case study allow for firsthand views of phenomena being examined and can be used to validate information from other data sources such as interviews and surveys. I observed each teacher for two observation periods of five consecutive days. In order to provide as little disruption to the class as possible, I sat in the teacher’s desk in the back corner of the room. Each class was taped using a very small recorder that sat on the desk. I made a seating chart of each class and noted the race, gender, and any exceptionalities of each student. I attempted to capture the general climate of each classroom as I took notes. The observation of the case-study participants occurred during one school semester.

Data Collection

Data were collected for both the quantitative and qualitative phase of the study. Several types of consent had to be obtained before the data could be collected. The next section describes the consent process. Followed by that is an explanation of the quantitative and qualitative data collection procedures.

Consent Process for Data Collection

In order to use data collected in the study, teachers taking part in the study in any way must sign a consent form. A copy of the teachers' consent form can be found in Appendix D. The teachers who responded electronically signed their consent electronically as a prerequisite to completing the survey. The teachers who returned the survey via postal mail included their signed consent form with the survey. All respondents to the survey signed the accompanying consent form, so all of the completed surveys were used in the study.

In addition to the teachers in the case study, permission had to be obtained from the schools to collect data. The superintendents of the case study teachers' school systems were contacted for permission to conduct the study. Each school system had different protocols for obtaining permission to conduct the research. Some required documentation including an abstract of the study or the IRB Protocol. Others simply requested that the principals be informed upon arrival at the school for observation. One curriculum director asked for a meeting so that I could explain the theoretical basis and design of the study. The principals were also contacted and sent an informational letter. I met with the respective principals or academic administrators to explain the purpose and direction of the study.

Quantitative Data Collection

The process of locating and contacting the prospective survey respondents is described earlier in the *Initial Participant Selection* section. Most of the surveys were returned electronically. When the electronic surveys were received, they immediately went to a spreadsheet file. The non-electronic surveys were hand coded into the spreadsheet package. All of the data from the surveys was located in that file.

Qualitative Data Collection

After the completion of the selection process for the case study participants (discussed earlier in the *Initial Participant Selection* section), I contacted each teacher and set up a schedule for interviews and observations. Each of the case study participants were observed in the spring of 2008. Each participant participated in a semi-structured interview prior to my observations (see Appendix B for interview questions). They were observed for five consecutive days during the months of January–February, 2008 and five consecutive days during the months of March–April, 2008. I observed either one block class or two traditional-length classes. Ms. Anthony was an exception in that she was observed for two block classes because she had two classes at both ends of the perceived ability spectrum. The RTOP instrument was used during the observations to provide an unbiased rating of the teachers' actual practices used in the classroom. During the observations, notes were taken documenting the seating arrangement, the discourse patterns of the teacher and students, activities used during the class, assessments, the level of engagement of the students, and the treatment of *all* students.

Each teacher participated in an interview between the first and second observation period. A third interview was conducted following the conclusion of the second observation period. Prior to the third interview, I reread all data produced by each case study participant to aid in constructing the questions necessary to clarify happenings in the classroom, beliefs, or sufficient answers to the research questions for this study. All of the observations and interviews were audio taped, and I personally transcribed them. The observation notes from the RTOP were also transcribed. For the most part, the transcriptions were completed the same day of an observation or interview in order to ensure the accuracy of the transcription. All of the transcriptions were put into word processing documents, and all of the data were subsequently loaded into a qualitative software package, Atlas.ti (Muhr & Friese, 2004). After transcribing the observation or interview, I reflected on the events of the day in light of the research questions. The reflection also aided in the development of the second and third interview.

Data Analysis

After collecting the data from a variety of sources, I had to analyze the data in such a way that would provide information contributing to an understanding of my research questions. First of all, I will describe the process that was used to analyze the data quantitatively. In the next section, I will explain the qualitative analysis which includes both the single-case analysis and the cross-case analysis. In the single-case analysis, I will detail my coding process and how I arrived at my categories and subcategories which were later used to report the results of the data.

Quantitative Data Analysis

The responses from the TPBS survey were located in a spreadsheet file. This file was then analyzed using a Statistical Package for the Social Sciences (SPSS: Shannon & Davenport, 2001). SPSS is a statistical software package used to analyze quantitative data for the social sciences (Shannon & Davenport, 2001). The survey data were analyzed quantitatively to look for trends in beliefs and practices of teachers who graduated from the secondary mathematics education program at Southern State University. Teachers' beliefs, teachers' practices, and equitable beliefs and practices were the three categories from the TPBS that were analyzed. The total score of items from Section A of the TPBS comprised the teachers' beliefs. The total score of items from question 10 of Section B of the TPBS made up the teachers' practices. The equitable beliefs and practices total score combined the items from the teachers' beliefs and teachers' practices that pertained to equitable teaching. The intercorrelations among teachers' beliefs, teachers' practices, and teachers' equitable beliefs and practices were analyzed. The mean, standard deviation, and coefficient alpha from the TPBS responses were also found for the teachers' practices, teachers' beliefs, and teachers' equitable beliefs and practices. The coefficient alpha measures the internal consistency of the items in attitudinal surveys and aids in establishing internal reliability (Shannon & Davenport, 2001). The means and standard deviations of the teachers' ratings were found on the factors of socioeconomic status of students, academic level of class, administration, curriculum, colleagues, time factors, high-stakes testing, and involvement in professional development. Specifically, regression analyses were run to predict teachers' practices and beliefs in light of these outside influences on teachers.

Qualitative Data Analysis

The first part of this section explains the analysis used for selecting the case studies. The second component explains the process used coding the data. An explanation of the reliability and validity of the qualitative data analysis follow this analysis section.

The responses from the TPBS used for selection criteria were divided into three parts. Section A of the TPBS investigated the beliefs of the teachers. Question 10 of Section B of the TPBS examined the practices of secondary mathematics teachers by reflecting on the practices of their first class of the day. From the TPBS, three items from Section A and eight items from Question 13 of Section B comprised teachers' beliefs and practices toward equitable teaching.

Teachers' beliefs scores. Section A contained 24 items, and the total score for teachers' beliefs was the sum of the 24 items. To facilitate the selection, I assigned a value to each survey item where "5" represented "Strongly Agree" and "4" represented "Strongly Disagree". The questions that were phrased negatively were reverse coded, that is, a "1" was replaced with a "5", a "2" was replaced with a "4", etc. The reverse coding allowed survey answers that indicated the strongest responses toward *Standards*-based beliefs and practices to be coded with the highest score, and vice versa. For example, the second item on the TPBS is "Teachers should ensure that students experience success in mathematics by clearly explaining and modeling how to complete each day's assignment to their students." An answer of "Strongly Agree" (coded as a "5") indicated alignment with traditional teaching, so that answer was replaced with a value of "1" to represent beliefs that are not representative of *Standards*-based principles. A high score reflected beliefs or practices in alignment with *Standards*-based practices, and, conversely, a low score conveyed more traditional beliefs and practices.

Teachers' practices scores. Question 10 of Section B contained 19 items, and the total score for teachers' practices was the sum of the 19 items. Similarly to arriving at the total beliefs score, I assigned a value to each survey item where "5" represented "All of Almost All" and "1" represented "Never." The questions that were negatively phrased were also reverse-coded, and a high score suggested alignment with *Standards*-based teaching practices.

Equitable beliefs and practices scores. The equity score for each teacher was calculated using three items from Section A and 8 items from Question 13 of Section B. The total equity score was calculated by adding scores from each of the 11 items. The response options for equitable beliefs and practices were the same as the beliefs portion, and each teacher's score was calculated similarly with reverse coding.

Coding process. The data gathered from observations notes, interviews, and transcripts of classroom observations represented a major portion of the data for this study. The coding of this data was based on a grounded theory approach as defined by the guidelines of Strauss and Corbin (1998). Grounded theory is defined as "theory that was derived from the data, systematically gathered and analyzed through the research process. In this method, data collection, analysis, and eventual theory stand in close relationship to one another" (Strauss & Corbin, 1998, p. 12). The software program Atlas.ti (Muhr & Friese, 2004) was used to simplify the coding process. Strauss and Corbin (1998) describe three types of coding that is used to analyze data qualitatively: open coding, axial coding, and selective coding. First of all, open coding is used to identify concepts and their properties in data (Strauss & Corbin, 1998). These concepts stand for phenomena and are divided into categories. In open coding, line-by-line analysis allows the categories to emerge quickly and general properties of categories to be developed (Strauss & Corbin, 1998). A word, sentence, paragraph, or combinations of paragraphs can be used as an occurrence of the category or code. After the categories are established, axial coding is used to put data back together that were splintered during open coding. Therefore, axial coding is used to analytically develop categories and relate categories to their subcategories in a way that provides detailed descriptions about phenomena (Strauss & Corbin, 1998). The coding was done until all of the categories were saturated. A category is considered saturated if new information no longer emerges during coding (Strauss & Corbin, 1998). Selective coding is then used to integrate and refine the categories to aid in building theory. Finally, the emergent ideas that have been developed throughout the coding process are compared with existing research.

The two stages of qualitative analysis in multiple case study research are single-case analysis and cross-case analysis (Merriam, 1998). First, I will explain the process used to analyze the cases followed by a description of the cross-case analysis.

Single-case analysis. For each case, the interview transcript, observation notes from the RTOP, and the transcripts from the classroom observations were coded. Using the open coding process explained in Strauss and Corbin (1998), I located themes and assigned initial codes or labels in a first attempt to condense the mass of data into categories. After reading each of the documents, response patterns surfaced and similarities were noted. Four general categories emerged as the main themes throughout the data. These categories held strong connections to the research questions for several reasons—the interviews were developed from the research questions, the observation transcriptions described teacher practices, and the notes taken during observations were taken with the research questions in mind. These categories included: Teachers' Beliefs, Teachers' Practices, Questioning, and Factors that Affected Teachers' Practices.

Teachers' Beliefs encompassed any references to teachers' philosophies and attitudes toward the various aspects of teaching. For example, a teacher's statement describing her philosophy on inquiry-based learning would be coded Teachers' Beliefs. Any transcriptions were coded as Teachers' Practices when they were related to teachers' actual practices in the classroom. An instance of Teachers' Practices might include observational notes describing an activity during a lesson. Any type of question that was asked in the classroom was coded as Questioning. Any situation, factor, or aspect of the school climate that affected the strategies that teachers used was coded as Factors that Affected Teachers' Practices. A teacher's use of a particular curriculum that affected his or her practices was coded Factors that Affected Teachers' Practices. A copy of all codes with their descriptions and an example can be found in Appendix E.

In the next phase, axial coding was applied to divide general categories into smaller subsets as defined by Strauss and Corbin (1998). I reexamined the transcriptions from each category several times to determine the subcategories. Since the subcategories were also determined by the case study data, the discussion of the category results in Chapter IV was also broken down by the following subcategories. The category of Teachers' Beliefs was separated into Philosophy toward Teaching, Expectations, and Pre-service. The category of Teachers' Practices was divided into Traditional Practices, *Standards*-based Practices, Equity, and Other. Questioning was divided into High-Order

Questioning and Low-Order Questioning. The category of Factors that Affected Teachers' Practices was divided into School Climate Factors and Teacher Factors.

When analyzing the data with the axial coding process, all of the transcriptions of the observations and observational notes were put into one or more categories. The total number of occurrences for each category was calculated and that number is located in parentheses following the category name. Any occurrences that related to the beliefs that a teacher held were coded as Teachers' Beliefs (104). The category of Teachers' Beliefs was further broken down into the subcategories of Beliefs Related to Pre-service (13), Philosophy toward Teaching (65), and Expectations (53). The code Pre-service was recognized as beliefs that were connected to a teacher's pre-service education. Philosophy toward Teaching was considered any belief that a teacher expressed about the practice of teaching. These beliefs included the attitudes toward curriculum, activity-based learning, questioning, the teacher's role, and so forth. Expectations were coded anytime a teacher expressed the beliefs about the ability of certain classes, students, or groups of students to accomplish homework or other activities. Since beliefs were not readily observable, most of the data from this category originated from teacher interviews.

Subdividing Teachers' Practices (556) was very difficult because of the multi-faceted nature of teachers' practices. After rereading the transcriptions numerous times, the thrust of the coding was either Traditional Practices (347) or *Standards*-based Practices (157). Traditional Practices occurred when the emphasis was on the teacher or not considered student-centered. Teachers working solutions on the board, a teacher's explanation of a mathematical procedure with no student input, close-ended questions, and a teacher-centered atmosphere were examples of Traditional Practices codes. Teachers' Practices were coded *Standards*-based Practices when they aligned with the NCTM's *Standards* documents (1989, 1991, 1995, & 2000). *Standards*-based Practices could include instances of students explaining or justifying their solutions, students working in groups to solve a non-routine problem, the use of technology to make mathematical connections, the incorporation of real-life or contextual problems, or conceptual-based teaching.

Another aspect of teachers' practices involved the equitable treatment of students in the classroom. Instances of equity or inequity were coded Equity (278). The Equity Principle provided an excellent baseline definition of the term equity, "Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students" (NCTM, 2000, p. 11). Previously in the review of literature, results from research outlined several examples of equitable and inequitable teaching practices. Rousseau and Tate (2003) reported that often teachers attempted to promote equity in the mathematics classroom by teaching all students equally, but they actually were promoting inequity. Szatjn (2003) recounted teachers' inequitable practices based on students' background or socioeconomic status. The inequitable practices included "adjusting" *Standards*-based teaching practices by presenting the curriculum in an orderly manner with a lack of conceptual teaching. In contrast, the teachers at Phoenix Park displayed equitable teaching practices by not adjusting their teaching styles based on socioeconomic status (Boaler, 2002). The equitable teaching practices of implementing advanced classes and raising the level of expectations for students of different cultures, socioeconomic status, or minority races were evidenced in research involving the dominantly Hispanic Union High (Gutierrez, 1999), the Algebra Project (Silva & Moses, 1990), and the QUASAR Project (Silver & Stein, 1996).

The category of Questioning (736) afforded a different lens with which to observe the classroom. Questions that only required a yes/no answer or a numerical answer were coded as Low-Order Questioning (253), and questions that required analyzing, synthesizing, evaluating, or justification were coded as High-Order Questioning (329) (Shiang & McDaniel, 1989). A question that was phrased as a high-order question but restated as a low-order question was coded as Low-Order Questioning. Questions that teacher answered themselves were not considered either High-Order Questioning or Low-Order Questioning but were coded Lack of Wait Time. High-Order Questioning aligned with *Standards*-based teaching principles while Low-Order Questioning was typical of traditional teaching practices (NCTM, 1991).

The coding entries that were not initiated by the teachers were coded as Factors that Affected Teachers' Practices (248). The subcategory of School Climate Factors (110) included items that teachers had no control over such as curriculum, administration, or school climate. If a statement was coded as Teacher Factors (159), then the factor affected the teacher's practices but could be addressed by the teacher in the classroom. An example of Teacher Factors included the lack of classroom control or a teacher's involvement in professional development. Table 2 contains a list of the codes of categories and subcategories with their respective frequency.

Table 2

Categories and Subcategories Used and Frequency

Code	Frequency
Teachers' Beliefs	104
Pre-service	13
Philosophy toward Teaching	65
Expectations	53
Teachers' Practices	556
Traditional Practices	347
Standards-based Practices	157
Equity	278
Questioning	736
High-Order Questioning	253
Low-Order Questioning	359
Factors that Affected Teachers' Practices	248
School Climate Factors	159
Teacher Factors	11

After the descriptive coding was completed, the documents were recoded to look for emergent codes. The recoding of documents was an ongoing process as new codes were entered into the code list. After all of the documents had been coded, each document was re-examined to make certain that any additional codes were used when appropriate.

During this process, several new categories came to light, and all of these categories could be associated with the original four categories. For example, as each document was reread, any instance of the flow of the class being disrupted by talking or actions was coded as “interruption.” Similarly, when the documents noted a student not participating during class, a code of “off-task” was assigned. Both of these examples fell into the general category of Factors that Affected Teachers’ Practices and the subcategory of Teacher Factors. An example of a code that unexpectedly emerged from the coding process was Students Actions Changed Lesson. This code described a situation in which teachers changed the direction of their lesson based on students’ comments, questions, presentations, or seat work. Some codes pertained only to one case study and did not appear in any of the data for the remaining case studies. Table 3 contains a list of the codes with the number of times each code was used after all the documents were coded.

Table 3

Codes Used and Frequency

Code	*Frequency*
Activity as Part of Lesson	35
Administration	12
Advice to Students	8
Connections	15
Curriculum	21
Fill in the Blank Discourse	74
High-stakes Testing	24
Individual Attention to Students	18
Interruption	82
Intimidation	12
Lack of Wait Time	67
Notes Taken in Class	35
Off-task	46
Patient with Students	5
Praise	13
Professional Development	10
Real Life Problems	57
Repeat Question	20

(table continues)

Table 3 continued

Code	*Frequency*
Revoices	8
Scaffolds	6
Students Actions Changed Lesson	41
Technology	78
Time Element	16

Cross-case analysis. After analyzing each of the single cases, a cross-case analysis was conducted in order to compare and contrast the practices, influences, and characteristics of the various cases (Merriam, 1998; Yin, 2003). The cross-case analysis can be used to look for similarities and differences among the cases. *Naturalistic generalizations* can be developed from analyzing the data. The generalizations allow others to "learn from the cases either for themselves or to apply to a population of cases" (Cresswell, 2007, p. 163). The findings can be compared with published research that is relevant to the findings (Cresswell, 2007). The cross-case analysis allowed me to achieve a stronger understanding of the similarities and differences between the cases, and the many factors that influenced their classroom instruction.

Validity and Reliability

During the course of the research, it is necessary to establish reliability and validity of the process. The simplest definition of reliability means the consistency of the research, and the concept of validity can be defined as relevance (Jones & Kottler, 2006).

More specifically, validity refers to the degree that an instrument or method measures what it is supposed to measure. In qualitative research, validity is considered strong if there is a good fit between the intent of the research and what was actually studied (McMillan & Wergin, 2006). This section will provide a case for reliability, interrater reliability, internal validity, and external validity. A section on peer debriefing is also included to help establish validity.

Reliability

In qualitative research, Merriam (1998) noted that reliability can be defined as the level of consistency between the results and the data. Structural corroboration (Eisner, 1998), the convergence of multiple sources of data, was used to develop reliability between the results and the data. Other steps taken to establish reliability were explaining the context of the research and the selection process for participants and leaving a path so that others could follow the exact research process. Additionally in Chapter IV, I provided detailed explanations of the contexts of the study and descriptions of the participants. I also have provided a detailed path of my research process both electronically and with hard copies, documenting the design of the study and the collection of data and including the creation of databases during the analysis process, notes taken throughout the process, and drafts of all write-ups.

Interrater Reliability

In order to establish interrater reliability of the coding process, I recruited two fellow graduate students to help in the process of analysis to see if the themes and description categories could be applied by a person not familiar with the data. This process helped to establish inter-rater reliability. Both of these graduate students had experience coding data. I gave each person a copy of the codes with the explanations of the codes, and then discussed some examples of each code. Both of the graduate students coded an identical section of transcripted data that I had coded. I coded 34 occurrences, and the other two coded 35 and 36 phrases. The percentage of agreement of codes was .91 and .88 respectively. Both the first and second coder identified two phrases as advice, but I did not view the words as advice. Specifically, one of the words was “Listen,” I remembered that “Listen” was an interruption when the teacher was trying to regain control of the class. I had the different experience of actually being in the classroom when “Listen” was uttered and remembered the context which could not be inferred simply from the transcription. The second coder viewed the phrase, “We’ll get through this a lot faster if you keep your mouth closed” as well as a similar phrase as Intimidation, but I coded the phrases as Interruptions. I had observed many times the difficulty that the teacher had with classroom management and did not view any references to being quiet as intimidating to the students. None of the mismatching codes of the three coders were in conflict but rather a slightly different interpretation of the intent of the teacher.

TPBS Reliability and Validity

The TPBS was adapted for a beliefs and practices developed by the Evaluation Planning Team of CTM. This CTM survey has been administered to thousands of teachers and has established reliability and validity. A minimum value of .7 for the coefficient alpha assures an acceptable level of internal consistency (Mehrens & Lehmann, 1987). The teachers’ practices segment of the TPBS ($a = .720$) and teachers’ equity segment of the TPBS ($a = .712$) met the test for internal consistency and aided in establishing internal reliability of the TPBS. To improve validity of the TPBS, five pre-service teachers in their final semester and three graduate students field-tested the TPBS in the spring of 2007. Those who participated in the field test of the survey were also asked for suggestions to clarify ambiguous or biased wording.

Reliability and Validity of the RTOP

The reliability and validity of the RTOP instrument is excellent. The content validity was established by the credibility of the sources that were used as consultants (AzTEC, 2002). The consultants also determined the construct reliability using a correlational analysis of the five categories. Four of the categories returned an R^2 above .940 and the category content: procedural pedagogical knowledge had an R^2 of .769 (AzTEC, 2002). To establish inter-rater reliability, the RTOP instrument was completed by two different observers during 16 different observations (a total of 32 independent observations) on the same class. The estimate of reliability was very high, and the proportion of variation had an R^2 of 0.954. However, the five teachers in this study that were observed taught in school systems that were located as far as 300 miles apart. The distance between the school systems made the possibility of finding an additional observer to establish inter-rater reliability virtually impossible. To aid in establishing the reliability of the RTOP instrument, I attended an RTOP training regiment along with several other participants. First, I watched a tape of a mathematics teacher presenting a lesson and completed the RTOP instrument. All of the training participants discussed their RTOP ratings and came to a consensus on any differences. The process was repeated watching another mathematics teacher presenting a lesson. The goal of the training session was to promote reliable scoring for the RTOP instrument.

Internal Validity

The methods for establishing internal validity were considered in the design and implementation of this study and during the data analysis. As Merriam (1998) stated, internal validity is a measure of how well research findings capture reality; for a study to have internal validity, researchers must accurately portray participants' "constructions of reality" (p. 203). Merriam (1998) noted that triangulation, numerous observations, and identification of the researcher's biases are some of the methods that can be used to enhance the internal validity of a study (p. 204). Triangulation is an emergent process in which the authentic meaning residing within an action can be best uncovered by viewing it from different vantage points (Schwandt, 2007). Triangulation can be accomplished by converging multiple sources of data or discovering a repetition of words or phrases that support a conclusion (Cresswell, 2007). Triangulation of data was used with observations, interviews, instruments, and surveys. Using the data, multiple examples were found to support themes that emerged during the data analysis. To improve internal validity, I observed teachers for five consecutive days at two different time periods to ensure a good understanding of their classroom practices because teachers may teach a "special" lesson if the observations are only sporadic. I identified my biases in designing my study and continued to monitor them throughout the study.

External Validity

External validity, which refers to the generalizability of the results, is difficult for qualitative researchers to establish (Merriam, 1998). Instead of using the term *external validity*, Lincoln and Guba (1985) stated that the term *transferability* is more appropriate for qualitative research. They note that it is the responsibility of the user of the research findings to determine whether the results can be transferred to another context. The readers of this study will be able to determine transferability of the results to instructors who have similar backgrounds and personal characteristics, teach similar student populations, and work in similar professional climates based on the detailed descriptions that I provide for each case. In addition, multiple sites or campuses were part of this study, and Merriam noted that this factor increases the range of contexts to which the results can be applied.

Peer Debriefing

In order to help establish validity to the research process, communication with peers was an ongoing component. Findings were discussed weekly with a fellow doctoral student who was also working on her dissertation. Several other experts in the field were consulted regularly to discuss emergent findings. My major professor provided input and direction at each phase of the dissertation research process. A professor whose field of expertise is quantitative research frequently reviewed the research process for the TPBS survey. Another professor who specializes in qualitative research provided advice on the qualitative aspects of the study. At a mathematics education conference, I discussed my research in several work sessions with fellow graduate students and teacher educators. At various times during the planning and data collection of the dissertation, I consulted with other professors and teachers for their feedback and opinions.

IV. RESULTS AND INTERPRETATION OF THE DATA

Brown and Borko (1992) asserted that most pre-service teachers experienced a traditional mathematics childhood education, and they often encountered a conflict between how they learned mathematics and how they were taught to teach mathematics. Research has shown that an effective *Standards*-based pre-service secondary mathematics program can have a significant effect on the beliefs and practices of prospective secondary mathematics teachers (Philipp, 2007). Climate and circumstances significantly impact the *Standards*-based practices of a mathematics teacher (Van Zoest & Bohl, 2002). In this chapter, I will discuss the results and interpretation of the quantitative and qualitative data concerning teachers' beliefs and practices after completing a *Standards*-based pre-service education in secondary mathematics and the impact of various factors. The quantitative results will present statistical data while the qualitative data will provide a deeper and more precise understanding of the beliefs and practices of the five case study teachers.

As previously noted, the purpose of this study was to contribute to an understanding of the relationship between the beliefs and practices of secondary mathematics teachers who participated in a *Standards*-based pre-service education. The relationship was viewed using a lens based on the *Standards* guidelines about mathematics teaching and learning. As described in the Chapter III, interviews, a survey examining teachers' beliefs and practices, and classroom observations were mechanisms to aid in investigating the connection or lack of connection between teachers' beliefs and practices from a *Standards*-based viewpoint.

As I attempted to coherently present the findings from this study, the results and the interpretation of the data could naturally be combined into one chapter. The first portion of the chapter contains the results of the Teacher's Practices and Beliefs Survey (TPBS) using quantitative analyses. The qualitative results of the chapter will contain the following information about each case: demographic data about the school and each teacher's class demographics; background information about each teacher; a vignette from each teacher's classroom; findings about each teacher's beliefs; findings about each teacher's practices; an analysis of each teacher's questioning strategies; findings about the factors that affected each teacher's practice; and a summary of each teacher's beliefs and teaching practices. A comparison of the case studies will follow the discussion of the five case studies. A final comparison will be made between the quantitative and qualitative results.

Results of the Quantitative Data Analysis

The TPBS survey was analyzed quantitatively. These analyses will contain several types of information. First, the descriptive statistics will be given for each item of the survey and each section of the survey that was taken into consideration for the case studies. Next, the results of the intercorrelations between teachers' beliefs, practices, and equity will be presented. The descriptive statistics on the factors that influence teachers are discussed with a table included. Finally, the results of the regression analyses for teachers' beliefs, practices, and beliefs and practices regarding equity are presented.

The quantitative analyses provide information concerning the overall picture represented by the 42 mathematics teachers who completed the survey. Responses were analyzed for the categories of teachers' beliefs, practices, and equitable beliefs and teaching practices. The mean and standard deviation was calculated for each item used. Appendices reporting the means and standard deviations for each item that makes up total teachers' beliefs can be in found in Appendix F, teachers' practices can be found in Appendix G, and teachers' equitable beliefs and teaching can be found in Appendix H. The items are arranged in descending order so that the item with the highest mean is first. The higher means indicate that on the average teachers were more in agreement with *Standards*-based practices for this statement.

The score for teachers' beliefs, teachers' practices, and teachers' equity contain different numbers of items. In order to help compare the three sections, the mean score per item was found for each of the three categories. Table 4 contains the means, standard deviation, and coefficient alpha for teachers' beliefs, practices, and equity. The numeric median between Strongly Agree (a value of "5") and Strongly Disagree (a value of "1") would be a 3. Both the responses to teachers' beliefs and teachers' equitable beliefs and practices fell below the median somewhere between Neutral and Disagree. Teachers' practices indicated even less alignment with *Standards*-based practices than teachers' beliefs and teachers' equitable beliefs with an average score that fell between Disagree and Strongly Disagree. These means showed that the majority of the teachers did not hold beliefs or practices that were in alignment with *Standards*-based principles. In analyzing the coefficient alpha, higher values represent a higher level of internal consistency. A minimum value of .7 for the coefficient alpha assures an acceptable level of internal consistency (Mehrens & Lehmann, 1987). The teachers' practices segment of the TPBS (α = .720*)* and teachers' equity segment of the TPBS (α = .712*)* met the test for internal consistency.

Table 4

Means, Standard Deviations, and Coefficient Alphas of Teachers' Beliefs, Practices, and Equity (n = 42)

Scale	# of Items	Mean	SD	Coefficient Alpha
Beliefs	24	2.378	.254	.615
Practices	19	1.878	.395	.720
Equity	11	2.359	.378	.712

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 5 presents the results of the intercorrelations between teachers' beliefs, practices, and equity. The strongest correlation in the study of teachers' beliefs and practices was between teachers' beliefs and teachers' practices ($p < .01$). The correlation was significantly negative. In other words, a teacher who held beliefs in agreement with the *Standards* most often exhibited practices that were not in alignment, or vice versa. Another significant correlation was between teachers' beliefs and teachers' equitable beliefs and practices ($p < .05$). The correlation was positive. According to the survey, this result indicated that teachers with beliefs that were in alignment with the *Standards* were more likely to exhibit equitable teaching beliefs and practices. After the analysis of the case studies, the results of the quantitative analyses will be compared with the case study findings.

Table 5

Intercorrelations Between Teachers' Beliefs, Practices, and Equity (n = 42)

	Beliefs	Practices	Equity
Teacher Beliefs	-.404**	.385*	
Teacher Practices		-.404**	-.503
Teacher Equity		.385*	-.503

* $p < .05$; ** $p < .01$; *** $p < .001$

Several factors were examined that were influences on teachers' beliefs and practices. There were eight factors that teachers rated on the survey: curriculum, time, academic level of students, professional development, colleagues, testing, administration, and the socioeconomic status of students. The options were "Guides my teaching practices" (a value of 4); "Significantly influences" (a value of 3); "Influences only slightly" (a value of 2); and "Not at all" (a value of 1). A higher score meant that the factor influenced the strategies that a teacher employed more significantly. Table 6 presents the means and standard deviations of the factors. The factor of curriculum was rated by the teachers as the most influential factor affecting teachers' methods and activities. The factor of time was the second most influential, and the next four factors had only a range of .27 separating them. The factor of socioeconomic status of students was reported to have the least impact. The Pearson Correlation summarizes the relationship between teachers' practices and the factors that influence teachers' practices.

Table 6

Means and Standard Deviations of the Factors that Influence Teachers (n = 42)

Factor	Mean	SD	Pearson Correlation
Curriculum	3.57	0.547	.43
Time	2.99	0.568	.34
Academic Level of Students	2.79	0.782	.27
Professional Development	2.64	0.791	.21
Colleagues	2.52	0.707	.19
Testing	2.52	0.833	.15
Administration	2.24	0.759	.08
Socioeconomic Status	1.83	0.730	.03

Table 7 presents the results from the regression analysis that used teacher factors to predict teachers' beliefs. The eight independent variables were entered and one factor was excluded from the restricted model. Overall the full model resulted in an R^2 of .421. The factor of colleagues was excluded because the contribution of this variable was very small, and the increased variance by including colleagues would be less than that expected by chance. Removing the factor of colleagues did not significantly change the impact that the other seven influences have on teachers' beliefs (R^2 change = .004, $p >$ .05). Professional development, administrators, and curriculum ($p < .05$) were significant factors in the full model. Academic level of students was also included in the restricted model ($p < .05$). Two variable (factors), professional development and curriculum, were positively related to teachers' beliefs. On the other hand, the significantly negative beta associated with administrators and academic level of students suggests that these two factors acted as negative influences on teachers' beliefs.

Table 7

Regression Table — Teachers' Beliefs (n = 42)

	Full Model	Restricted Model
# of Independent Variables	8	7
R square	.421*	.417
R square change		-.004
Std Error of the Estimate	5.170	5.109
F	2.993*	3.474
Factors	Beta	Beta
Professional Development	.355*	.389**
Administrators	-.346*	-.320*
Curriculum	.332*	.339*
Academic level of students	-.315	-.327*

(table continues)

Table 7 (continued)

Factors	Beta	Beta
Socioeconomic status of students	.294	.284
Testing	-.275	-.259
Time	.234	.248
Colleagues	.079	

*$p < .05$; **$p < .01$

Table 8 presents the results from the regression analysis that uses teacher factors to predict teachers' practices. The eight independent variables were entered and four factors were excluded in the restricted model. An overall R^2 of .396 resulted from the full model. Testing, time, administrators, and colleagues were excluded in the restricted model because their contribution was very little, and the increased variance by including testing, time, administrators, and colleagues would be less than that expected by chance. Removing the factor of testing, time, administrators, and colleagues did not significantly change the impact that the other four influences have on teachers' practices (R^2 change = .058, $p > .05$). These factors were curriculum ($p < .05$), the academic level of the students ($p < .05$), socioeconomic level of students ($p < .05$), and professional development ($p < .05$) were significant in both models. The beta in the factor of academic level of students was significantly positive, and this indicates that the academic level of students positively impacted teachers' practices. The factor of academic level does not distinguish between upper and lower academic levels so no inferences can be made about which level of students that teachers were considering. However, the significantly negative betas associated with curriculum, socioeconomic level of students, and professional development suggest that these three factors acted as barriers to teachers implementing their preferred teaching approaches.

Table 8

Regression Table—Teachers' Practices (n=42)

	Full Model	Restricted Model
# of Independent Variables	8	4
R square	.398*	.341
R square change		.058
Std Error of the Estimate	6.497	6.421
F	2.724*	4.777
Factors	Beta	Beta
Curriculum	-.535*	-.460*
Academic Level of Students	.400*	.450*
Socioeconomic Status of Students	-.390*	-.333*
Professional Development of Students	-.287*	-.329*
Testing	.233	
Time	-.102	
Administrators	.106	
Colleagues	-.035	

*$p < .05$

Table 9 presents the results from the regression analysis that uses teacher factors to predict teacher's beliefs and practices regarding equity. The eight independent variables were entered and three variables were excluded in the restricted model. The full model resulted in a statically significant R^2 of .426, while the restricted model produced an R^2 of .420. Socioeconomic status of students, academic level of class, and curriculum were excluded from the restricted model because the contribution of these variables was very little, and the increased variance by including socioeconomic status of students, academic level of class, and curriculum would be less than that expected by chance. Removing the socioeconomic status of students, academic level of class, and curriculum did not significantly change the impact that the other five influences have on teachers' beliefs and practices regarding equity ($R^2 = .006$, $p > .05$). These factors were testing ($p < .05$), colleagues, administrators, professional development, and time. The factor of testing significantly acted as a barrier to teachers' equitable beliefs and practices.

Table 9

Regression Table—Teachers' Beliefs and Practices Regarding Equity (n = 42)

	Full Model	Restricted Model
# of Independent Variables	8	5
R square	.426*	.420
R square change		-.006
Std Error of the Estimate	3.836	3.693
F	3.066*	5.210
Factors	Beta	Beta
Testing	-.393*	-.395*
Colleagues	.331	.324
Administrators	-.286	-.266
Professional Development of Students	.272	.281
Time	-.231	-.242
Socioeconomic Status of Students	.088	
Academic Level of Class	-.059	
Curriculum	.026	

*$p < .05$

Results of the Qualitative Data Analysis

The Teaching Principle emphasized the complexity of teaching mathematics using *Standards*-based guidelines (NCTM, 2000). The multifaceted nature of teaching makes it difficult to analyze qualitative data. In qualitative analysis, it is very important to accurately tell the story of each case study. To better understand each case study, the data was coded, and this process of coding is described in detail in the *Data Analysis* section in Chapter III. Four categories and subsequent categories emerged from the coding of the data. In an attempt to effectively portray the case study participants, I have described them in terms of the categories and subcategories that were developed in the coding process. Table 2 lists the categories and subcategories used in coding and the frequency of each of the categories and subcategories. I also included information relevant to the list of emergent codes (see Table 3) to ensure that important concepts and activities related to teachers' beliefs and practices were included. From the TPBS, the case study teachers' responses to the beliefs, practices, and equitable beliefs and teaching practices, and influence of the factors on teachers' practices are included in Appendix I.

In order to better understand the description of the case studies, some background information will be provided. First of all, an overview of the school and community setting for the case study participant will be given. Next is a detailed description of each case study which will be followed by a cross-case comparison that compares the similarities and differences of the cases.

School and Community Setting

The picture of a teacher's beliefs and practices could not be accurately painted without including a description of the school settings that surrounded each teacher. I envisioned each school setting with anxious anticipation since I had never set foot in any of the teachers' schools prior to the study. The impact of the initial impression as I entered each school for the first time was unforgettable. The schools ranged from exquisite with every imaginable perk to a school in need of many repairs, while others were somewhere in the middle.

A summary of the school demographics is listed in Table 10. Not only did the five case-study teachers represent diversity in their school climate, but also in their classroom settings. Table 11 gives an overview of each of the five teachers' classes taught, the racial makeup of each class, and the presence or lack of presence of an inclusion teacher.

Table 10

School Demographics

Teacher	Grades Serviced	Total Population	Student/ Teacher Ratio	Students Eligible for Free/Reduced-Price Lunch	Spending per Student	Racial Background
Mr. Easterly	9–12	1412	13	11%	$8300	White = 76% African American = 17% Asian = 3% Hispanic = 3% American Indian = <1%
Ms. Danforth	9–12	987	18	86%	$7754	African American = 100% White = <1% Asian = <1% Hispanic = <1% American Indian = <1%
Mr. Barry	6–8	559	16	29%	$7554	White = 80% African American = 18% American Indian = 1% Hispanic = <1% Asian = <1%
Ms. Anthony	7–8	603	21	46%	$6135	White = 61% African American = 37% Hispanic = 2% Asian = <1% American Indian = <1%
Ms. Chandler	10–12	1045	14	24%	$7955	White = 64% African American = 29% Asian = 4% Hispanic = 2% American Indian = <1%

Table 11

Summary of Teachers' Classes

Teacher	Classes Taught	*Racial Makeup of Classes	Inclusion Teacher
Mr. Easterly	Algebra IA (1st)	9/7/1	Yes
	Algebra IA (4th)	12/8/4	Yes
	Algebra IA (5th)	7/4/3	Yes
	Algebra III	19/4/1	No
Ms. Danforth	Alg Connections (6th)	0/20/0	No
	Alg Connections (7th)	0/7/0	No
Mr. Barry	Advanced Algebra I	24/1/2	No
	Pre-algebra (2nd)	15/5/0	No
	Pre-algebra (4th)	18/7/0	No
Ms. Anthony	7th Math	10/13/3	Yes
	Pre-algebra	23/1/2	No
	Algebra I	Not observed	
Ms. Chandler	Algebra II	5/13/2	No
	Geometry	9/8/1	No

*Racial makeup of class is shown by number of students in the following order: White/African American/Other

Case Studies

For each case study, I will describe each teacher and his or her school in detail and give a short vignette from his or her classroom. Then, I will explain teachers' beliefs in terms of their pre-service education, their philosophy toward teaching, and their expectations in terms of equitable teaching. Next, I will provide details concerning teachers' practices with the categories of traditional practices, *Standards*-based practices, equity, and the results from the Reformed Teaching Observational Protocol (RTOP) instrument. I will then discuss each teacher's questioning techniques as well as factors that affected their teaching practices. Finally, I will summarize each teacher's beliefs and teaching practices.

Case 1: Mr. Easterly

Mr. Easterly had been teaching five years and was in his second year at Rolling Hill High School. It was an ultramodern school that boasted a brand new beautiful school with a spacious courtyard complete with a fountain. Walking into Rolling Hill was like walking into an upscale metropolitan hotel. The announcements were easily visible on an electronic screen, and the front desk was manned by numerous employees to help visitors or students with tardy arrivals, academic issues, parental questions, substitute sign-ins, etc. Upon arrival, I was required to provide a valid driver's license for identification, which was used to make a visitor's pass complete with a picture, name, identifying school, and time and date of arrival. Rolling Hill, considered one of the top academic schools in the state, oozed of order and excellence. The school had 1412 students in grades 9–12. The student teacher ratio was 13 to 1, and only 11% of the students qualified for free or reduced lunch. The school was three quarters White. From the summary of his classes (described in Table 12), it is apparent that Mr. Easterly's classes were not representative of the demographics of Rolling Hill High School. Mr. Easterly taught four sections of Algebra IA and one section of Algebra III. In addition to his teaching duties, Mr. Easterly coached football and baseball.

Table 12

Summary of Mr. Easterly's Classes

Teacher	Classes Taught	*Racial Makeup of Classes	Inclusion Teacher	Teaches Classes of Differing Abilities
Mr. Easterly	Algebra IA (1st)	9/7/1	Yes	Yes
	Algebra IA (4th)	12/8/4	Yes	
	Algebra IA (5th)	7/4/3	Yes	
	Algebra III	19/4/1	No	

*Racial makeup of class is shown by number of students in the following order: White/ African American/Other

Teaching in the prestigious Rolling Hill High was a good fit for Mr. Easterly. Mr. Easterly exhibited a strong physical presence in the classroom. The administration viewed his authoritative presence as a necessary characteristic in an algebra IA teacher because the students were perceived as lower-achieving and needed strong discipline. As a coach and ex-football player, a disciplined and orderly classroom was very important to him.

As I walked into Mr. Easterly's classroom, it almost had that fresh paint smell, and the desks, carpet, and walls looked new. The walls were dotted with colorful mathematics and sports posters. Students' work could also be seen on the wall. In the rear of the room was a list of the top ten students for each mathematics course for the past nine weeks. Mr. Easterly had access to all of the latest technologies—a tablet computer that was used in connection with an LCD projector, a computer at his desk, and a document camera. The strict order of Mr. Easterly's teaching was also apparent in his classroom. The room exuded an air of organization; every book and stack of papers was in its proper place.

Mr. Easterly believed that the direct method of teaching was the best method. He had two reasons for his beliefs. First of all, he had a positive experience in his pre-college education with direct teaching and wanted to teach in a similar fashion. Secondly, his internship reinforced these beliefs; his cooperating teacher taught in a very traditional manner. He saw his role as a teacher to be twofold. One was to teach mathematical concepts, and the second was to instill a good work ethic in his students.

Observations of Mr. Easterly's Lessons

As I observed Mr. Easterly teaching, a pattern of regimen and orderliness emerged. No nonsense, no talking, and methodical, accurate explanations of mathematical procedures described the daily regimen. Bellringers were projected onto the screen as the students entered. Bellringers are several problems written on the board for students to work as they enter the room. They are used as review or warm-up for the day's lesson and to help get the students on task as soon as the bell rings. Tardiness was not an issue because it simply was not tolerated. All students in every class worked the bellringers. Mr. Easterly proficiently displayed the bellringers on his tablet computer and moved quickly to the topic of the day. Mr. Easterly's explanations were displayed on a large screen so that all of the students could readily view his solution. He sat on a stool in the back of the classroom while writing on his tablet computer. Mr. Easterly quickly worked representative problems from the homework and asked, "Any questions?" I rarely observed any students asking questions regarding the homework. He worked several examples on the tablet computer to illustrate the new mathematics concepts. The problems were presented procedurally and did not include conceptual explanations. The students then practiced a couple of practice problems independently to check for comprehension. The remaining time was given for the students to work on their homework individually. During this time, all of the students were engaged and worked quietly at their desks.

The following vignette was a representative sample of Mr. Easterly's classroom practices:

> Mr. Easterly: If you can't count to five, there's nothing I can do for you, or you just made up numbers and filled in the blanks for homework. I can tell you right now if that's what you did to get your homework done, then you're probably in trouble. If your process of getting homework done is just to write down answers, that's not going to do any good. My 4-year-old nephew can do that. What was our formula for finding our slope if we had two points?
>
> (Writes notes on SMART Board about finding slope with two points.)
>
> Student #1: The change in y over the change in x.

Mr. Easterly: Good, Student #1. That’s what we’re going to focus on today. I’m going to give you 2 points, and you’re going to use the points. It doesn’t matter which point you label which. (Writes problem on SMART Board both ways switching x_1 and x_2 and y_1 and y_2.) What do you want to label as your first set of points?

Student #2: 9 and 9

Mr. Easterly: No remember your formula. What is 9 – 9?

Student #3: 0

Mr. Easterly: What is 13 – 5?

Student #4: 8

Mr. Easterly: So what’s our slope? Zero slope or we could write no slope. What was our clue that this was zero slope? The y’s were the same which meant the equation for that line is y = 9. That's a horizontal line, and the equation of a horizontal line is always y = some number. Do the next one on your own. Find the slope.

Mr. Easterly’s Beliefs

Pre-service. Like some teachers in Cooney’s research (1998), Mr. Easterly’s beliefs toward teaching mathematics were virtually unaffected by his pre-service education. He commented on his disagreement with the strategies taught in his methods classes:

> They [mathematics education professors] were trying to incorporate a lot of things all at once, like going up a ladder. I thought that will work with really smart students that can comprehend more than one thing at a time.

> Not all kids learn that way. If there's one thing in there that they don't understand, it kind of makes it hard to grasp all of it.... Now, if you take an advanced math class, they would probably be able to do it.

Mr. Easterly's traditional views were reinforced by his internship. He explained that his cooperating teacher's practices were in alignment with his beliefs toward teaching mathematics. He summed up his beliefs at the conclusion of his internship, "This is how I knew the way that I wanted to teach. It comes from two things—all through school, I had very good teachers and that's [traditional teaching] how they did it, and my cooperating teacher solidified this."

Philosophy toward teaching. Mr. Easterly's philosophy toward teaching has remained constant since his pre-service education. He explained his views on how students learn best, "I feel they [the students] learn best by understanding what's going on. You can give them rules and steps, and just say do that. As far as understanding, I try to get them to do this as best I can." Later in the interview he elaborated on his conception of understanding mathematical procedures, "... you ask why is that the answer. What did you do to get the answer? That way they can remember the steps that they do." He also clarified that in algebra IA there is not a "whole lot of why." He gave the example of the discussion of theoretical and experimental probability that had just occurred. "Once I broke it down into simple examples, to me it seemed like they got a little bit better understanding.... Maybe breaking it down into that simple way helped them to understand why the theoretical probability works." Mr. Easterly seemed to be equating the "why" with knowing each step and working each step accurately.

Mr. Easterly's responses to the Teacher's Practices and Beliefs Survey (TPBS) added to my understanding of his philosophy toward teaching. He strongly agreed that the teacher should model and demonstrate the concept first, and then give students the opportunity to practice those procedures. Similarly, he strongly agreed that teachers should ensure that students experience success in mathematics by clearly explaining and modeling how to complete each day's assignment to their students. He also strongly agreed that students will not understand a mathematical concept until they have memorized the definitions and procedures associated with that concept. However, he strongly agreed that students should understand the meaning of a mathematical concept before they memorize the definitions and procedures associated with that concept. These two responses seemed to be in direct conflict with each other but do not conflict when viewed through Mr. Easterly's definition of "understanding." In general however, Mr. Easterly's responses to the beliefs portion of the TPBS did not align with *Standards*-based beliefs.

In addition to teaching his students mathematics, Mr. Easterly felt that part of his role as a teacher was to instill a good work ethic into his students. One of the goals for his algebra IA class was to motivate them to do the best they can. He illustrated his viewpoint, "... if they choose to be a garbage man one day, they'll still work hard. Just trying to get them to be a good person—I feel like there's more to teaching, especially with freshman." Mr. Easterly suggested in his TPBS open response that he believed that one way to promote these ideals in his students was to create a comfortable atmosphere in his classroom. Mr. Easterly definitely conveyed an expectation of excellence from all students and attempted to create a "safe" environment for his students.

Expectations. Mr. Easterly's previous comments on his methods classes shed some light on his expectations for different levels of students. He emphasized his expectations with the statements, "In calculus, they [the teachers] are more facilitators. In this class [algebra IA], you have to teach students how to do this at the lower level. They don't remember how to do things." He commented specifically on his current algebra IA students, "It's so hard just to get them [algebra IA students] to understand what we're doing. Sometimes I feel like if I got that in depth with them, I would just confuse them." Mr. Easterly definitely believed that a different approach could be used for more advanced classes that lower-level classes would not be able to comprehend. Another factor that affected Mr. Easterly's expectations was students' home life. In the TPBS, he agreed with all of the statements that emphasized that a student's home environment was more influential than the impact that a teacher could have.

Mr. Easterly's Teaching Practices

RTOP averages. As discussed in the instrumentation section, the RTOP (AzTEC, 2002) was used as one means of analyzing Mr. Easterly's teaching practices in light of *Standards*-based practices. I completed an RTOP for each observation and calculated the mean RTOP scores for Mr. Easterly. The RTOP mean for all of Mr. Easterly's classes was 1.03. The RTOP averages illustrated the similarity of teaching style that Mr. Easterly used in all of his classes—he supported traditional teaching practices. Mr. Easterly's RTOP averages also provided evidence that his teaching practices were not in alignment with *Standards*-based teaching practices but followed a more teacher-centered, traditional style. Specifically, the RTOP averages pointed out that Mr. Easterly's lesson design and implementation, as well as involvement of students in the learning process (procedural knowledge) were more blatantly traditional. Table 13 summarizes the RTOP averages.

Table 13

RTOP Averages for Mr. Easterly's Observations

	Implementation	Propositional Knowledge	Procedural Knowledge	Communicative Interactions	Student/ Teacher Relations	Total
Algebra IA	0.60	2.00	0.30	1.10	1.20	1.03
Algebra III	0.50	2.10	0.20	1.20	1.10	1.03
Average	0.55	2.05	0.25	1.15	1.15	1.03

Traditional practices. The beliefs and teaching practices of Mr. Easterly were consistent. Mr. Easterly's beliefs and practices were similar to those of Ms. Compton in Frykholm's (2004) study. His survey responses on the TPBS ranked in the bottom quartile with respect to *Standards*-based practices. Mr. Easterly agreed that he never asked students to give a written explanation about how they solved a math problem for assignments or tests. He rarely promoted students' participation in small group discussions to help them make sense of mathematics. Never did Mr. Easterly have his classes do a math project or investigation that took several days to complete. My observations found these statements to be true. Each day the format of Mr. Easterly's lessons was almost identical—bellringer, discuss homework, introduce new topic, practice new topic, and work on homework. Mr. Easterly incorporated the use of technology effectively, but in a traditionally procedural manner. Mr. Easterly enlightened me on his lack of contextual problems, “We don’t do many [contextual problems], and the main reason is—I got this from my mentor teacher—it’s just so hard for them to do a word problem. You’re almost better to just to get them to understand how to do a problem.” As discussed earlier, Mr. Easterly’s RTOP scores also provided evidence to support traditional teaching practices. Since no *Standards*-based practices were claimed or observed, discussion of *Standards*-based teaching practices is a moot point. In summary, Mr. Easterly’s lessons were extremely teacher-centered with an emphasis on direct instruction and completely misaligned with his pre-service education.

Equity. During a conversation with Mr. Easterly on his teaching practices, he commented that equity carried the connotation of equality, and his definition of equity meant treating each student the same in his classroom. Mr. Easterly applied his ideas of treating all students equally in his classroom practices. For example, two students in Mr. Easterly’s algebra IA class spoke Spanish in casual conversation with each other because it was their first language. Mr. Easterly made no accommodations for them and did not attempt to infuse their culture into the curriculum. Instead, he treated them the same as all other students in the class without considering the learning outcomes of the students. Mr. Easterly’s actions of equality were an example of inequitable treatment of students as illustrated in Rousseau and Tate’s (2003) research.

In line with Mr. Easterly’s notion of equality, his teaching practices were similar in the algebra IA and algebra III class. There were virtually no differences observed in the way that he conducted the two classes. In his previous teaching assignment, he was teaching pre-algebra to a group of students that were labeled as high-ability. He distinguished between the practices of those students and his current algebra IA students:

> I've tried to show them [algebra IA class] a few things [conceptual explanations of mathematics problems] this year, and I just get that blank stare. I have done that before when I taught pre-algebra at a different school, and we did formulas for quadrilaterals. I always tried to show them where this formula [for quadrilaterals] came from. The difference is the makeup of the class.

Even though Mr. Easterly recognized a distinction in the perceived ability level of his current algebra IA students and his former pre-algebra students, he still approached teaching them using basically the same strategies and covering the same concepts. The practice of teaching for understanding according to the *Standards* generally was not included in his repertoire of teaching mathematics to any students at any level.

Mr. Easterly's Questioning Techniques

Mr. Easterly's inequitable but traditional teaching practices are further confirmed in his questioning techniques. The transcriptions of Mr. Easterly's lessons revealed that he asked low-order questions 109 times and high-order questions only seven times. On no occasion was a student discussion held. Mr. Easterly provided the vast majority of the explanations for solutions. Several instances were noted where Mr. Easterly made disparaging remarks to his students for lack of response to his questions. Further discussion of this will follow in the classroom factors.

Factors that Affected Mr. Easterly's Teaching Practices

School climate factors. The school climate at Rolling Hill could not be used as a hindrance. Each day a 30-minute study hall was built into the schedule for students to seek help in any class that was proving difficult. Mr. Easterly had access to all of the latest technology. Mr. Easterly used his tablet computer in combination with the LCD projector daily but had a document camera that was never used. The halls were empty and silent while classes where in session.

The school climate can be attributed to strong administrators with effective school policies. I spoke with Mr. Easterly's administrator, and she was very happy with Mr. Easterly's work with "those lower-achieving kids." Mr. Easterly clarified the administration's position:

> The administration wants to make sure your class is structured, however you do that—that you get your kids in a bit of a routine. I was told on my last evaluation that my assistant principal could tell that every day I was going to do a bellringer, then a lesson, and then they [the students] are going to do an assignment. He [the administrator] could tell that they're used to that. They [the administrators] just want us to try to be as consistent as possible.

The administration supported and encouraged Mr. Easterly's traditional teaching practices.

Teacher factors. The disciplined climate of Rolling Hill High School extended into Mr. Easterly's classroom. If a student was ever sleeping, playing with his calculator, not paying attention, etc., the situation was dealt with quickly and decidedly. On several occasions, he asked the straying student to come and sit by him. He then proceeded to help the student understand that this behavior was never tolerated. If the student was involved in any extracurricular activity, Mr. Easterly promised to speak to the coach and make sure there was retribution for the behavior. Therefore, behavior was not an issue, but, on the other hand, the climate in the room was not “safe.” Students seemed hesitant to raise their hands to ask questions. On one occasion during seatwork, an inclusion student tentatively raised her hand and called Mr. Easterly’s name softly several times. She finally lowered her hand and continued quietly at her desk. I observed several instances of Mr. Easterly using sarcastic remarks. Once he compared the intelligence of his class to his four-year-old nephew. Mr. Easterly’s classroom climate could be summed up as orderly but stifling.

Summary of Case 1

The discussion above overwhelmingly points to a traditional teaching style. He rejected the *Standards*-based practices presented in his methods class, and his traditional internship experience solidified his traditional beliefs and practices. Mr. Easterly's traditional beliefs were in alignment with his teaching practices. The administration was the only factor that had a considerable impact on Mr. Easterly's teaching practices. His administration was extremely supportive of a traditional teaching style and discouraged unruly group activities.

Mr. Easterly had definite beliefs that classes that are perceived as lower ability required different teaching strategies. Mr. Easterly omitted conceptual explanations of certain topics. However, Mr. Easterly added that he only occasionally provided conceptual descriptions of mathematical topics, even for upper-level classes.

Case 2: Ms. Danforth

Forrest Park High School was the location of Ms. Danforth’s second year of teaching. The school showed many signs of aging and disrepair. The floors in the hallways were basically covered with dried glue where the carpets had been removed.

A very friendly gentleman at the front door simply asked me to sign a visitor's log as I entered the school. Forrest Park High School had a population of 987 for grades 9–12 with an 18 to 1 student-teacher ratio. The student population of the school was all African American with 86% of the students qualifying for free or reduced lunches. Ms. Danforth taught six sections of algebraic connections, a senior-level class for students who took a low-level class for the fourth required mathematics curriculum. Algebraic connections uses algebraic and geometric techniques to make financial and economic decisions, including banking and investments, insurance, personal budgets, credit purchases, recreation, and deceptive and fraudulent pricing and advertising (Alabama Department of Education, 2008).

Ms. Danforth was born and raised in the Middle East. Her husband was a professor, and she had two grown children. Ms. Danforth felt that her motherly experience helped her to deal with her senior students whose lives were at a crossroads. Before coming to the United States, Ms. Danforth taught mathematics 11 years in her homeland. Since she was not certified in the United States, she opted for an alternative masters in mathematics education. The demographics of her classes were all very similar (see Table 14), but each class had its own personality. The administration gave Ms. Danforth free reign to teach her classes.

Table 14

Summary of Ms. Danforth's Classes

Teacher	Classes Taught	*Racial Makeup of Classes	Inclusion Teacher	Teaches Classes of Differing Abilities
Ms. Danforth	Algebraic Connections			No
	(6th period)	0/7/0	No	
	(7th period)	0/20/0	No	

*Racial makeup of class is shown by number of students in the following order: White/African American/Other

Ms. Danforth's surroundings were not amenable for teaching her students. The classroom itself was in disrepair and did not appeal to the eye. The shade on the only small window in the room was torn and hanging, the carpets were worn and stained, and the ceiling showed evidence of many leaks throughout the years. Ms. Danforth had hung several posters on the wall that represented the students' only project. There were not enough textbooks for each student to have one, so Ms. Danforth left the books in the classroom and used them occasionally.

Observations of Ms. Danforth's Lessons

The observations of Ms. Danforth's mathematics lessons yielded a systemized approach to teaching. The term "procedural" accurately described Ms. Danforth's teaching approach. Ms. Danforth had to wait to start class because students were typically five to fifteen minutes late for a 50-minute class. The bells seemed meaningless to the students. The air of confusion seemed to rub off on the students, and they had difficulty settling down. Ms. Danforth had notes written across several whiteboards. The students were familiar with the routine of copying the notes from the board when they arrived. She wanted them to "practice their writing." Then Ms. Danforth explained what the notes meant and worked an example for them. The lessons were very procedural with step-by-step explanations. Most of the topics were very practical and investigated relevant concepts like credit cards and mortgages. After the class worked collectively on a practice problem, the students were given the remainder of the class time to complete a few problems that could easily be completed in class. Ms. Danforth took great care to help students individually on numerous occasions during seatwork. Fridays were always reserved for quizzes, and many times they were open-note.

The following vignette characterized a portion of Ms. Danforth's typical lesson. The vignette illustrated Ms. Danforth's practice of simplifying the mathematical concepts into very concrete steps and using low-order questioning. This particular lesson was investigating calculating mortgage payments:

> Ms. Danforth: Copy these notes down, and we will use this huge formula later. The mortgage is $90,000. The bank requires 10% down, and also one point. Do you remember what 1 point is equal to? We did it yesterday. It is some percent of some amount, what is that? It is some percent of a certain value—a certain percent is worth a point. Look at your notes from yesterday. A point it equal to ___?
>
> Student: (finally looks in notes) 1% of the loan.
>
> Ms. Danforth: The bank wants you to pay 1% of the mortgage. What is the mortgage?
>
> Student: $81,000.
>
> Ms. Danforth: How did you find that?
>
> Student: Subtract the down payment.

Ms. Danforth: You subtract the down payment, that's right. Please finish. How did you find the mortgage? If you have made some down payment, you subtract the down payment from the cost of the house. You have to subtract $9,000 from $90,000, which is $81,000. Open your book to p. 439 and use the table.

Find out how much you have to pay for $1000. How much?

Student: $9.85.

Ms. Danforth: $9.85, you're going to have to pay $9.85 for every how many dollars?

(no response)

Ms. Danforth: $1000, for every $1000. And for the amount of the mortgage $81,000, you must calculate.

The vignette emphasized Ms. Danforth's traditional style that gave students little opportunity to participate and exposed Ms. Danforth's low expectations for her students.

Ms. Danforth's Teaching Beliefs

Pre-service. Ms. Danforth returned to traditional teaching that was very similar to her high school education. Ms. Danforth provided an intriguing story about her path to the love of mathematics:

> Up until eighth grade, I was not very good at mathematics. I could pass, but I was not a fan of math. I was not thinking of studying math, but when I was in classes ninth and tenth, they had just started the new math. When we started it, I was fascinated by it. After tenth grade, we had our longest break of all—five months. I went to stay at my uncle's house for the break. He had a lot of books, and I found a calculus book. I taught myself calculus every day during the break while they were at work. I decided at that point that I was going to study math. Similar to the

mode of teaching in the United States thirty years ago, teachers in her country were very traditional, and the teachers 'told the class what to do.'

Connecting her high school education to her pre-service experiences, she described her pre-service education at Southern State University:

> I had learned about group activities in my classes with my mathematics education professors, but I had never used them in the actual classroom. She [my cooperating teacher] showed me how they [group activities] did work. I was comfortable using groups, otherwise, I would have had difficulty doing it myself. It was helpful to see someone actually doing it and doing it successfully.

Summarizing her teaching beliefs after her pre-service education, "Southern State was a whole new way. I can't say I don't like it, but I would modify it as well." Connecting her beliefs coming from her early education and pre-service education, "I came from a country where the teacher told us what to do, and the group work was not common—it was a traditional teaching. I found that you need to have a balance—you cannot rely on group work and cannot do only the traditional lecture sort of thing. There needs to be a balance."

Philosophy toward teaching. Ms. Danforth felt that the principles that she learned in her pre-service program were useful for certain teaching situations,

> I think this [*Standards*-based teaching] would work better in the elementary and middle grades, but high school students, especially at the junior and senior levels, need to learn to work independently. Once in a while, I try to have them sit down together and do group work, but independent work is very important.

She stated that students learn best by using examples from real life. Ms. Danforth also believed that it was very important to write and be able to communicate in complete sentences in mathematics. She clarified by saying that they knew how to calculate on the calculator, but they did not know how to write what the answer means. Her philosophy toward teaching had changed since coming to Forrest Park because her students were all seniors who did not know how to read and write properly. She was also affected by the fact that her students had not even started thinking about what they wanted to do after graduation. She explained that her goals for teaching needed to be different.

Ms. Danforth's responses to the beliefs survey ranked in the bottom quartile among all participants. In support of *Standards*-based practices, she strongly agreed that students should understand the meaning of a mathematical concept before they memorize the definitions and procedures associated with that concept. She agreed that teachers should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages greater student-student and student-teacher interaction. Supporting her traditional beliefs, Ms. Danforth strongly agreed that time should be spent practicing mathematical procedures before students spend much time solving mathematics problems. She also agreed that students learn mathematics best from their teacher's demonstrations and explanations, and she preferred to show students how to use the model of a mathematical situation first.

One interesting belief concerning the benefits of physical activity emerged during Ms. Danforth's second interview, "I think the best thing is to give the students some physical activities. In the gym only those go who are in athletics. If all of the students could get a chance to exercise every day, they could let off some steam. In my country, after lunch everybody would be in a hurry to finish lunch and then go outside and run around."

Ms. Danforth also felt that part of her role as a teacher was to serve as a substitute parent, and her experience raising her own children was invaluable, "They don't have anybody to talk to. Since I have had children that have gone through this stage, I was there to tell them what they needed or help them." Ms. Danforth compared the home life and education of her students to her own and the education of her children. These beliefs had a huge impact on her expectations of her students.

Expectations. Unlike teachers at Phoenix Park (Boaler, 2002), Ms. Danforth lowered her expectations for her students because she believed that their background affected their ability to learn. "But now I have changed my opinion [about how much she can teach them] because these students when they go back home do not do anything." Additionally, Ms. Danforth's beliefs of the effect that a students' background had on student learning was illustrated by the comment:

> If my students were from, should I say, a rich background where they could afford an internet in their home. Many students do not have their own computers, and they are not forward about going to community places like the library. They cannot do homework on the computer, and they cannot do research work... It also would be better if their parents were at home and making sure that they were working and doing their homework. My headache would have been less about discipline, and I could get more done.

Ms. Danforth commented on her expectations about low socioeconomic students' ability to learn, "They're not ready to learn the conceptual idea."

Ms. Danforth’s responses to the TPBS portrayed a mixed bag of beliefs toward expectations, and her total equity score ranked in the lowest quartile. In alignment with her comments above, she agreed that if parents did more for their children, she could do more. Along that same line, she strongly agreed that if students are not disciplined at home, they are not likely to accept discipline at school. One response seemed contradictory to her previous statements—she disagreed that the hours in her class had little influence on students compared to the influence of the home environment. She considered herself neutral on the statement, “A teacher is very limited in what she can achieve because a student's home environment is a large influence on achievement.” From Ms. Danforth’s comments during her interviews as well as her TPBS responses, she definitely believed that students’ backgrounds and home lives limited their academic capacities at school. Like the teachers in Rousseau and Tate (2003), Ms. Danforth placed the blame for achievement on the home situation of the student.

Ms. Danforth’s Teaching Practices

In connection with the students’ home environment, Ms. Danforth felt a duty to reach out to her students who had a disadvantaged background. She often offered advice to her students about important decisions that they made about life in general. In addition Ms. Danforth showed extreme patience with her students and frequently praised her students. She also felt an obligation to help her students appreciate the free education that is available to them, “I try to talk to them about their home life, and then tell about mine ... People have to pay for their education in my home land.”

RTOP averages. As discussed in the instrumentation section, the RTOP (AzTEC, 2002) was used as one means of analyzing Ms. Danforth’s teaching practices in light of

Standards-based practices. I completed an RTOP for each observation and calculated the mean RTOP scores for Ms. Danforth. The RTOP mean for Ms. Danforth's classes was 1.66. The summary of a typical day in Ms. Danforth's class followed a very traditional format, and the RTOP scores also indicated teaching practices that were not in alignment with the *Standards*. In particular, the procedural aspect of Ms. Danforth's teaching followed an especially traditional format because she did not actively engage students. However, Ms. Danforth incorporated real world problems and fundamental mathematics concepts, so propositional knowledge was more *Standards*-based than other aspects of her teaching. Table 15 summarizes the RTOP averages.

Table 15

RTOP Averages for Ms. Danforth's Observations

	Implementation	Propositional Knowledge	Procedural Knowledge	Communicative Interactions	Student/ Teacher Relations	Total
Algebraic Connections	1.40	2.40	0.70	1.40	2.10	1.66

Traditional practices. Ms. Danforth's portion of the TPBS survey that reflected her teaching practices ranked in the top quartile in terms or *Standards*-teaching practices. However, her responses to the survey did not always agree with her actual practices. For example, she stated that students rarely listened to her lecture about math, but most of her lesson time was spent in lecture or individual seatwork. Another example was that her students never memorized formulas or rules for a test or quiz. That statement is true only because her students were allowed to use their notes to look up the formulas and rules. Another contradiction was noted when Ms. Danforth responded about using mathematics problems that required critical thinking. She responded that this happened almost all of the time, but most of her problems involved real-life problems that incorporated the procedural use of formulas. On her survey, she answered that her students often copied notes off the board, and I observed that copying notes off of the board was a regular part of her daily routine.

The observations of Ms. Danforth's lessons reflected the procedural and traditional focus of her teaching style. The RTOP averages for Ms. Danforth's lessons reinforced the conclusion that she did not incorporate *Standards*-based practices in her teaching. Ms. Danforth's teaching practices centered around the teacher and her notes on the board explaining how to calculate relevant financial procedures.

Standards-based practices. While I observed traditional teaching during most of Ms. Danforth's lessons, on one occasion she incorporated an activity exploring mean, median, mode, and range by measuring the distance that two items bounced away from the point of contact when dropped from the chalkboard. The two items were a paper towel and a piece of notebook paper, both of which were wadded into a ball. The students thoroughly enjoyed the activity and worked on a worksheet informally with each other. The worksheet, however, contained only one open-ended question that asked the students to describe the differences between notebook paper and paper towels. Ms. Danforth actually discussed the open-ended question with the entire class, and the students completed that question from their fellow students' suggestions.

Ms. Danforth selected topics that were relevant to the students' lives. In agreement with this, she had indicated on her survey that she almost always applied math situations to life outside of school. The administration gave Ms. Danforth the freedom to choose her curriculum to a large extent. I observed that many of the topics dealt with financial matters that were relevant to seniors in her class. She tried to cater her examples to the makeup of the class. For example, her first period class was composed mostly of football players, so she made up examples that were related to football. Her second period class was mostly female, so she designed her examples for a feminine audience. In summary, Ms. Danforth tried to incorporate relevant problems, but they seldom were engaging tasks that required critical thinking or utilized student presentations of solutions. The students often worked collaboratively as a group but used very procedural processes. Ms. Danforth had abandoned most of the teaching practices that she learned in her pre-service education.

Equity. While discussing Ms. Danforth's view of equity, she clearly agreed with the definition set forth in the Equity Principle that every student should "receive reasonable and appropriate accommodations as needed to promote access and attainment for all students" (NCTM, 2000, p. 13). However, she qualified that this statement is only theoretical, and the implementation of equity is virtually impossible when attempting to teach mathematics to one hundred students each day. Observations of Ms. Danforth's teaching practices brought to light an obvious lowering of expectations for her students. The research of Singh and Ozturk (2000) provides some insight into Ms. Danforth's lowering of expectations. They suggested that students holding part-time jobs in high school produced a negative impact on their selection of mathematics courses and their achievement. Singh and Ozturk (2000) also asserted that teachers often lower their expectations for students who have part-time jobs out of empathy which leads to poorer student performance. To compensate for students' job responsibilities outside of the classroom, Ms. Danforth lowered expectations of her students by giving only a handful of procedural problems for class that could be worked in 10-15 minutes. On one occasion the students were working problems on factoring the difference of two squares. The classwork consisted of seven problems. Each problem had three statements in the incorrect order. The assignment was for the students to correct the order of the steps. The students often "worked on" Ms. Danforth and convinced her to omit some of the problems. Unlike Lubienski (2002), Ms. Danforth elected to simplify her curriculum rather than provide a relevant context for the mathematical concepts to accommodate her students. Her lower expectations denied her students the opportunity to attempt higher-level learning and produced an inequitable education for her students.

Ms. Danforth's teaching practices were very similar to Teresa's actions in Szatjn's research (2003). Both Ms. Danforth and Teresa did not incorporate conceptual learning because they felt that the students were not able to comprehend the conceptual concepts. The RTOP average for Ms. Danforth reinforced the observations of her teaching practices. In the specific statement that the lesson promoted conceptual understanding, the RTOP average for Ms. Danforth was less than one and was marked as never occurring on half of the teaching observations. Ms. Danforth summed up the essence of her goals for these students that were perceived as low-achieving, "Most of the students don't have much conceptual knowledge, but they should do simple mathematical calculations, like add or subtract, just to get along in the real world."

Ms. Danforth's Questioning Techniques

From the discussion of the previous section on Ms. Danforth's teaching practices, it is evident that Ms. Danforth had returned to her traditional teaching practices. Her questioning techniques strongly backed up the theory that traditional teaching was indeed her mindset. On 55 occasions Ms. Danforth was observed asking low-order questions while only seven high-order questions were asked during the entire observation period. In addition to the number of low-order questions being noticeably more than high-order questions, there were significantly fewer questions asked than by the other case study teachers. An analysis of Ms. Danforth's questioning practices revealed a habit of asking fill-in-the-blank questions to make it easier for students to be able to answer questions. No student-to-student discussions about mathematics were noted.

Factors that Affected Ms. Danforth's Teaching Practices

School climate factors. The chaotic nature of the school hindered the learning environment for Ms. Danforth. When asked about the problem of extreme tardiness, she commented on the first period,

> Most of the students work in the morning, so they're coming after that, or they're working at night and have to sleep late. I think the school is a bit lenient on them. It is very distracting because I have to wait until everybody comes in to start something.

Another distraction was the interruptions over the intercom. Any student that needed to come to the office was announced over the intercom. A typical 50-minute class had between five and ten interruptions. In addition to these interruptions, students wandered the hall listening to their portable music devices or talking on their cell phones. A couple of times during each lesson a random student walked into the classroom and started talking to students who were actually in the class.

Ms. Danforth's experiences were similar to those found in Kitchen's (2003) research in high poverty schools. Danforth mentioned the related factors of student motivation, lack of parental involvement, and the community in a predominantly African American school. Unfortunately, Ms. Danforth's school family did not join forces to raise the expectations of the students like the communities discussed in the Algebra Project (Silva & Moses, 1990) and the QUASAR Project (Silver & Stein, 1996). Ms. Danforth explained that the influence of her students' community surroundings impacted their center of attention, "Some of the students, they are working. Some girls are mothers.... Their mind is focused on personal problems at home." She also commented on their lack of background knowledge.

> These students are not exposed to better education. I don't know what these students are doing in middle school, but they don't know how to add or subtract and read. If I give them word problems, they are not interested because the whole paragraph scares them.

In Ms. Danforth's survey, she reported that only her professional development had guided her teaching practices. She regularly participated in the CTM quarterly meetings and just completed a six-week technology course focusing on incorporating Geometer's Sketchpad (GSP: Key Curriculum Press Technologies, 2008) into the classroom. GSP is a dynamic construction, demonstration, and exploration tool that adds a powerful dimension to the study of mathematics. GSP provides a tangible, visual way to explore and understand abstract concepts in algebra, geometry, trigonometry, precalculus, and calculus. The technology course provided Ms. Danforth new ways to present difficult algebraic topics to her students, but she had not incorporated her newfound knowledge into her teaching practices. She hoped to add some GSP activities next year.

The professional development participation improved the access to resources at Forrest Park. Because the Forrest Park mathematics department participated in the six-week technology course, the school received a set of graphing calculators and GSP software for the mathematics teachers. In order to better service her students, Ms. Danforth was interested in obtaining an LCD projector possibly by means of a grant. By connecting her classroom computer to the projector, she could project various illustrations using the new technology software. Ms. Danforth did not feel like she had enough resources, and the projector could help remedy this situation. Ms. Danforth explained that she had not used the graphing calculators yet. During several lessons, she handed out four-function calculators for the students to use.

In connection with the technology resources, the school in general was lacking in many basic supplies. There were not enough textbooks for the students to have their own textbook. The textbooks were so out of date that Ms. Danforth often just typed up her own notes and mathematics problems. Many of her lessons came from lesson plans and information off of the internet. Ms. Danforth commented that often the copying machine was broken, so she took her handouts and paid to have them copied. The general condition of the classroom was not conducive to learning. The room was distractingly warm, and the one window in the classroom was usually open allowing for various noises to float into the room.

Similar to the findings in Rousseau and Tate (2003), the factor of time came into play for Ms. Danforth twofold. Not only did Ms. Danforth have to write her lessons, she also had very short class periods. The length of the class also created problems because of the tardiness problem and generally disorganized climate of the school. She commented that it was very hard to finish an activity in a 50-minute class.

Teacher factors. Ms. Danforth was a very caring teacher who wanted all of her students to succeed. However, she was "too nice," and her soft nature created classroom management difficulties. Classroom management is often a problem in research conducted with novice teachers (Adams & Krockover, 1997; LaBerge & Sons, 1999). I observed students frequently texting openly on their phones, talking rudely throughout the entire lesson, sleeping in class, and students listening to portable music devices. On the topic of behavior management, she felt that the teacher had to pick her battles. When Ms. Danforth nicely asked a student to put his phone away, he just ignored her. Apparently, discipline was not really a battle that she picked.

Summary of Case #2

Ms. Danforth entered her pre-service education from a very traditional background. Her teaching practices reverted back to traditional strategies even though she learned how to organize *Standards*-based group activities during her internship with a cooperating teacher who practiced effective *Standards*-based strategies. After Ms. Danforth began teaching at Forrest Park, she adjusted her beliefs in particular to older high school students. She supported the *Standards*-based teaching practices for younger students at the elementary and middle school levels but felt differently about juniors and seniors. Since Ms. Danforth only taught seniors in high school, she had modified her beliefs for this specific grade so that her beliefs were in alignment with her traditional teaching practices.

A number of factors definitely seemed to solidify Ms. Danforth's traditional beliefs and teaching practices. In order to implement group activities, the classroom must be under control for group rules to be effective. Both the chaotic nature of the school and Ms. Danforth's poor classroom management hampered the implementation of *Standards*-based activities. Tardiness in connection with the time element in a 50-minute lesson added to the difficulties of implementing *Standards*-based practices. The 6-week professional development course that Ms. Danforth attended provided her with strategies to incorporate *Standards*-based teaching. However, she presently was not incorporating the concepts learned, and she gave the lack of resources as the reason. Specifically, she expressed the need for an LCD projector in order to make her use of computer software effective.

Examining other factors, Ms. Danforth altered her teaching style based on her students. She expressed concern about her students' socioeconomic status, background, and home life. Secada (2003) noted that some teachers deny their students an opportunity to learn by caring in an inequitable way. Teachers can take caring to an extreme and attempt to overly protect their students from failure which results in lowering expectations and not challenging students (Secada, 2003). In the case of Ms. Danforth, her caring attitude actually created a negative impact for her students because she lowered her expectations due to their home life and socioeconomic statues and reduced her assignments based on these expectations. Her concern about providing guidance in her students' lives seemed as important in her teaching role as teaching mathematics skills.

Case 3: Mr. Barry

Mr. Barry is a White male teacher who was in his inaugural year as a mathematics teacher. He taught in the Riverwood School System which has earned a reputation for excellence in education over the years. Returning home to the school of his youth, Mr. Barry jumped at the opportunity to teach at his former alma mater. Riverwood Junior High School had a total population of 559 for grades 6–8 where 80% of the students were White and 18% were African American. The student-teacher ratio was 16 to 1, and only 29% of the students qualified for free or reduced lunch.

The school was showing signs of age, but all of the halls were nicely decorated with various examples of students’ work. Riverwood Junior High was the only junior high in a small town. The school atmosphere was one of discipline and achievement. The school had a homey feel, and the secretary recognized me each day as I came in for my visitor’s pass. Mr. Barry taught all of the eighth-grade students, and his classes consisted of two pre-algebra classes and one algebra seminar. The algebra seminar was designed for the “advanced” students in the eighth grade.

Riverwood had very traditional tendencies which included the Saxon curriculum (Larson, Hake, & Wrigley, 2007). Most of the teachers “understood” that the use of pencil-and-paper calculations was highly valued over the use of calculators. Regular preparation for standardized tests was strongly encouraged by the administration at Riverwood Junior High School as well.

In keeping with the orderliness of Riverwood, Mr. Barry’s room was tidy and conveyed a feeling of organization even though he taught in a portable classroom. The students were seated in very straight rows. The walls were sparse but included a copy of the discipline policy. The room was ample for the number of desks that made the room appear spacious. All of the technological “niceties” were strategically placed for easy access for both the student and teacher. These included a document camera and a classroom computer that were connected with an LCD projector.

The traditional reputation of Riverwood Junior High continued in Mr. Barry's classroom. Mr. Barry did not have a problem with the procedural-based Saxon curriculum. He also felt that doing calculations by pencil and paper was better than using calculators. Mr. Barry supported the idea that incorporating these two policies promoted high standardized test scores. Mixing in *Standard*-based practices, he tried to present mathematical topics using a conceptual approach, and he often integrated real-world examples to help students make connections.

Mr. Barry taught all of the eighth-grade students at Riverwood Junior High School. He taught two sections of pre-algebra and one algebra seminar, a class designed for the advanced eighth-grade students. Table 16 summarizes Mr. Barry’s classes. Even though Mr. Barry taught two sections of pre-algebra, he made a definite distinction between the two. Both classes followed a non-accelerated curriculum, but Mr. Barry had considerably more difficulty managing the behavior of the second block pre-algebra class. In fact, this class was moved directly across from the office at the beginning of the school year to have close proximity to the office but was moved back to Mr. Barry’s classroom in March.

Table 16

Summary of Mr. Barry's Classes

Teacher	Classes Taught	*Racial Makeup of Classes	Inclusion Teacher	Teaches Classes of Differing Abilities
Mr. Barry	Advanced Algebra I	24/1/2	No	Yes
	Pre-algebra (2nd block)	15/5/0	No	
	Pre-algebra (3rd block)	18/7/0	No	

*Racial makeup of class is shown by number of students in the following order: White/African American/Other

Observations of Mr. Barry's Lessons

On most days, the students entered the room with the answers to the previous night's homework waiting on the document camera. There was no talking, and all of the students were feverishly checking their homework. Mr. Barry then took down the numbers of the problems that students did not understand. Students then volunteered to show their solution to those difficult homework problems. They could work the problems on the whiteboard or show their work on the document camera. They explained their solutions to the rest of the class. All basic calculations used in the answer are written out clearly in the solution. After the homework discussion, Mr. Barry went over new materials with real-life examples and stressed the conceptual basis of the topic. The students practiced the new concepts individually, and the balance of the class time was spent on homework.

The following vignette was representative of a typical scenario in Mr. Barry's pre-algebra classroom. The students were trying to find the area of a big rectangle that was part of a non-standard polygon :

> Mr. Barry: What's another way to think of it? Let's not think about what it really looks like—like a key. Let's think about how we could figure out the area.
>
> Student: We could find the area of the big rectangle.
>
> Mr. Barry: Really? And how would you do that?
>
> Student: Length times width.
>
> Mr. Barry: You said find the area of the big rectangle, is that right?
>
> Student: Right.
>
> Mr. Barry: And then you took out what?
>
> Student: The smaller rectangle.
>
> Mr. Barry: How big was that little rectangle? Let me go back real quick. I thought 10 was the length here. How can it happen that you have 30 on the bottom and 40 on the top?
>
> Student: Because the top is longer than the bottom.
>
> Mr. Barry: No, I almost made the same mistake. She says that the tens look like they go on the bottom, but where do they really belong?
>
> Student: The sides.
>
> Mr. Barry: The sides. So what did you say the distance at the top was?
>
> Chorus of students: 40.
>
> Mr. Barry: It's 22 and _______?
>
> Student: 18.

Mr. Barry: Instead of 30, it should be 40, and the area of the new rectangle is? (No response). The height is still __?

Student: 30

Mr. Barry: That would make the total area of the big rectangle?

Student: 1200.

Mr. Barry's Beliefs

Pre-service. Similar to Mr. Barry's current teaching style, his precollege education was very traditional all the way through high school. Even though he experienced an extensive exposure to *Standards*-based teaching strategies in his methods classes, the cooperating teacher during his internship practiced very traditional teaching practices. He spoke about his internship, "I might have been more open to incorporate discovery learning in my classroom if I had experienced it more in my internship." Adams and Krockover (1997) also reported that new teachers needed more *Standards*-based field work to solidify their teaching approach. Looking at another aspect of Mr. Barry's internship, he struggled with his classroom management during his internship and was determined to start his teaching career with a classroom that was orderly.

Philosophy toward teaching. Mr. Barry's responses to the belief's portion of the TPBS ranked in the upper quartile among respondents, indicating that his beliefs were in alignment with *Standards*-based teaching. He agreed that it was important for students to figure out how to solve mathematics problems for themselves. He also disagreed with the statement, "Students learn best from their teacher's demonstrations and explanations." His responses seemed somewhat contradictory because he agreed that teachers should ensure that students experience success in mathematics by clearly explaining and modeling how to complete each day's assignment to their students. During his interviews, I asked Mr. Barry to articulate his beliefs more specifically. To Mr. Barry, conceptual learning and good questioning techniques were components of *Standards*-based learning that were essential in a teacher of excellence. He noted about his own education, "I just figured it (the conceptual understanding of concepts) for myself, so I want to try to teach from a conceptual viewpoint."

In his first interview, Mr. Barry was asked to share his views about how students learn best. He explained, "If the students think that they came up with something, I like that. Whichever way they like to do it (math problems), I don't have a problem, as long as they understand why it works." He weighed the pros and cons of investigative activities but in the end was not convinced of their effectiveness, "If you think of it (*Standards*-based strategies) in the context of learning through exploration versus drill and repeat, drill and repeat wins." Mr. Barry admitted that his beliefs have "changed a little bit in that you have to adapt to the environment you're in." He concluded, "I think the long and short of it is that it (*Standards*-based teaching) is good to be used as a supplement to the regular curriculum. I don't really think you could use it all of the time." In Mr. Barry's second interview, he related his teaching beliefs to his early education, "I am comfortable with the way I teach. It's the same school that I attended and it's the way I learned."

Expectations. Another different aspect of Mr. Barry's teaching beliefs involved the expectations of students. I observed the pre-algebra classes six times and the algebra seminar class three times. Riverwood Junior High School followed a block schedule with four blocks per day. Mr. Barry's approach to teaching and expectations of his students were affected by the academic level of the class. For instance, he felt more in tune with the algebra seminar:

> I have to admit that I bonded with my seminar class from the very first day. They are a lot like myself. I tend to incorporate extensions for this class. It is hard to get as excited about my 2nd block class. I do have different expectations—I hate to admit it, but it's there. It's hard to feel the same way about the two classes.... I tend to lead the pre-algebra class more with my questioning. There's no way that my pre-algebra class could ever cover the amount of material that I'm expected to cover in Seminar Class. I cover two lessons a day, and they have a lot more homework. There's no way those kids (pre-algebra) would do that much homework.

Mr. Barry indicated that he had been in the same advanced mathematics track as a student in high school. His higher level of comfort with the algebra seminar class tainted his expectations for the pre-algebra classes.

Mr. Barry's Teaching Practices

RTOP averages. As discussed in the instrumentation section, the RTOP (AzTEC, 2002) was used as one means of analyzing Mr. Barry's teaching practices in light of *Standards*-based practices. I completed an RTOP for each observation and calculated the mean RTOP scores for Mr. Barry. The mean for the pre-algebra class RTOP was 1.91 for six observations and 2.72 for the algebra seminar RTOP. From the example of a typical day in Mr. Barry's classroom, it is evident that his teaching style followed a mostly traditional style with elements of *Standards*-based teaching interspersed. For the RTOP ratings, the more traditional aspects of Mr. Barry's pre-algebra classes included the design of the lesson and lack of student engagement. With the exception of procedural knowledge, Mr. Barry's RTOP averages for the algebra seminar indicated that he incorporated *Standards*-based techniques (discussed below). The pre-algebra class RTOP rated higher than the algebra seminar RTOP in each subcategory. The disparity of the RTOP averages between the pre-algebra and algebra seminar classes showed that a more traditional style of teaching was incorporated in the pre-algebra class than the algebra seminar. Table 17 summarizes the RTOP averages.

Table 17

RTOP Averages for Mr. Barry's Observations

	Implementation	Propositional Knowledge	Procedural Knowledge	Communicative Interactions	Student/ Teacher Relations	Total
Pre-algebra	1.60	2.50	1.10	2.20	2.00	1.91
Algebra Seminar	2.70	2.90	2.00	2.90	3.10	2.72
Average	2.20	2.70	1.55	2.55	2.55	2.32

Traditional practices. From the explanation of a typical day in Mr. Barry's classroom previously explained, each day followed a fairly traditional format of going over homework, introducing a new lesson, practicing with students, and allowing the remainder of the time for homework. Mr. Barry used lecture sprinkled with questions as his primary method of teaching. He agreed on the TPBS that his students often listened to him lecture about mathematics. Another traditional practice of asking fill-in-the-blank questions was coded 23 times from the transcripts of the classroom observations. I observed the frequent use of fill-in-the blank questions.

In relation to other survey respondents, Mr. Barry scored in the bottom quartile for the practices portion of the TPBS survey where low scores indicated that his teaching practices were not in alignment with *Standards*-based principles. Following the traditional pattern of teaching, he agreed that his students often memorized formulas and rules for a test or quiz. Mr. Barry never used a calculator to explore a concept or extend the understanding of a concept. The RTOP average for lesson design and implementation reinforced Mr. Barry's responses on the TPBS. Every day in class, Mr. Barry tediously worked every single arithmetic computation by hand on the board while lecturing. Similarly when his students presented their solutions on the board, they were required to show all calculations needed to arrive at the solution. I never observed Mr. Barry or any of his students using a calculator in class.

Standards-*based practices.* Mr. Barry exhibited some bright spots during the observations of the mathematics classes that resembled *Standards*-based practices. Mr. Barry took great care to use real-life examples and explain the conceptual basis behind new mathematical topics. On 18 occasions Mr. Barry incorporated real-life examples to illustrate a new mathematical concept or to solidify previously presented topics. On one occasion in pre-algebra class, he involved a student volunteer to demonstrate the concept of similar figures. The length of the student's finger was compared to the actual length of the Statue of Liberty's finger to establish a ratio. Given the volunteer's height, students worked in pairs to develop a hypothesis for the Statue of Liberty's height. Mr. Barry also routinely assigned homework problems that required written explanations and were worthwhile tasks for the students. In conjunction with his observed teaching practices, Mr. Barry commented on his TPBS in the open response portion about his teaching strategies. He wrote that relevant examples in context along with making conceptual connections between mathematics concepts were the most effective strategies that he implemented in his teaching.

On several occasions, I observed Mr. Barry make conceptual connections between mathematical topics. This conceptual approach represented a change from Mr. Barry's own high school education. I only witnessed one occasion in which Mr. Barry facilitated his algebra seminar students learning a new mathematical concept through a cooperative learning activity. In algebra seminar, he sometimes introduced mathematics topics by having students work a short investigative activity in a whole group setting. Mr. Barry enjoyed the few times that students discussed differing views of the correct solution with their peers while he took a back seat. After one such occasion, Mr. Barry commented to me that the student-to-student discussion was "really exciting." Instances of student-led discussions in Mr. Barry's classroom were coded 24 times and showed intentional attempts to incorporate *Standards*-based practices. The vast majority of student-centered occurrences took place when the students presented their homework problems on the board at the beginning of each class. Often this process took at least half of the class.

In reference to *Standards*-based practices on the TPBS, Mr. Barry agreed that students should give written explanations, present their problems to the class, and take tests where they have to explain their answers. He was observed routinely having students present their explanations to solutions of homework problems and in-class explorations. Mr. Barry summed up his practices succinctly, “I have to pull the delicate balance of a happy medium. The knowledge is there with the questioning, and blending that with, okay this is how we’re going to do it for this test.” I observed Mr. Barry’s concentrated attempts to incorporate student-led discussions into the classroom. He welcomed students presenting different ways to solve problems and encouraged them to explain their hypotheses. These instances of student participation were observed considerably more often in the algebra seminar. The atmosphere in the pre-algebra classroom was stricter and less inviting to student discussion. In summary, Mr. Barry definitely followed a more traditional format in his pre-algebra class. In alignment with his *Standards*-based pre-service education, he made concerted attempts to incorporate worthwhile tasks with good student discussion.

Equity. When looking at Mr. Barry’s teaching practices through the equity lens, his TPBS scores on equitable beliefs and practices ranked in the top quartile among all survey participants. After closely examining his TPBS, his responses regarding students’ home life indicated that teachers’ practices can have a significant influence compared to the influence of the home environment. Six of the 11 statements dealt with students’ backgrounds and home lives, and he answered consistently in all six of these statements. However, when examining the statement on instructional grouping based on perceived ability level of students, his traditional background resurfaced. On the TPBS, Mr. Barry agreed that students receive the level of instruction that is most appropriate when they are grouped based on past mathematical performance.

In keeping with ideas about teaching practices based on grouping, the RTOP averages quantified the gap between Mr. Barry’s teaching practices in pre-algebra and algebra seminar. His inequitable teaching practices were based on the perceived ability level of the pre-algebra and algebra seminar classes. The following section on *Questioning Techniques* also illustrated the inequitable teaching practices between the different academic levels of classes. Mr. Barry summed up his diverse approaches to teaching practices with the frank statement, “I’m almost a coach in first block (algebra seminar), and in second block (pre-algebra), I’m a warden. Third block (pre-algebra) I get to teach students—hammer through it.” During the three observations of the algebra seminar, I was privy to three excellent discussions among the students where Mr. Barry served only as a facilitator in the process. I did not observe any student-initiated or student-led discussions in the pre-algebra classes during any of the seven observations except for homework explanations. The atmosphere in the pre-algebra was less inviting for students to participate in student-to-student discussion.

On Mr. Barry’s TPBS, he rated the academic level of the class as the most influential factor of his teaching practices. The analysis of the high-order and low-order questioning (see below) showed that Mr. Barry used very different questioning techniques based on the academic level of the class. “With my algebra seminar class, I try to get to higher levels.... The kids are up there with it. They’re great.” Mr. Barry’s inequitable teaching was not based on gender, race, or socioeconomic status, but perceived ability levels. His cherished connections with advanced mathematics classes from his own high school education biased his teaching practices.

Mr. Barry’s Questioning Techniques

An important segment of Mr. Barry’s teaching practices involved his questioning techniques. Mr. Barry explained his questioning practices, “You know—sometimes when

I plan to their strengths, one of the questions I will ask will be a lower order question, but it's one that it'll catch 'em. Every once in a while I try to bring it up to a higher order. Like—'What does that mean?' or 'Have you tried a different way?'"

The coding of the two pre-algebra and algebra seminar classes helped to quantify the diversity of the teaching practices in the pre-algebra class and the algebra seminar. During the six observations of the pre-algebra class, Mr. Barry asked 112 low-order questions and 20 high-order questions. The ratio of low-order to high-order was 5.6 to 1. On 28 occasions Mr. Barry either did not wait on a reply and changed a high-order question to a low-order question or answered his own question. For statistical purposes, a high-order question rephrased as a low-order question is considered a low-order question. During the three observations of the algebra seminar, Mr. Barry asked 23 low-order questions and seven high-order questions. The ratio of low-order to high-order was 3.3 to 1. On only eight occasions was the lack of wait time a factor in Mr. Barry's questioning practices. In summary, Mr. Barry used a much higher percentage of low-order questions in his pre-algebra classes.

Factors that Affected Mr. Barry's Teaching Practices

School climate factors. Mr. Barry had control over his own practices, but he had no say-so over some factors that came as a package deal with his new teaching position. Several factors emerged as a detriment to Mr. Barry's incorporation of *Standards*-based practices. The most dominant factor was the use of the Saxon curriculum (Saxon Publishers, 2007). The Saxon curriculum presents new concepts in small increments while continuing to daily assess previous concepts. The daily reviews strengthen comprehension throughout the year so that no concepts or skills are forgotten (Saxon

Publishers, 2007). On his survey, he answered that curriculum significantly influenced his teaching practices. During his initial interview he stated the following: “Teaching from Saxon is a pretty good swing from the curriculum that we focused on at Southern State University. It’s made my teaching style change more towards teaching to the test.... I’m non-tenured, they hand me the books and that’s it.” During my observations of Mr. Barry’s mathematics lessons, he never strayed from the curriculum. On a subsequent interview, he explained that Saxon mathematics was very “concrete”. On occasion Mr. Barry balanced the concreteness of the curriculum by supplementing an illustrative activity or example from real life. Mr. Barry explained that the Saxon curriculum was effective because it “produced good test results.”

The pressure to produce good test results affected Mr. Barry’s teaching style. Nichols and Berliner (2008) emphasized that the pressure to prepare students to perform well on high-stakes tests encouraged teachers to engage in repetitious instruction that left little time for inquiry-based instruction. Because of high-stakes testing, the primary purpose of learning evolved into scoring well on standardized tests (Nichols & Berliners, 2008). In order to uphold the reputation of the Riverwood School System and its past history of standardized test scores, high-stakes testing emerged as a very influential factor on Mr. Barry’s teaching practices. For example, eighth-grade students at Riverwood Junior High scored an average of 84% on the mathematics portion of the state reading and mathematics test in 2007. The state average in that same year was 66%, and the fear of failure to achieve Adequate Yearly Progress (AYP) status was never really a factor. The No Child Left Behind (NCLB) Act (NCLB, 2002) required each state to establish challenging content and performance standards and to implement assessments that measure students' performance against those standards. The requirements were identified as the AYP. On his survey Mr. Barry selected that testing significantly influenced his teaching practices. During an interview he supported his answer to the survey, "The impact of high-stakes testing is pretty big—it's a daily reminder. Otherwise, I would try to bring in a lot more of the exploration stuff as a supplement to the regular curriculum."

Mr. Barry explained the actual impact that standardized testing had on his teaching practices, "The teaching for standardized tests is highly emphasized ... the open-ended questions once a week and the gridded response with the basic skills test. Those are the two things we really have to practice on." He illustrated specifically the incorporation of practice for high-stakes testing during his mathematics lesson, "About two to three times a week, we'll have what we call basic skills, which are an emphasis on multiplication, division, addition, and subtraction with mixed number, fractions (both proper and improper), decimals, and integers." I observed that Mr. Barry usually practiced "basic skills" at the beginning of class, but only about once a week.

In conjunction with the high-stakes testing and curriculum factors, Mr. Barry also indicated on his survey that the administration significantly influenced his teaching practices. While the administration believed strongly in the Saxon curriculum (Saxon Publishers, 2007), they gave the teachers freedom to implement the curriculum using their own strategies. Mr. Barry made the connection between the administration and the curriculum, "As far as what I teach, it's dictated by curriculum and school policy."

Teacher factors. While Mr. Barry had no control over such factors as curriculum and administration, he did have an influence on certain factors in his classroom. The behavior in the classroom was an important aspect of Mr. Barry's teaching. In his second interview, he explained that the second block pre-algebra class has been moved from his portable classroom to the class right across from the office due to behavior difficulties. After the behavior improved, the class was allowed to move back to the portable classroom which happened between my first and second set of observations. Even though he had two sections of pre-algebra, the chemistry in the second block class proved more difficult for Mr. Barry to maintain control of the classroom. During all of the observations, I was quite impressed by the respectful behavior of the students. If a small amount of talking began, Mr. Barry said, “I’m waiting,” and simply paused until the talking stopped. He then resumed his lesson.

Mr. Barry obviously felt a lot of pressure to keep an "orderly" classroom. One day I observed an attempt at an activity during Mr. Barry's second block pre-algebra class. He divided his students quickly into pairs and asked them to collaborate on a graphing activity. The activity was quickly aborted because the behavior of the class was out of control and chaos was ensuing. After the incident, Mr. Barry explained that second block could not really do activities in groups because of their behavior. On another very frustrating day during second block, Mr. Barry seemed almost at his wit’s end, “Please, I’m begging you, please stop talking. I can’t, I’m not gonna—I’ve been patient with you. Be quiet, I don’t want anybody talking.” These two examples were the exception rather than the rule, and the other two classes rarely exhibited off-task behavior.

Summary of Case #3

Mr. Barry's teaching practices represented a modified traditional approach. The general format of his teaching followed a very traditional pattern. However, he integrated *Standards*-based strategies in a variety of ways. Mr. Barry encouraged student participation and student-led discussions, but they were mostly in whole-group situations. He attempted to introduce new mathematics topics conceptually but did not include the students' investigative phase of the concepts. Mr. Barry was cognizant of his questioning and wanted to use high-order questioning as much as possible.

Mr. Barry had adapted both his beliefs and teaching practices so that they were in alignment. He adjusted his beliefs so that they were a mix of traditional and *Standards*-based. His teaching practices followed his new compromise of his beliefs. Mr. Barry felt that his high school mathematics teachers used traditional teaching practices that were effective but lacked the conceptual basis. He integrated the conceptual basis, engaging problems, and student involvement of presentations with the traditional teaching strategies.

Mr. Barry's beliefs and teaching practices were influenced by several factors. Similar to findings from LaBerge and Sons (1999), the curriculum was geared for a very traditional teaching style, and the administration was convinced of it effectiveness. Mr. Barry felt that the fact that he was not tenured gave him virtually no options for different strategies. The looming threat of standardized test scores was an additional incentive for Mr. Barry to stay on track and not take time for student explorations. The administration felt that covering the Saxon curriculum was imperative for achieving excellent test results. Finally, the expectation for an orderly class was a deterrent for group activities and other *Standards*-based strategies.

The perceived ability level of Mr. Barry's classes was an additional factor that affected Mr. Barry's beliefs and teaching practices. He readily admitted his affection for his algebra seminar class and expressed doubts about the abilities of his pre-algebra class.

Similar to the research findings of Lubienski (2002), Mr. Barry's teaching practices reflected his lowered expectations and adjustment of his teaching styles. The questioning techniques and RTOP averages blatantly pointed out the discrepancies.

Case 4: Ms. Anthony

Ms. Anthony, was in her second year at Northern Junior High School, a rural community school. She had three prior years of experience at another school. The school was an older school but certainly very functional. The principal was readily available and very supportive of all her teachers. I was only required to sign in at the office each day upon arrival. Northern Junior High School had 603 students in grades 6–8. The student-teacher ratio was the highest of all the schools with a 21 to 1 ratio. The ratio of Whites to African Americans was approximately two to one and about half of the students were eligible for free or reduced lunch. Ms. Anthony taught two seventh-grade classes and two eighth-grade classes. She taught one advanced and one non-advanced class for each grade. Ms. Anthony was also very involved with the drama productions at the school.

Ms. Anthony had initially earned a bachelors degree in science and later decided to return for an alternative master's degree in mathematics education. Ms. Anthony was a young White female bubbling with enthusiasm. Ms. Anthony was a school teacher leader for the CTM systemic project connected with Southern State University.

Both of the classes I observed were seventh-grade students. One class was a basic mathematics class for students who were perceived as low-achieving, and the other class was the faster paced pre-algebra class. The school system used a traditional textbook, but Ms. Anthony supplemented it with *Connected Mathematics Project (CMP)* units (Lappan, Fey, Fitzgerald, Friel, & Phillips, 2004). The administration expected the teachers to follow a 7-month curriculum policy. This policy required the teachers to cover the entire curriculum in seven months and give benchmarks each month to test the objectives for that month.

Ms. Anthony’s classroom was crowded in a number of ways. The room was packed in rows with 30 desks, leaving no room to walk around the perimeter of the desks. The front of the room was organized with drawers of paper, graph paper, and a drawer for each class’s warm-up problems for the week. The walls were decorated randomly with students’ work, current vocabulary words for each class, and relevant mathematics posters. Ms. Anthony's various extracurricular activities were apparent by the number of props and artwork distributed around the room. The room itself was showing age through the condition of the carpet, walls, and desks. Ms. Anthony had virtually no technology available to her with the exception of a classroom computer. She often gave students transparencies to present their solutions on the overhead projector. Ms. Anthony’s eclectic interests and the students’ use of the room for storage of athletic and academic equipment added to the cluttered nature of an already crowded room.

Ms. Anthony’s tendencies toward disorganization spilled over into her teaching and discipline style. Since there were no bells, the time when class actually began was fuzzy. Generally, class started five to ten minutes after the scheduled time.

Ms. Anthony revealed that she started out with formal groups with rotating roles but did not continue to follow through with the routines as the year progressed. Ms. Anthony admitted that she needed to work on developing stronger routines and sticking with them. Her lack of discipline was a hindrance to working in groups and using activities as a regular teaching strategy. She described her role in teaching as that of a “guide” and consciously made an effort to “make her students think, not just feeding it to them.”

Ms. Anthony’s basic mathematics class was not representative of the makeup of Northern Junior High School. In a class of 26 students, 10 were White, 13 were African American, and 3 were Hispanic. The students of Hispanic descent used English as their first language. An inclusion teacher came into the basic mathematics class a couple of times a week to make an appearance. On the other hand, Ms. Anthony’s pre-algebra class contained a majority of White students with 23 White students, only 1 African American, and 2 Hispanics. When Ms. Anthony and I were making a plan for the observations, I explained that I wanted to observe some classes of diverse ability levels. Ms. Anthony immediately suggested these two classes because they represented the widest gap in achievement levels. Table 18 provides a summary of Ms. Anthony’s classes.

Table 18

Summary of Ms. Anthony's Classes

Teacher	Classes Taught	*Racial Makeup of Classes	Inclusion Teacher	Teaches Classes of Differing Abilities
Ms. Anthony	7th Math	10/13/3	Yes	Yes
	Pre-algebra	23/1/2	No	
	Algebra I	Not observed		

*Racial makeup of class is shown by number of students in the following order: White/ African American/Other

Observations of Ms. Anthony's Lessons

I observed Ms. Anthony's teaching both the pre-algebra and basic mathematics classes seven times. Of the ten scheduled days for observation, Ms. Anthony scheduled a test on both Fridays, and another day was a scheduled visit to the computer lab to practice for standardized tests, the state reading and mathematics test and the SAT-10. The state reading and mathematics test is a standardized test that is administered to all students in grades 3-8 in the state where the research is being conducted. The test has both gridded-response questions and open-ended response questions. The SAT-10 is another standardized test for grades 3–10 that is composed of all multiple-choice responses.

The general format in both of Ms. Anthony's lessons followed a traditional style. She generally started with the bellringer, and more class time was spent on the discussion of the bellringers in the basic mathematics class. One student handed out small pieces of paper on which to work the bellringers, and another volunteer collected them. These problems were designed to help students practice for the standardized tests. Often half or more of the basic mathematics students did not bother to even try the bellringers, whereas most of the pre-algebra class were engaged. Next, the homework was discussed. Each day Ms. Anthony assigned some homework problems that were contextual, and most of the homework discussion was spent on these problems. In the pre-algebra class, these discussions were very student-oriented and often produced an engaging discussion of various methods of solving the problem. Students in the basic mathematics class were active in explaining their solutions to the homework problems but never engaged in any student-to-student discussions during the observation period.

After the discussion of the homework was complete, the new topic for the day was introduced. Often, Ms. Anthony employed a conceptual or real-life approach to introduce the new topic. For example, the concept of slope of a line was introduced in the pre-algebra class. On the overhead, Ms. Anthony enlisted the aid of her students to suggest and help graph equations in the $y = ax$. She asked high-order questions to encourage the class to think about what happened to the slope of the line as the value of "a" changed. Ms. Anthony usually worked a couple of examples, and then gave the class a problem to try individually or with the help of a partner. Ms. Anthony usually gave the class 15–20 minutes to work on their homework at the end of class. She usually allowed both classes to work with a classmate on the homework if the class had been cooperative during the lesson.

The following vignette is characteristic of a typical day in Ms. Anthony's room:

Ms. Anthony: For the parallelogram, what you're looking for is the height that is perpendicular with the length. What does that mean?

Student #1: It has to have a 90 degree angle.

Ms. Anthony: There has to be a 90 degree angle involved. Listen! There has to be a perpendicular angle for the height. Raise your hands if you can explain how to find the area of that parallelogram?

Student #2: 9*3

Ms. Anthony: Why are you choosing 9 and 3?

Student #2: They are the base and the height.

Ms. Anthony: Why is the unit squared?

Student #3: Because it's squared.

Ms. Anthony: But why?

Student #3: Because you're finding area.

Ms. Anthony: What's another reason? Hush! What do we get when we multiply 9 inches by 3 inches? What do you get when you multiply inches by inches?

Student #4: Inches squared.

Ms. Anthony: Don't forget for area that we've got square inches. (Goes into off-task discussion about how to say acre with several students.) Please stop! Let's do another example. HUSH!

In the vignette of a segment from Ms. Anthony's lesson, the atmosphere of disorder was evident, as well as an attempt at high-order questioning.

Ms. Anthony's Beliefs

Pre-service. Ms. Anthony thought mathematics was really boring during her early education. She also commented that "I didn't really like any of my math teachers that I had growing up, and I knew that there had to be a better way." After receiving her bachelor's degree in a science-related field, her job possibilities led her back to pursue an alternative masters in mathematics education. During her experiences in her methods class, Ms. Anthony became convinced that the *Standards*-based teaching approach was much better than the traditional approach to teach mathematics. Her internship with a reformed traditional teacher reinforced Ms. Anthony's beliefs about *Standards*-based teaching practices. She commented on her internship experience, "She [my cooperating teacher] definitely shaped the way I teach now. She had a very positive classroom environment that I am still trying to perfect. She combined the text and CMP units to cover everything required, trying to make even text book lessons more problem-based." Ms. Anthony came away from her pre-service education thoroughly convinced that using the *Standards*-based teaching principles was far superior to traditional teaching.

Philosophy toward teaching. Ms. Anthony's *Standards*-based beliefs continued after her pre-service education. In her interviews, Ms. Anthony stated that she believed that a teacher should be a guide and not a dictator. She explained her views toward teaching, "Different students learn different ways—some of them need to hear it, some need to see it, and some like pictures.... I think they learn best if they DO it." Discussing the conceptual aspect of teaching, she made a conscious effort "to make them [her students] think instead of just feeding it to them." She defended her adjustments to her beliefs toward *Standards*-based ideals:

> My philosophy has not changed, implementing my philosophy has. I've had to realize you know, I'm not teaching in a vacuum. I have to be a little bit more flexible, and I can't be so hard on myself. Last year I felt guilty so much if we did anything out of the book. This year, because I'm more relaxed, I'm able to use the book. It's the way you're teaching, not what you're using.

Ms. Anthony's responses to the TPBS reported very strong beliefs that were in agreement with *Standards*-based strategies. She strongly agreed that teachers must provide a variety of mathematics problems to challenge the students and should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages more student interaction. On her survey, she also strongly agreed that it was important for students to figure out how to solve mathematics problems for themselves and that students achieve mathematical understanding through the direct personal experience of figuring out their own solutions. She strongly agreed that it was better for the teacher to allow students to figure out their own way of solving the problem rather than demonstrating it. Of all of the survey respondents, Ms. Anthony's answers represented the highest score; this indicated that her beliefs were more closely aligned to *Standards*-based beliefs than all of the other teachers who were surveyed.

Expectations. In addition to the beliefs portion of the TPBS, Ms. Anthony's philosophy also purported expectations for all students. She disagreed with the idea that the amount a student can learn is primarily related to family background. She also disagreed with the statement, "The hours in my class have little influence on students compared to the influence of the home environment." She also disagreed that a teacher is very limited by the student's home environment.

When asked for a definition for equity, Ms Anthony responded, “Equity is expecting greatness from every student and providing them with the opportunity and support that they need to accomplish it. I don’t think this means that you provide the same support to every student, you have to meet individual needs.” However, she indicated in her interviews that her expectations were different for the pre-algebra and basic mathematics class. She expressed her beliefs about her fourth block basic mathematics class, “Fourth block won’t even get started or read the problem. I have to feed them an example to get them going.” She additionally commented about her feelings about the fourth block learning conceptually, “They would probably look at me like I was nuts.” Ms. Anthony believed that certain factors (discussed below) affected her ability to incorporate *Standards*-based practices.

Ms. Anthony’s Teaching Practices

RTOP averages. As discussed in the instrumentation section, the RTOP (AzTEC, 2002) was used as one means of analyzing Ms. Anthony’s teaching practices in light of *Standards*-based practices. I completed an RTOP for each observation and calculated the mean RTOP scores for Ms. Anthony. The mean for the pre-algebra class RTOP was 2.65 and 2.23 was the average for the basic mathematics RTOP. Table 19 summarizes the RTOP averages.

Table 19

RTOP Averages for Ms. Anthony's Observations

	Implementation	Propositional Knowledge	Procedural Knowledge	Communicative Interactions	Student/ Teacher Relations	Total
Pre-algebra	2.50	3.20	2.10	2.40	2.70	2.65
7^{th} Math	1.90	3.00	2.00	1.60	1.60	2.23
Average	2.20	3.10	2.05	2.00	2.65	2.44

The categories of Propositional Knowledge, Procedural Knowledge, and Student/Teacher Relations were approximately the same for the pre-algebra and basic mathematics classes. The Lesson Design and Implementation category of teaching involved engaging students and encouraging student exploration and investigation. The lower RTOP score for the basic mathematics class showed that Ms. Anthony did not intend for her basic math lessons to be as inquiry-based. The difference in the Communicative Interactions indicated that the climate in the basic mathematics classroom was not as student friendly and did not encourage student discussion. Ms. Anthony's high RTOP averages in the area of propositional knowledge indicated that she promoted conceptual understanding that incorporated real-world problems. Her high averages in the final category showed Ms. Anthony's desire to create an environment in which students felt free to participate.

Traditional practices. The expectations that Ms. Anthony held impacted her teaching practices. She commented on her current practices, "They [all classes] can't come in and sit in a group from the beginning to the end of class because of fourth block. Otherwise, I'd have to move the desks at the end of third, and then move them back at the end of the day every day. The first three gather in some kind of group most days." On the TPBS, Ms. Anthony recorded that she promoted student participation in small group discussions to help them make sense of mathematics all or almost all of the time. However, I only observed them doing a group activity in basic mathematics class twice and none in the pre-algebra class. Most of the instances of group work were students working on homework or practice problems. On several occasions I observed that the teacher wrote notes on the overhead projector, and the students were supposed to copy them in their notebook. However, most of the students did not bother to copy them. In respect to her pre-service education, Ms. Anthony was not able to effectively use collaborative groups. Her classroom was teacher-centered.

Standards-based practices. Even though Ms. Anthony's group activities were not usually exploratory, she incorporated several characteristics of *Standards*-based teaching. During one entire lesson, the basic mathematics class participated in an activity called "Rate My Song." The students first listened to twenty clips of music and rated the music from one to five. The next day the students worked in pairs to graph their ratings to reinforce graphing points on a coordinate plane.

Ms. Anthony indicated on the TPBS survey that she often used mathematics problems that required critical thinking. She also strongly agreed that she stressed to students that it's important to understand each concept, not just get the right answer. She marked that she often applied math situations to life outside of school. These three areas were rated as in alignment with *Standards*-based practices on her RTOP ratings. On the subject of explanation of answers, Ms. Anthony designated on her TPBS survey that the students often gave a written explanation about how they solved a math problem and took tests where they have to explain their answers. Ms. Anthony used contextual problems or real-life problems every day that she was observed in both classes. However, these problems were not used in investigative activities but as reinforcement of a concept already presented. Ms. Anthony explained in the interview that she tried to incorporate portions of CMP units into the relevant curriculum as time permitted. I never personally witnessed Ms. Anthony using activities from CMP units during the two weeks of observations, but Ms. Anthony gave illustrations of portions of the units that she had used throughout the year. In summary, Ms. Anthony implemented certain aspects of the *Standards*-based tenets that she had practiced in her pre-service education. She engaged students with worthwhile tasks, encouraged students to present solutions, and encouraged diverse solutions and ways of thinking.

Equity. The makeup of the fourth-block class (basic mathematics) visibly affected Ms. Anthony's use of activities and group work. She explained how her teaching practices in her fourth block were affected by the academic level of the class,

> It’s a good example of how if I just gave it [activity from a CMP unit] to them, they would just sit there and say, ‘I don’t know what to do.’ They will not work independently. They definitely need scaffolding. They were sitting in groups for this, but not working.

I observed that Ms. Anthony’s basic mathematics lessons involved less student discussion and more direct teaching. The observation of the diverse use of practices in the third and fourth class was reinforced by disparity in the RTOP averages in the Lesson Plan and

Implementation and Student/Teacher Relations subcategories. In finding similar to Lubienski's research (2002), Ms. Anthony implemented inequitable teaching practices based on the perceived ability level of the class.

On Ms. Anthony's TPBS survey, she indicated equitable practices for individual students. She disagreed with the idea that a teacher should call attention to students' work that is incorrect or poorly written as an example of what not to do. She also did not put students on display, either by displaying the work of the highest achieving student or making an example of students who were not prepared to answer questions in class. Ms. Anthony attempted to provide individualized instruction for her students. However, the factors of class sizes in the upper twenties coupled with as many as seven inclusion students in each class made this task daunting. In summary, Ms. Anthony's attitudes toward the perceived academic level of a class, the lack of classroom control, and the large class sizes with inclusion students combined together to promote inequitable teaching practices and lower expectations for all students.

Ms. Anthony's Questioning Techniques

Examining Ms. Anthony's questioning techniques can create a more accurate picture of her practices through the equity lens. She attempted to ask as many high-order questions as possible. In the basic mathematics class that I observed, she used low-order questions 50 times and high-order questions 25 times. No student-to-student discussions were examined, and students explained their answers on only two occasions. The pre-algebra class had an only slightly better ratio with 71 low-order questions and 56 high-order questions. On seven occasions I observed several students justifying their explanations student-to-student. A total of 21 instances involved students explaining homework or activity solutions. Ms. Anthony explained her practices on questioning,

> Usually I consciously try to think about it [questioning]. I try to do high-order question with both classes. I always in the back of my head know what I'm supposed to be saying. Sometimes I start and change to a high-order question. Even if I'm doing straight lecturing and can work in some questions to make them think, I feel like I'm not a bad teacher.

Factors that Affected Ms. Anthony's Teaching Practices

School climate factors. Ms. Anthony was adamant about the impact of the school system's curriculum policy on her teaching practices. In her survey, she considered "Curriculum" and "Amount of class time to cover as essential topics" the two factors that guided her teaching practice. The policy required that the curriculum for the entire year must be completed in seven months before testing begins. She explained, "Our county has a 7-month plan. We have benchmarks we have to give.... Covering it [the curriculum] before testing, I'm sorry, it doesn't matter how you teach it. The 7-month plan is insanely crazy!"

In conjunction with the curriculum issue, high-stakes testing was the moving force behind the 7-month curriculum plan. As described by Nichols and Berliner (2008), Ms. Anthony felt the pressure to adjust her teaching practices to prepare for standardized testing. Ms. Anthony talked about her frustration with the state testing of mathematics and reading, "The way they want us to do it, it breaks it up and is one topic. The CMP units are not one topic. The whole focus on testing is in conflict with the way I teach."

She described the pressure applied due to high-stakes testing, “We’re on delayed status—we didn’t make AYP (Adequate Yearly Progress) two years ago.”

Ms. Anthony illustrated her difficulty with the curriculum and time issues,

> I got huge pressure a couple of weeks ago because we’re up for accreditation renewal and they’re coming April 22. We had our preliminary visit two weeks ago. I was the only teacher in the school who was way behind on my benchmarks.... They’re awful, they’re so badly written.

She expressed her frustration,

> I follow the CTM pacing guide. They suggest that you use the whole modules. I had to look through and find parts of the module that were self-contained because of the time issue. If I didn’t have the benchmarks, I would teach straight out of CMP.

Teacher factors. The School Climate Factors of curriculum and time were substantially impacted by the Teacher Factors of interruptions and off-task behavior. In the open response question regarding teaching strategies that are most effective, Ms. Anthony felt that group interaction was best, but she had to seat students in rows more because they were too distracted to listen. I readily observed that Ms. Anthony’s classroom climate was chaotic. Most of the observational notes taken during the basic mathematics class pertained to the lack of order in the classroom. When the students divided into groups, there were no group rules and very little learning was occurring. At times, Ms. Anthony seemed to be begging the basic mathematics class to behave. She defended her teaching practices, “Part of the reason I stand up and lecture more for fourth block than third is because I’m up there talking, they’re under better control.

The chemistry is definitely a problem." The fact that Ms. Anthony had 26 students squeezed into each class only magnified her classroom management difficulties.

The basic mathematics classroom was chaotic, but Ms. Anthony also had problems with classroom management with the pre-algebra class as well. Ms. Anthony confessed that she needed to develop stronger routines. She admitted that in general she had difficulty with this,

> As the year has gone on, I've fallen away from making it [groups] so formal, which was part of my problem. Starting out with formal groups and rotating roles. I'm not good at that in my life anywhere. I start something and drop it because it becomes too much to keep up with.

Later in the interview, Ms. Anthony summed up her classroom management difficulties, "The behavior is a problem, I guess I'm not a strong enough classroom manager yet to enjoy teaching a variety of strategies." Ms. Anthony had attempted several different discipline policies throughout the year, but the county vetoed all of her approaches. For example, she had students write 25 mathematics facts for violations of the behavior policy but had to discontinue that strategy. Ms. Anthony truly was hindered from incorporating her *Standards*-based beliefs due to her lack of classroom management.

Summary of Case #4

Ms. Anthony was attempting to incorporate *Standards*-based teaching practices on a daily basis. As a change from her first year of teaching, her teaching practices had reverted to more traditional practices. Her desks in the classroom were no longer in groups but back in rows. Ms. Anthony still made a conscious effort each day to incorporate effective questioning techniques and to be more of a facilitator of student discussion. When her students worked in groups, they generally discussed homework problems without formal group guidelines and did not participate in investigative activities. To increase her *Standards*-based teaching practices, Ms. Anthony had integrated portions of several CMP units throughout the year.

Ms. Anthony still had very strong beliefs that *Standards*-based teaching was the best approach for equitable and effective student learning. She was not incorporating the practices to the extent she really wanted. However, she no longer had guilt feelings about her practices but acknowledged that flexibility required some accommodations to *Standards*-based teaching.

Ms. Anthony's flexibility was necessary because of several factors that influenced her teaching practices. The main deterrent to incorporating *Standards*-based strategies was the county's policy of covering all of the objectives of the course of study in seven months. This policy did not mix with the investigative nature of *Standards*-based practices. Closely related to the curriculum policy was the issue of high-stakes testing. The students had to receive exposure to each concept in the course of study by testing time in April. To make matters worse, one lesson out of ten was dedicated to "practicing" for the high-stakes tests in the computer lab. These factors coupled with Ms. Anthony's difficulty with classroom management presented a rather formidable roadblock to *Standards*-based teaching practices.

Ms. Anthony's approach to teaching was somewhat different for her two different levels of classes. The actual cause of the difference is complicated. The primary reason that she adjusted her teaching practices entailed the less controlled atmosphere of the basic mathematics class. However, Ms. Anthony also portrayed her doubts toward the appropriateness of presenting mathematics topics conceptually to her basic mathematics class. She did not feel that the basic mathematics class could comprehend a conceptual approach. If Ms. Anthony could get a handle on the behavior of the classroom and not have the constraints of a 7-month curriculum, her teaching practices would definitely align more closely with *Standards*-based teaching practices.

Case 5: Ms. Chandler

Ms. Chandler was in her fifth year of teaching but only her second at South City High School. Ms. Chandler was an enthusiastic young White teacher who always had a smile on her face. Ms. Chandler, a more seasoned teacher, was the only case study participant with a bachelors and masters from Southern State University. She served as both a school teacher leader and a presenter for CTM.

South City was very modern and had a pleasant atmosphere. A new mathematics, science, and foreign language building was just completed during the span of time that I was observing. One administrator was in charge of all visitors' passes and quickly knew me by name. There were no students in the hall during instructional time. South City School had 1045 students with a student-teacher ratio of 14 to 1 and was the only high school for a college town. The demographics of the student population of South City were 64% White, 29% African American, 4% Hispanic, and 2% Asian.

Even though the school had a very challenging academic curriculum, all of Ms. Chandler's classes were composed of students who were labeled as "low-achieving" (see Table 20). Ms. Chandler enjoyed teaching the slower-paced classes and requested these classes each year. Ms. Chandler taught two sections of geometry and one section of algebra II without trigonometry. She was chosen to pilot the newly created algebra II without trigonometry class that was designed especially for seniors who were college-bound but were not able to keep up with the pace of algebra II with trigonometry. Even though South City High used a traditional curriculum, Ms. Chandler supplemented the curriculum with the *Interactive Mathematics Program (IMP*: Alper, Fendel, Fraser, & Resek, 2003)

Ms. Chandler's room was decorated in such a way that made mathematics appealing to teenagers. She provided many opportunities for students to display their successes and projects around the room. The room was rather large and allowed plenty of room for the students to work in groups. In addition the room had fresh paint and modern amenities, including a tablet computer that connected to a LCD projector. She used the TI-Smartview emulator software (Texas Instruments, 2008) to allow students to view several windows from the graphing calculator simultaneously. Her desks were arranged neatly in rows, but the positioning for the first desk in each row was marked by an "x." The "x" marked the spot so that the desks could easily be put back in rows after the students had been working in groups. Each student had a laminated card which allowed them to "check out" a graphing calculator for use in class or even to take home overnight. The incorporation of the graphing calculator was an integral part of her teaching. She used it to explore, justify, and connect mathematical concepts.

Ms. Chandler also felt that she should take on the cause for the so-called "low-achieving" students that most teachers preferred not to teach. She took special steps to make sure that these students were successful. One effective technique included assigning students problems to present a day early so that they could be prepared. She pointed out that presenting the concepts in several different ways reached out to students with different learning styles. Ms. Chandler also believed that supporting the students by attending their extracurricular activities improved the rapport between teacher and student. Ms. Chandler did not want to make the same mistake as her own teachers. She wanted to make sure that her students made connections between mathematical concepts and understood what they were learning.

Table 20

Summary of Mr. Chandler's Classes

Teacher	Classes Taught	*Racial Makeup of Classes	Inclusion Teacher	Teaches Classes of Differing Abilities
Ms. Chandler	Algebra II	5/13/2	No	No
	Geometry	9/8/1	No	

*Racial makeup of class is shown by number of students in the following order: White/African American/Other

Observations of Ms. Chandler's Lessons

Ms. Chandler's upbeat surroundings were matched by her positive approach to teaching mathematics to low socioeconomic students. "Never a dull moment" described Ms. Chandler's mathematics lessons. The lessons were varied, and the activities were engaging. A description of a typical day in Ms. Chandler's classroom was difficult because no day was typical. Portions of her lessons were similar most days. Upon arrival students worked bellringers that were written on board. The students presented their solutions to the bellringers on the whiteboard. Most days Ms. Chandler then quickly checked homework for completion. A score of “2” indicated that the homework was completed, a score of “1” meant half or more, and all others received a “0.” A discussion of the previous day’s homework usually ensued. Some days Ms. Chandler worked requested homework problems on her tablet computer that was connected to the LCD projector. Many times she enlisted the aid of students to explain the solutions while she transcribed their explanations on the computer. Other days, the students volunteered to put homework problems on the board and explained them to their peers. Sometimes, the order of the day was a continuation from the previous day’s activity, so there was no discussion of homework.

The bulk of the lesson was usually spent doing an investigative activity in groups to help the student “discover” a new concept. Sometimes Ms. Chandler provided scaffolding in the form of background knowledge to promote success during the activity. The group work was effectively organized, and almost all students were cognizant of the roles in their group and were engaged. Each group explained its responses to the entire class. The verbal explanation was accompanied by a written solution either on the document camera or an overhead transparency. A portion of each student's grade was based on presenting solutions to the class. If the activity were short, a discussion followed connecting the activity to the mathematical concept. A “safe” environment could readily be felt because all students appeared at ease to share their ideas freely.

For example, the geometry students worked in groups to investigate and make conjectures about the relationship of the sides in a 30-60-90 triangle using the Pythagorean Theorem. The groups were provided with a chart to complete the activity. Ms. Chandler had facilitated a discussion prior to the activity to help all students have a good working knowledge of a 30-60-90 triangle. After the activity and discussion of the findings, Ms. Chandler helped the students make a connection between that day's findings and yesterday's discussion of 45-45-90 triangles. The remaining time was given to work on homework problems.

In the following vignette from Ms. Chandler's classroom, she was introducing a group activity investigating systems of equations:

(Ms. Chandler handed out worksheets from the IMP Cookies unit and had different students read the scenario.)

Ms. Chandler: we have a lot of information. What information are we given?

Student: How many cookies they could make.

Ms. Chandler: What else?

Student: How much icing they had.

Ms. Chandler: What else?

Student: How much profit on each kind of cookie.

Ms. Chandler: And what's the point—why are we trying to figure the amount each time?

Student: We want to make as much money as possible.

Ms. Chandler: All right, we want to maximize our profit. What you're going to do is get into your groups, and I'm going to give you a piece of poster paper there. What I would like you to do today, first of all, is to write down all of the conditions that have to be met. And once you've got all of the conditions written down, then you'll do #1, which is to do what?

Student: To find one combination that fits all of the requirements.

The vignette from one of Ms. Chandler’s lessons illustrated her desire to get all of the students engaged. The vignette is relatively short because the students were engaged in their groups the remainder of the lesson trying to maximize their profit selling cookies.

Ms. Chandler’s Beliefs

Pre-service. The belief in student-centered teaching changed during Ms. Chandler’s pre-service education. Her mathematics education methods classes helped her to “see the light” about learning with understanding and viewing mathematics as a connected whole. She elaborated on her pre-service experience:

> I’m a little bitter that this [learning conceptually] is not the way that I was taught. I went into college in my calculus class totally unprepared. I had a horrible background base. I thought I was a great math student because I could learn the rule, and I could get A's on the math test. I had no idea why the rule worked or what was taught. I couldn't make connections between concepts. I saw the light in my methods classes. I was converted 100%! Not only do I believe that it’s the best way to learn because it’s the base that I'm giving them to build. It’s much more enjoyable for me. I want them to understand.

Ms. Chandler gave details of her internship. Her cooperating teacher used very traditional practices, but he wanted an intern that would implement GSP (Key Curriculum Technologies, 2008). Ms. Chandler accepted the challenge and “just came in and took over.” Like Greg in Cooney et al. (1998), Ms. Chandler’s incorporation of technology helped her to experience success and to solidify her beliefs in *Standards*-based teaching practices during her internship.

Philosophy toward teaching. In her first interview, Ms. Chandler confirmed that her pre-service beliefs have remained true to *Standards*-based principles since her pre-service education. Her total score for the beliefs portion of the TPBS ranked in the top quartile of the teachers' responses. A score in the top quartile represented beliefs in strong agreement with *Standards*-based principles. As Ms. Chandler examined her beliefs, she agreed that it was important for students to figure out how to solve mathematics problems for themselves and disagreed that students learn mathematics best from their teacher's demonstrations and explanations. In her beliefs responses, she strongly agreed that students achieve mathematical understanding through the direct experience of figuring out their own solutions to problems and then verifying their thinking for themselves.

In her interviews, Ms. Chandler expressed her support of *Standards*-based beliefs and conceptual learning, "There are key things that I need to get covered based on the course of study, and I'm making sure that the concept is deep. Not teaching a whole bunch of things that they don't really understand." Ms. Chandler also felt that her students should be able to make connections between the mathematics that they're learning and their lives, "I want them to see that math might be used to solve something that they're actually interested in. Someday they might want to maximize their profit."

Expectations. In keeping with promoting conceptual learning and mathematical connections, Ms. Chandler considered that she carried very high expectations for her students, almost too high. In an interview, Ms. Chandler explained that she requested to teach classes that were labeled low-achieving. She felt that these classes were often avoided by many teachers, and these students were capable of achieving much higher levels. Ms. Chandler scored in the top quartile for the statements dealing with equity. A high score indicated that a teacher had high expectations for all students. On the survey, Ms. Chandler strongly disagreed with the statement, “When it comes right down to it, a teacher can’t do much because most of a student’s performance depends on his/her home environment.” She also disagreed with the statement that the amount a student can learn is primarily related to family background.

Ms. Chandler’s Teaching Practices

RTOP averages. As discussed in the instrumentation section, the RTOP (AzTEC, 2002) was used as one means of analyzing Ms. Chandler’s teaching practices in light of *Standards*-based practices. I completed an RTOP for each observation and calculated the mean RTOP scores for Ms. Chandler. The RTOP mean for Ms. Chandler's teaching was 3.18. Of the five case studies, Ms. Chandler’s score was by far the highest and most aligned with *Standards*-based practices. The average of 3.6 on Student/Teacher Relations highlighted the student-centered atmosphere of Ms. Chandler's classroom. Table 21 summarizes the RTOP averages.

Table 21

RTOP Averages for Ms. Chandler’s Observations

	Implementation	Propositional Knowledge	Procedural Knowledge	Communicative Interactions	Student/ Teacher Relations	Total
Ms. Chandler	3.00	3.20	3.00	3.10	3.60	3.18

Traditional practices. Unlike her teaching beliefs and equity beliefs, Ms. Chandler's responses to the teacher practices of the TPBS ranked in the bottom quartile when compared with the remaining respondents. Her responses would normally be equated with a traditional teaching style. After observing her for two weeks, I specifically asked questions in her exit interview that helped account for the gap in survey responses and actual observed teaching practices. In Ms. Chandler's survey, she responded that she rarely promoted student participation in small group discussions to help them make sense of mathematics. Ms. Chandler expounded on the intent of her answer. She did not think of the statement in terms of having group activities, but rather the extent to which she was doing all she could to facilitate the group activities. Ms. Chandler responded on the survey that she never worked on one math problem for more than 10 minutes. She did not consider time spent on activities as "one math problem" but indicated that often 45 minutes to an hour could be spent on an activity.

On the topic of lecturing, Ms. Chandler responded on the survey that she often lectured. Ms. Chandler explained that she lectured when summarizing a lesson when the students could have been doing a lot more talking. Ms. Chandler furthered clarified that the lecture format is not typical of the whole class period but only small segments of the lesson. On three items of the TPBS survey, Ms. Chandler indicated that sometimes students presented how they solved a problem to the math class, did math problems that required critical thinking, and thought about why something in math class was true. Ms. Chandler corrected that answer and acknowledged that these three situations happened daily.

These clarifications to Ms. Chandler's responses on the TPBS survey pointed out that Ms. Chandler judged her practices very critically on the TPBS survey. In considering actual observations of traditional teaching practices, two days of observations of Algebra II lessons followed a more traditional pattern. One of the days Ms. Chandler spent discussing operations with functions. She explained her use of the more traditional teaching because the topic was heavily driven by notation. During this lesson, however, Ms. Chandler was observed several times asking students to make an attempt at performing an operation before she provided an explanation. Ms. Chandler also commented that sometimes she has to use more direct teaching to cover all of the objectives of the course of study. "It is nearly impossible to get through everything [course of study objectives]. I've spent four days on graphing linear inequalities, and linear programming is not even an objective. It's so important, I just can't skip it."

Standards-based practices. From the moment I entered Ms. Chandler's classroom, I could feel a different atmosphere from the teacher-centered classrooms of the other four case studies. The students were attentive and interested in mathematics. The use of activities to promote conceptual understanding was woven seamlessly into her lessons. One entire lesson was spent allowing groups to investigate and inch closer to a thorough understanding of the purposes of linear programming.

> I love to teach this class [perceived low-achieving] in context because these kids have been drilled and drilled and drilled. These kids [perceived low-achievers] learn so much better in context. I do find that when I teach higher-level kids that they HATE learning in context—give me the rule. They hate it because they have been successful with the drill.

Ms. Chandler excitedly shared that her favorite part of teaching was walking around the room and facilitating student discussions. She also emphasized the importance of using calculators to make connections in mathematics, "Especially in Algebra II, I don't see how they [teachers] could get away with not using the calculator. That helps them [the students] see the connection between the table and the graph."

The direction of Ms. Chandler's teaching was influenced by her students' discussions. For example, she did not intend on teaching the Interactive Mathematics Program (IMP) unit Cookies (Fendel, 1999). After she graded their unit test, she realized that her students needed reinforcement on graphing. She revisited graphing using the Cookies unit from IMP. On 41 different occasions, the act of changing directions because of student discussion was noted in the transcripts of Ms. Chandler's observations and observational notes. Students' conceptual understanding was paramount to Ms. Chandler.

Ms. Chandler's emphasis on conceptual learning included many non-routine problems and group activities. She used these strategies to improve her students' affect because she knew that her students had had many negative experiences in mathematics classes in the past. She hoped her students would attain a more positive affect by incorporating group activities in a manner similar to Rita in Hannula's research study (2002). Ms. Chandler's use of non-routine problems seemed to produce a more positive affect for her students like the students in the research of McLeod (1992).

The RTOP scores completed the puzzle of Ms. Chandler's *Standards*-based teaching practices. Her scores were by far the highest of any of the case studies and showed a strong tendency toward *Standards*-based teaching practices. When comparing Ms. Chandler's current teaching practices to those learned in her pre-service education, her *Standards*-based techniques had improved over time. I observed her using worthwhile tasks coupled with students exploring these tasks collaboratively followed by presentations of a variety of solutions. Ms. Chandler effectively used technology to aid in conceptual comprehension that was enhanced by effective questioning. Ms. Chandler's classroom could definitely be defined as student-centered with Ms. Chandler acting as a facilitator.

Equity. In order to make her classroom more student-centered, Ms. Chandler made accommodations to incorporate *Standards*-based strategies for her students. To reduce mathematics anxiety, she allowed students to work in pairs or groups, using a similar technique that Harper and Daane (1998) used with elementary pre-service teachers. These techniques included learning cooperatively, using manipulatives, writing in mathematics journals, and making presentations of solutions or concepts. In an interview, she explained, "I do a lot of accommodations [in my non-inclusion classes] that I do in my inclusion classes even though they are not documented because I know that they need them to be successful." To compensate for some of the students' weak background knowledge, she used a lot of visualization and integrated the use of graphing calculators. To provide equitable teaching, she made sure that every single student had a calculator every single day. Ms. Chandler's use of technology provided scaffolding to promote conceptual learning for her students.

During an interview, I questioned Ms. Chandler about her teaching practices. She had confidence that her students could grasp the mathematics concepts. She explained that she went at a slower pace when necessary because she really wanted her students to understand it. She might even have to revisit the topic—an example follows:

> Like you saw today, I'd already done graphing with inequalities, but it was clear that there was not a good understanding, so I took a different approach and had them draw the pictures. After they drew the pictures, they were able to finish the activity and graph on their transparencies, whereas yesterday they had just stared at me.

Ms. Chandler often made similar accommodations to her teaching to provide scaffolding for students who required it. High expectations for her students were highlighted by the comment, "As a teacher, I wanted to teach at a higher level than the book [basic geometry]—it's so low. I pulled in a lot of problems from the old geometry book to bring in those higher-order problems." Ms. Chandler exhibited many equitable teaching practices that included providing accommodations for *all* students, teaching *all* students from a conceptual viewpoint, raising the level of the curriculum, promoting high expectations and worthwhile opportunities for *all* students, and using technological resources to provide scaffolding for *all* students.

Ms. Chandler's Questioning Techniques

Ms. Chandler did not lower her expectations for her classes in the area of questioning. She was the only case study participant that asked more high-order questions than low-order questions. She proposed 52 low-order questions and 71 high-order questions. In an attempt not to take away the "aha" moments in her lessons, she changed a high-order question to a low-order 13 times. For example, in an exploration activity in the Cookies unit, Ms. Chandler asked the groups to answer a high-order question which required students to take numerous criteria into account. When she realized that the question was overwhelming, she gave each group a different condition to satisfy.

Each group successfully presented solutions and subsequently understood how to attempt the higher-order question. The *Standards*-based thrust of her questioning techniques aligned with the observations and RTOP scores to produce a united presentation of *Standards*-based teaching practices.

Factors that Affected Ms. Chandler's Teaching Practices

School climate factors. Ms. Chandler's *Standards*-based teaching practices were certainly enhanced by the resources available to her. Daily she took advantage of the technology in her classroom: a tablet computer connected to an LCD projector, a document camera, and a classroom set of graphing calculators. Her tablet computer also contained SmartView emulator software from Texas Instruments (2008) that allowed her to display several windows from the graphing calculator onto the screen at once. For example, to boost understanding of graphing relationships, students were able to view the graphs, the ordered pairs, and the equations of the graphs on the screen simultaneously. Ms. Chandler even commented that the emulator software has helped her own conceptual understanding in algebra II. During the last week of observations, Ms. Chandler was preparing to move to a new wing of the school, where she would have easy access to computer labs and a SMART Board in her room (SMART Technologies, 2008). A SMART Board is an interactive whiteboard that boasts a touch-sensitive display connected to the computer and digital projector to show the computer image.

One factor that Ms. Chandler noted in her survey was that her colleagues significantly influenced her teaching practices. I was puzzled by that response and asked her to explain. In a surprisingly different twist she confessed, "I feel like I have to be a role model, and I feel like I always have to 'walk the walk.' Being involved with CTM, trying to be a presenter, and a teacher, if I don't walk the walk, then it's hard for me to get them [her fellow teachers] to buy into it." She continued by adding that there were both teachers who promoted *Standards*-based teaching practices and those who wholeheartedly opposed it. The administration supported anything that produced success.

A second factor that Ms. Chandler responded in her survey as significantly influencing her teaching practices was time. During her Cookies unit (Fendel, 1999), Ms. Chandler pointed out that she spent four days on a linear programming program which was not even included in the course of study. Time pressure was more of a factor in geometry than in algebra II. She pointed out that she had been able to do a lot less investigations and hands-on activities because of time constraints. She added, "I have a lot of objectives that I have to meet, and I have to get them in."

The final school factor addressed the issue of the low socioeconomic status of Ms. Chandler's students. This factor has already been discussed as part of her beliefs and teaching practices. The school actually created the Algebra II class for students of low socioeconomic levels. Many of the students in this class are planning to go to college on an athletic scholarship, and they needed algebra II to qualify for college sports. The perceived level of this algebra II class did not discourage Ms. Chandler, but she volunteered to teach it. She emphasized that she really wanted the students to understand the material, and the only repercussion of this factor was that she understood that their background knowledge might require extra scaffolding and different approaches.

Teacher factors. Related to the socioeconomic factor was the atmosphere created in the classroom. Many of Ms. Chandler's students experienced mathematics anxiety and a lack of confidence from prior negative experiences in mathematics classes. It was obvious to the observer that Ms. Chandler's students felt comfortable in her classroom. Discipline was not a factor in her classroom. Ms. Chandler explained her secret to earning respect from her students:

> I definitely have a rapport with my students because I'm not afraid to be myself around them. Also, I'm pretty consistent with the way I enforce things [discipline] and pretty laid back when it comes to things that don't affect their understanding.... I know that when I was a student, I wasn't focused 100% of the time. I let that [100% of class's attention] go and decided that I needed the majority, and I need mathematical understanding.

Another aspect of Ms. Chandler's teaching practices included viewing each student as a whole person. Ms. Chandler's practices embraced the tenets of Noddings' studies (2005). Noddings (2005) explained that teachers need to meet the interests of the whole student which could extend beyond the academic curriculum and instill a feeling of safety. Ms. Chandler always wanted students to feel that they can be themselves, but they know what is expected of them and still do what is expected in a non-threatening way. Often, her students wandered in during the day to ask for advice or to seek help with college applications. She supported her students by attending many of their extracurricular events. Ms. Chandler was concerned about the whole student and not just mastery of the recommended mathematics concepts.

Ms. Chandler's strong involvement in professional development was another factor that influenced her *Standards*-based teaching practices. She commented on the effects of her professional development, "All my professional development has verified and encouraged the way I wanted to teach in my profession. We do a lot of technology-based professional development here at the school. I've really tried to make the use of technology a focus." Ms. Chandler's active involvement in CTM and her inservice professional development impacted her *Standards*-based teaching practices.

Summary of Case #5

Ms. Chandler exhibited an excellent model of *Standards*-based teaching practices. She effectively incorporated investigative-type activities, and all of her students presented findings to the class. An air of openness and safety was apparent in the classroom, and student-to-student discussions were common. Ms. Chandler was content to be a facilitator that provided the necessary support for effective student learning. Ms. Chandler's beliefs were in total alignment with her *Standards*-based teaching practices.

Ms. Chandler had a very strong personality and overcame any obstacles to teaching using *Standards*-based strategies. Neither her internship nor her school was particularly supportive of *Standards*-based teaching, but she did not succumb to any political pressures and stayed true to her beliefs. The student demographics of her class would certainly be a deterrent to many mathematics teachers, but Ms. Chandler gladly accepted the challenge with high expectations for all of her students. She even went the extra mile and filled the needs of the whole child for many of her students (Noddings, 2005).

Comparison of the Cases

A discussion of each case study by categories preceded the comparison of the cases. In this next section, the cases will be compared using the same categories. It is important to compare the cases to highlight similarities and differences of the participants' teaching beliefs and practices. The comparison also emphasizes the wide variety of teaching beliefs and practices of these five participants that emerged from this study, as well as the diversity of factors that impacted them. The categories are: teachers' beliefs, teachers' practices, teacher questioning techniques, and factors that affected teacher's practices.

Teaching Beliefs of Case Studies

Pre-service

According to Cady (2006), the pre-service experience had the most effect on teachers' beliefs. This study agreed with the previous research that the pre-service education affected the teachers' beliefs very distinctly (Cooney et al., 1998; Hart, 2002a; Wilkins & Brand, 2004). Like Alice (Van Zoest & Bohl, 2002), Ms. Chandler and Ms. Anthony were both thoroughly convinced of the effectiveness of *Standards*-based teaching. On the opposite end of the spectrum, Mr. Easterly's beliefs were virtually not affected by his exposure to *Standards*-based strategies during his methods classes and internship. He indicated in his interviews that he was more convinced of the effectiveness of direct teaching after participating in his methods classes and internship. Both Mr. Barry's and Ms. Danforth's beliefs were impacted by their pre-service education. Mr. Barry wanted to incorporate the conceptual element into his traditional philosophies. Ms. Danforth thought that a modified version of *Standards*-based teaching was a good compromise.

Philosophy Toward Teaching

The teachers came out of their pre-service training with certain beliefs toward teaching. Mr. Easterly continued to hold strong beliefs supporting a direct method of teaching. After Ms. Danforth began teaching seniors, she adjusted her beliefs and felt that the grade level of the students impacted the usefulness of the *Standards*-based approach. She believed that *Standards*-based strategies were useful for younger students, but not juniors and seniors. Mr. Barry also adjusted his beliefs after he began teaching. He felt that that these concepts were effective to be used as a supplement to the regular curriculum. He acknowledged that he adjusted his beliefs because of his school climate and the curriculum. As classroom teachers, Ms. Anthony and Ms. Chandler both believed that a student-centered, inquiry-based method of teaching was important for students' learning. Their beliefs had not changed since their pre-service education.

Expectations

With the exception of Ms. Chandler, all of the other teachers held different expectations for students based on the ability level or socioeconomic status. Like Julie in Sztajn's research (2003), Mr. Easterly compared his current algebra IA students to students at a previous school and acknowledged a belief that they could not comprehend topics conceptually. Most of Ms. Danforth's students came from backgrounds of lower socioeconomic status. The students had such a different background from Ms. Danforth's that she felt they were unable to follow an intensive curriculum and lowered her expectations. Ms. Danforth's lack of community and administrative support promoted actions that were similar to several studies in the review of literature (Kitchen, 2003; Sztajn, 2003). Mr. Barry and Ms. Anthony had different expectations for their classes of perceived differing levels of ability. Ms. Chandler had high expectations for all students and welcomed the challenge to teach classes that were labeled "low-achieving." Even though Ms. Chandler had limited support from administrators, colleagues, and parents, she still believed in her students, and they accomplished a high level of achievement that was similar to the research in the review of literature (Gutierrez, 1999; Gutstein, 2003; Silva & Moses, 1990; Silver & Stein, 1996).

Teaching Practices of Case Studies

RTOP Averages

Although the RTOP average for each teacher reported a very quantitative outlook on each teacher's practice, it still gave an overview of each teacher's strategies from a more objective vantage point (see Table 22). A score of 2 represents a ranking in the middle between traditional teaching and *Standards*-based teaching. The averages made apparent the diversity of the teaching practices of Mr. Easterly, the teacher whose teaching was most closely aligned with traditional teaching practices, and Ms. Chandler, the teacher whose teaching was most closely aligned with *Standards*-based teaching practices. The other teachers fell somewhere on the continuum. The RTOP averages also emphasized the disparity of teaching practices in Mr. Barry's accelerated and non-accelerated classes was much larger than Ms. Anthony's two classes. Mr. Easterly's scores indicated no distinction between his two classes, even though the age of the students and the perceived ability level of the class were very different.

Table 22

RTOP Averages for Case Studies

	Implementation	Propositional Knowledge	Procedural Knowledge	Communicative Interactions	Student Teacher Ratios	Total
Mr. Easterly						
Algebra IA	0.60	2.00	0.30	1.10	1.20	1.03
Algebra III	0.50	2.10	0.20	1.20	1.10	1.03
Average	0.55	2.05	0.25	1.15	1.15	1.03
Ms. Danforth						
Algebraic Connections	1.40	2.40	0.70	1.40	2.10	1.66
Mr. Barry						
Pre-algebra	1.60	2.50	1.10	2.20	2.00	1.91
Alg Seminar	2.70	2.90	2.00	2.90	3.10	2.72
Average	2.20	2.70	1.55	2.55	2.55	2.32
Ms. Anthony						
Pre-algebra	2.50	3.20	2.10	2.40	2.70	2.65
7th Math	1.90	3.00	2.00	1.60	2.60	2.23
Average	2.20	3.10	2.05	2.00	2.65	2.44
Ms. Chandler	3.00	3.20	3.00	3.10	3.60	3.18

All five teachers incorporated some teaching practices that have generally been equated with traditional teaching. Mr. Easterly and Ms. Danforth most closely followed a traditional teaching pattern with very few diversions. Mr. Barry incorporated conceptual explanations, student presentations of homework, and student discussions that were representative of *Standards*-based teaching. However, the thrust of his lessons involved more direct teaching and not inquiry-based learning. In findings similar to the review of literature (Arbaugh et al., 2006; Lloyd, 1999; Roehrig & Kruse, 2005), the use of a *Standards*-based curriculum made teaching with *Standards*-based strategies easier to implement. Ms. Anthony and Ms. Chandler were the only two teachers whose curriculum aligned with *Standards*-based principles. Ms. Anthony attempted to incorporate *Standards*-based teaching practices by using some activities, portions of CMP units, and effective questioning. She encountered overwhelming factors that severely hampered her intentions to incorporate *Standards*-based practices. Ms. Chandler simply incorporated *Standards*-based teaching practices no matter what the circumstances. With the exception of Ms. Chandler, the effects of teachers' beliefs associated with demographics lowered the teachers' expectations and caused them to reduce the amount of conceptual-based learning.

Questioning Techniques

In addition to the RTOP means, the breakdown of teachers' questioning practices helped to provide insight into the teacher's practices. The use of high-order questions is a major component of *Standards*-based teaching strategies. Mr. Easterly and Ms. Danforth only included seven high-order questions in all of their observations. Mr. Barry had a few more high-order questions. Ms. Anthony's questioning yielded more high-order questions, especially in her pre-algebra class. Her questioning also spurred noticeably more student discussions. Ms. Chandler was the only teacher who posted more high-order questions than low-order questions. During observations in Ms. Chandler's class, I could almost see Ms. Chandler's brain working overtime to think of questions that helped the "light to come on" for her students.

Factors that Affected Teaching Practices

School climate factors. During the observation of the five teachers, a number of school factors that affected teaching practices were noted. Like research previously cited (Cady et al., 2006; LaBerge & Sons, 1999; Rousseau & Tate, 2003), the most common factor that each teacher mentioned was the issue of time. All of the teachers but Mr. Easterly indicated that time was a factor in implementing a more *Standards*-based approach. Several other factors were closely connected to time. Mr. Barry, Ms. Anthony, and Ms. Chandler also discussed the time pressure of covering the course of study as a hindrance to incorporating *Standards*-based teaching strategies as was also found in Rousseau and Tate (2003). In keeping with current research (Cady et al., 2006), the burden of completing the course of study was related to the students' success on high-stakes testing. The completion of the curriculum should increase the scores on the high-stakes tests. Mr. Barry and Ms. Anthony expressly named high-stakes tests as a considerable factor.

Some of the teachers were encouraged by their administrators to promote certain teaching styles. Mr. Easterly's administration supported his traditional teaching style. Mr. Barry's administration gave him leeway in his teaching but expected to incorporate the very traditional Saxon curriculum. Looking at the bigger picture of the school as a whole brought some teachers advantages and some disadvantages. The turmoil that Ms. Danforth's school conveyed definitely made teaching using any style more difficult. On the other hand, the orderly nature of Mr. Easterly's school promoted his teaching practices. Looking at another aspect of the school, the availability of resources affected some teachers' practices. Mr. Easterly and Ms. Chandler had access to the most modern technologies, and they both used them daily. Ms. Danforth claimed that a lack of resources was an issue for her, and this included basic needs like textbooks and access to a functioning copying machine. On the technology side, an LCD projector could have helped her significantly, but she did not make use of the graphing calculators that were available to the entire mathematics department.

Teacher factors. The most influential of the school climate factors, classroom management was by far the biggest influence of the teacher factors. The task of discipline as a general obstacle was noted previously in several research studies (Kitchen, 2003: LaBerge & Sons, 1999). For Ms. Danforth and Ms. Anthony the lack of control in their classrooms severely hampered any attempts at teaching. The more open nature of investigative activities made classroom management even more important. Ms. Anthony had commented that a lack of effective class routines, especially for group activities, added to her poor classroom management. Mr. Barry had excellent control of his classroom but tended to avoid group activities for fear of the class getting out of hand. Ironically, the tight reign of Mr. Easterly made it easier for him to implement *Standards*-based strategies, but he chose to follow the traditional route. Ms. Chandler had no issues with classroom management because she had established her expectations and routines earlier in the semester. Ms. Chandler also included professional development as a positive factor that aiding in her *Standards*-based teaching strategies.

Comparison of the Quantitative and Qualitative Results

The purpose of this study was to contribute to an understanding of the relationship between the beliefs and practices of secondary mathematics teachers who participated in a *Standards*-based pre-service education. The relationship was viewed using a lens based on the *Standards* guidelines about mathematics teaching and learning. It is important to compare the quantitative results with the qualitative results. A comparison will reveal where the results are in agreement and where the results conflict. The reasons for these similarities and differences can be examined closely in an effort to resolve the discrepancies. In addition, the thick description of the qualitative results enhances the “why” of the quantitative results.

The results of the quantitative analysis showed a negative correlation between teachers’ *Standards*-based beliefs and practices. Three of the case studies were specifically selected with survey responses that had beliefs and practices that were at different ends of the spectrum. The analyses of the five case studies did not agree with the findings from the quantitative analysis. Four teachers’ beliefs were in agreement with their practices—three were more traditional, and Ms. Chandler’s beliefs were based on the *Standards.* Ms. Anthony’s beliefs and practices were not in alignment. She wanted to implement *Standards*-based practices more often in her classroom and was frustrated by her obstacles of classroom management, the county curriculum policy, and large class sizes. The survey responses for Ms. Danforth, Ms. Chandler, and Mr. Barry did not match the analysis of their teaching beliefs and practices.

Several factors must be considered in attempting to account for the difference in the quantitative results and the qualitative results. The 42 teachers completed the TPBS in very different surroundings from the face-to-face interviews of the case study participants. All but 6 teachers completed the survey on a computer in a setting that they chose. The TPBS respondents reported on their practices of their first class of the day.

This class may not have been representative of their teaching practices for a variety of reasons. The case study participants were given a chance to explain any differences between their beliefs and practices, but the rest of the respondents did not receive this opportunity.

A secondary purpose of the study was to investigate what influences affected teachers' practices. The TPBS responses placed curriculum as the leading factor, and curriculum negatively influenced teachers' practices ($p < .05$). The curriculum was a driving force for Mr. Barry, Ms. Danforth, and Ms. Anthony. Time and the academic level of students were next in line. In all five cases, the academic level of the students affected the teachers' practices, most of them substantially. According to the TPBS results, the academic level of students had a negative impact on teachers' beliefs ($p < .05$). The pressure of time affected the teaching practices of Mr. Barry, Ms. Anthony, and Ms. Chandler. The analysis of the case studies agreed with the TPBS results in that administration and socioeconomic status had little impact on teaching practices. The exceptions were Ms. Danforth (socioeconomic status) and Mr. Barry (administration). These results were roughly similar, but it was difficult for teachers to assign a numeric value on their teaching influences. A qualitative study brought the advantage of a more detailed insight into teachers' practices and beliefs. The discussion of the qualitative results also pointed out that *Standards*-based teaching cannot be considered in isolation but is intricately interwoven with many other factors that affect teachers' practices. These complex relationships cannot be unraveled in a simple survey.

V. SUMMARY AND RECOMMENDATIONS

This chapter will bring to a close the discussion on teachers' beliefs and practices in this study. The chapter opens with a listing of the limitations of the study. The main portion of the chapter sets forth the conclusions, and they are organized by each research question. The chapter closes with the implications that can be drawn from the study, possibilities for future research, and concluding remarks.

Limitations

Before discussing the conclusions of this study, the limitations of this study should be brought to light. First of all, the data were self-reported, and I was the only researcher involved in the data collection process. In reference to the quantitative portion of the study, the number of participants was not very large (n = 42) relative to the number of influences analyzed. Looking at the qualitative segment of the study, the case study was limited to five participants. There are many combinations of years taught, school setting, professional development participation, etc. that were not observed or analyzed. Unfortunately, some observation days were eliminated or shortened due to school scheduling or testing. Despite these limitations, a maximal, purposeful sample was obtained and added to the base of knowledge concerning teachers' beliefs and practices.

Conclusions

I would like to revisit the original purpose of the study and then investigate the conclusions that can be drawn from research questions associated with the study. The purpose of this study was to contribute to an understanding of the relationship between the beliefs and practices of secondary mathematics teachers who participated in a *Standards*-based pre-service education. The relationship was viewed using a lens based on the *Standards* guidelines about mathematics teaching and learning. This study was guided by the following research questions:

1. To what extent are secondary mathematics teachers incorporating the *Standards*-based approach that was promoted in their pre-service education?

2. How consistent are the secondary teachers' beliefs with a *Standards*-based teaching framework?

3. To what extent are other factors impacting secondary mathematics teachers' beliefs and practices toward *Standards*-based mathematics?

4. To what extent do teachers change their teaching style based on student demographics, such as socioeconomic status, race, gender, and ability level?

The survey used in this study was helpful in guiding the qualitative portion of the study. The results showed that there was often a conflict between teachers' beliefs and practices, and the in-depth case studies were an excellent option to research the heart of these conflicts. The survey responses from the case study participants did not always match the observed behavior in the classroom. The interviews were used to clarify the discrepancies between survey responses and actual teaching practices. The survey responses were also employed as a launching point to explore teachers' beliefs in the interviews. The case studies were selected as a purposeful sample, and very different results emerged from each case study.

Are Secondary Mathematics Teachers Incorporating the Standards?

To investigate the first research question, I looked at the extent to which secondary mathematics teachers were incorporating the *Standards*-based approach that was promoted in their pre-service education. In the teaching practices section of the TPBS, the results indicated that the average mean per question was well below the median of three. A ranking of five implies teaching practices aligned with *Standards*-based teaching practices. The results suggest that the majority of survey respondents considered that their teaching practices aligned more closely with traditional teaching practices, but to varying degrees.

In the case studies, the teaching styles varied considerably. In all facets of teaching, Mr. Easterly exhibited a very traditional style of teaching. Similarly, Ms. Danforth followed a traditional teaching pattern with few diversions. Mr. Barry incorporated conceptual explanations, student presentations of homework, and student discussions that were representative of *Standards*-based teaching. However, the thrust of his lessons involved direct teaching and not inquiry-based learning. Ms. Anthony attempted to incorporate *Standards*-based teaching practices with the following: activities, lessons from CMP units, real-world problems, and effective questioning. Ms. Anthony's classroom still had many characteristics of teacher-centered teaching. In her second year of teaching, Ms. Anthony reduced the number of group activities and became more resigned to using more traditional teaching methods. Ms. Chandler's classroom had a distinctively different feel to it—the focus was on the students, and Ms. Chandler was their facilitator. She seemed to make the guidelines in the *Standards* jump from the page and into her classroom. The overall picture shows that teachers were teaching in a traditional teacher-centered style, and some teachers were incorporating certain aspects of the *Standards*-based methods. Ms. Chandler was the exception.

How Consistent Are Teachers' Beliefs with Their Practices

As I move onto the next three research questions, I will attempt to answer the question of why these teachers implemented certain teaching strategies. In comparing teachers' beliefs and practices, I want to reiterate that Rokeach's (1968) theory presumed that teachers' beliefs are a precursor to their practice. Starting with Mr. Easterly, his beliefs were extremely consistent with his practices. His teaching beliefs and practices were in alignment with the philosophies and strategies that he had experienced in high school. Like Henry in Cooney et al. (1998), his pre-service education did not affect those feelings and ideas from his high school education. The studies of Cady et al. (2006) also reported some cases of mathematics teachers whose pre-service education did not change their traditional beliefs.

Unlike Mr. Easterly, Ms. Danforth's beliefs were impacted by her pre-service education. She participated in an internship with a cooperating teacher who did an exemplary job of modeling *Standards*-based practices, and this positive experience changed her beliefs toward *Standards*-based strategies. Her change in beliefs was very similar to Alice's change in beliefs after an internship with a cooperating teacher that promoted *Standards*-based practices (Van Zoest & Bohl, 2003). Ms. Danforth modified her beliefs after she began teaching to be in alignment with her traditional teaching style.

She felt that *Standards*-based approaches were more appropriate for elementary and middle school mathematics students, not juniors and seniors.

Mr. Barry and Ms. Anthony also had to make adjustments after they began teaching. Mr. Barry's pre-service education created *Standards*-based beliefs about teaching that caused a conflict with his preexisting beliefs system. He amended his beliefs by finding a common middle ground. His teaching practices incorporated some components of *Standards*-based strategies into his traditional teaching so that his beliefs and practices were consistent. Ms. Anthony's pre-service education convinced her of the merits of *Standards*-based teaching. Ms. Anthony indicated that her methods course had a huge impact on her teaching beliefs and practices. Wilkins and Brand (2004) reported similar finding of teachers who were heavily impacted by their methods courses. Ms. Anthony encountered numerous obstacles as she began teaching. Because of these obstacles, Ms. Anthony was not implementing a teaching style that was consistent with her beliefs. Like Ms. Anthony, Ms. Chandler's pre-service education had a lasting impact on her teaching beliefs. Using these newfound beliefs, Ms. Chandler incorporated *Standards*-based concepts into her daily teaching, which was in harmony with her beliefs. Similar to the research findings of Van Zoest and Bohl (2002), both Ms. Anthony and Ms. Chandler were overwhelmingly convinced during their pre-service education that the *Standards*-based approach was superior to the traditional approach.

The case study participants held beliefs that aligned with their teaching practices with the exception of Ms. Anthony. Unlike the case study participants, the teachers' beliefs were not aligned with teachers' practices on the TPBS. The median of teachers' beliefs was higher than teachers' practices. Generally speaking, teachers' beliefs were more aligned with the *Standards* than their practices. As explained in the previous chapter, the surveys were completed in a completely different atmosphere than the face-to-face interviews with the case study participants. In fact, the three case study teachers whose beliefs and practices were at opposite extremes were questioned specifically about the differences in their interviews. These three teachers were able to explain that the beliefs actually did align with their practices and illustrate Leatham's (2006) theory that teachers organize beliefs into systems that are logical to them. This might be the case with other survey respondents as well.

What Other Factors Impacted Teachers' Beliefs and Practices

Teachers' worlds are very complex and are comprised of many components. A variety of components affect the way that teachers teach. Teachers share some of these factors, but they also have unique factors that influence them. During these teachers' pre-service education, they all participated in the same coursework with very similar requirements. However, they experienced varied internships. Mr. Barry and Mr. Easterly worked with cooperating teachers who incorporated traditional teaching styles. Mr. Barry frankly stated that he might have implemented more inquiry-based learning activities in his teaching if he had experienced more meaningful activities during his internship. In conjunction with Mr. Barry's statement, the research of Adams and Krockover (1997) reported that teachers cited a need for more *Standards*-based fieldwork in their pre-service education.

Ms. Danforth and Ms. Anthony interned under teachers who did an excellent job of implementing *Standards* guidelines; the internship experiences promoted positive beliefs toward *Standards*-based strategies. Ms. Chandler's cooperating teacher promoted traditional methods but strongly encouraged Ms. Chandler to implement technology into her teaching. The implementation of activities using technology during her internship promoted conceptual learning in her students and solidified her *Standards*-based beliefs. Ms. Chandler's internship closely paralleled Greg (Cooney et al., 1998). During his internship, Greg's success of incorporating technology to promote mathematical understanding precipitated a change in beliefs and practices that were consistent with the *Standards.*

After entering the classroom, all of the teachers but Mr. Easterly indicated that the issue of time impinged on their teaching. The factor of time was the second most influential factor reported on the TPBS survey. In several studies in the review of literature, teachers reported time as a major barrier in implementing the *Standards* (Adams & Krockover, 1997; Cady, 2006; Cady et al., 2006; Kitchen, 2003; LaBerge & Sons, 1999). Different aspects of time included a lack of time to complete investigative activities, to cover the course of study, for teacher preparation, and to observe and be observed by colleagues. Mr. Barry, Ms. Anthony, and Ms. Chandler also discussed the time pressure of covering the course of study as a hindrance to incorporating *Standards*-based teaching strategies. Ms. Anthony's time pressure was more intense because the county expected all teachers to cover the objectives for the course in the first seven months; this policy did not allow time for students to participate in investigative projects that supported conceptual learning and connections among topics. If Ms. Anthony were in a supportive environment that was conducive to investigative, inquiry-based learning like that of the Atlanta Math Project, it would be easier for her to implement her *Standards*-based beliefs.

In connection with covering the content, Mr. Barry and Ms. Anthony expressly named high-stakes tests as a considerable factor. In Cady et al. (2006), Vicky also felt the pressure to complete the curriculum in order to promote success on high-stakes tests. The results of test scores are often directly related to administration and even tenure. A combination of pressures influenced Mr. Barry to incorporate a basically direct teaching method. These pressures included high student test scores, covering the curriculum, pleasing his administrators, and gaining tenure. Mr. Easterly's administration supported and encouraged his traditional teaching style.

The teaching tools of technology, curricula, and resources can also help or hinder teachers from implementing strategies. Mr. Easterly and Ms. Chandler had access to the most modern technologies, and they both used them daily. Ms. Chandler chose to use graphing calculators and accompanying software to enhance learning conceptually. Ms. Danforth claimed that a lack of resources was an issue for her, and this included basic needs like textbooks and access to a functioning copying machine. However, she did not make use of the graphing calculators that were available to the entire mathematics department, and she had not begun using her recently acquired technology software.

Curriculum can drive a teacher's practice. The results from the TPBS showed that curriculum was ranked the most influential factor on teachers' practices. Mr. Barry was asked to use a curriculum that supported direct and procedural teaching. If Mr. Barry's teaching situation had included a *Standards*-based curriculum with an administration that preferred *Standards*-based practices, he would have been more likely to incorporate *Standards*-based teaching practices. The research of Lloyd (1999) and Arbaugh et al. (2006) gave positive examples of this situation. Ms. Anthony and Ms. Chandler were the only two teachers who incorporated curricula that aligned with *Standards*-based principles. Ms. Chandler was deeply involved with *Standards*-based professional development and also participated in professional development to enhance the use of technology. The combination of curriculum and professional development promoted *Standards*-based beliefs and practices for Ms. Chandler. In a similar situation, the research of Roehrig and Kruse (2005) reported the change in teachers' beliefs and practices when combining *Standards*-based curricula and professional development.

In addition to teacher tools, the school climate can heavily influence teachers' practices. Like the findings in the research of Adams and Krockover (1997) and LaBerge and Sons (1999), classroom management was a major issue for several of these teachers. For Ms. Danforth and Ms. Anthony the lack of control in their classrooms severely hampered any attempts at teaching. The more open nature of investigative activities made classroom management even more important. Ms. Anthony had commented that a lack of effective class routines, especially for group activities, added to her poor classroom management. Ms. Anthony's large class sizes compounded the classroom management dilemma. The entire school climate can make implementation of *Standards*-based strategies extremely difficult; the influences of administration, curriculum, physical surroundings, lack of parental support, lack of resources, and the socioeconomic level of students all worked together to compound Ms. Danforth's difficulties. The turmoil that Ms. Danforth's school conveyed definitely added to her difficulty with classroom management. Some of the teachers in Kitchen's (2003) study experienced similar problems in high poverty schools. If Ms. Danforth could have been surrounded by a supportive teaching staff, faculty, parents, and students, she would have been more likely to implement *Standards*-based teaching practices.

Mr. Barry had excellent control of his classroom but avoided group activities because he felt that his students "could not handle activities." Mr. Easterly's orderly classroom made it easier for him to implement *Standards*-based strategies, but he chose to follow the traditional route. In Ms. Chandler's classroom, discipline was not an issue because she had established her expectations and routines early in the semester.

This study showed that many factors influence teachers' practices. The threat of job security that an administrator holds is very powerful, and that authority impacted the teachers in this study. In connection with administrators, inquiry-based teaching requires time for students to develop their own ideas, and teachers in this study felt the pressure to stay on track with their school's pacing guide. This pressure was intensified because of the importance of preparing students for high-stakes testing and the danger of their schools not attaining Adequate Yearly Progress. Additionally for Mr. Barry, the objectives of his curriculum were not in alignment of the guidelines of the *Standards*. Finally, the difficulty of managing students' behavior or even the threat of the students becoming unruly had a significant impact on teachers' practices in this study.

To What Extent Do Student Demographics Affect Teachers' Practices?

Teachers' expectations of students depending on their demographics are an important piece of teachers' beliefs and practices. The TPBS results conveyed that the factor of academic level of students had the third highest mean score as an influence on teachers' practices. Also from the TPBS, the results from the questions associated with equitable teaching indicated that on average teachers lowered their expectations of students based on student demographics. With the exception of Ms. Chandler, teachers lowered their expectations based on student demographics. Mr. Barry incorporated more student discussions and presentations in his faster-paced algebra I seminar. Mr. Barry readily admitted that he had different expectations and attitudes toward classes based on their perceived ability level. Mr. Barry's feelings were similar to those found in other research where teachers showed different expectations for different groups of students (Sztajn, 2003; Reeves et al., 2001; Thomas et al., 1998).

Mr. Easterly's expectations were impacted by the perceived ability level of his classes. Like Julie in Sztajn's research (2003), Mr. Easterly compared his current algebra IA students to students at his previous teaching assignment at another school. Unlike his previous students, he felt that his present students could not comprehend topics conceptually because of their perceived ability level.

Most of Ms. Danforth's students were classified as students of lower socioeconomic status, and Ms. Danforth felt that their weak academic background and home life hampered their ability to learn conceptually. Ms. Danforth's beliefs were similar to Teresa (Sztajn, 2003) who believed that it was not feasible to teach students of low socioeconomic status critical thinking. Ms. Danforth's felt sympathy for her student and lowered her expectations. She felt that she was "helping" them by reducing the number of problems required each day and giving plenty of time to complete them in class. Ms. Danforth's lower expectations were similar to the research by Rousseau and Tate (2003). Teachers in their study blamed the students' backgrounds and home environments for their low achievement and lowered their expectations for these students.

Ms. Anthony also exhibited lowered expectations for her slower-paced classes. Her RTOP observations reflected her use of more traditional teaching practices for those slower-paced classes. Unlike Boaler (2002), she adjusted her teaching for the slower-paced classes by incorporating a more teacher-centered style and lowered expectations. Ms. Chandler had high expectations for all students and welcomed the challenge to teach classes that were labeled "low-achieving." Even though Ms. Chandler had limited support from administrators, colleagues, and parents, she still believed in her students, and they accomplished a high level of achievement that was similar to the research in the review of literature (Gutierrez, 1999; Gutstein, 2003; Silva & Moses, 1990; Silver & Stein, 1996). Ms. Chandler believed that *Standards*-based methods were effective for all students, and she had confidence in her students' capability to grasp mathematical topics at a conceptual level. Ms. Chandler was motivated to provide the opportunity for her students to be successful at learning mathematics conceptually. She also possessed the self-efficacy to implement her ideas.

Summing up the five case studies, Ms. Chandler was the only teacher who was incorporating *Standards*-based strategies at a high level. Ms. Anthony was striving to utilize *Standards*-based teaching practices that hopefully would improve each year as her classroom management improved. With the exception of Ms. Anthony, the mathematics teachers felt that their beliefs were in alignment with their teaching practices. Several influences were instrumental in affecting participants' teaching practices. Classroom management was a factor to some extent for all five teachers. The outside influences of administration, curriculum, high-stakes testing, and colleagues were also very strong. Apart from Ms. Chandler, all of the case study participants were influenced by student demographics. The most influential demographic factors were the socioeconomic status of students and the perceived ability level of students.

In an effort to present a summary representation of the findings, I have included a summary table and flowchart. Table 23 gives a summary of the teachers' beliefs and practices. The table compares each case study participant's beliefs and practices from various data sources. These sources include TPBS *Standards*-based beliefs, *Standards*-based beliefs communicated at the interviews, TPBS *Standards*-based practices, RTOP teacher observations, *Standards*-based practices that I observed, TPBS equity responses, and actual equity practices as observed in the classroom. An adjective of "high" describes a teacher who has beliefs or practices in alignment with the *Standards.* "High" also illustrates teaching that exhibits equitable teaching beliefs and practices.

Table 23

Summary of Teachers' Beliefs and Practices

Teacher	TPBS Stds-based Beliefs	Interview Stds-based Beliefs	TPBS Std-based Practices	RTOP Teacher Observations	Observed Stds-based Practices	TPBS Equity Responses	Actual Equity Practices
Mr. Easterly	Low	Low	Low	Low	Low	Low	Low
Ms. Danforth	Low	Mixed	High	Low	Low	Low	Low
Mr. Barry	High	Mixed	Low	Mixed	Low	High	Low
Ms. Anthony	High	High	High	Mid-High	Mixed	High	Low
Ms. Chandler	High	High	Low	High	High	High	High

Figure 1 visually represents participants in the case study, their potential positive and negative influences, and their current beliefs and teaching practices relative to the *Standards*. A rectangular-shaped influence represents a potential positive influence, and a potential positive influence promotes teaching according to *Standards* guidelines. A diamond-shaped influence represents a potential negative influence, and a potential negative influence acts as a barrier for incorporating *Standards*-based teaching practices. The circles at the end of each teacher's influences state each teacher's beliefs and practices exhibited during the study. Ms. Chandler was the only teacher whose influences were all categorized as positive. She used her influences in such a way as to transform them into positive experiences. For example, her cooperating teacher during her internship practiced very traditional teaching methods, but she discovered through her own student teaching experiences that the use of technology was an effective approach to presenting mathematics topics conceptually and making connections between concepts.

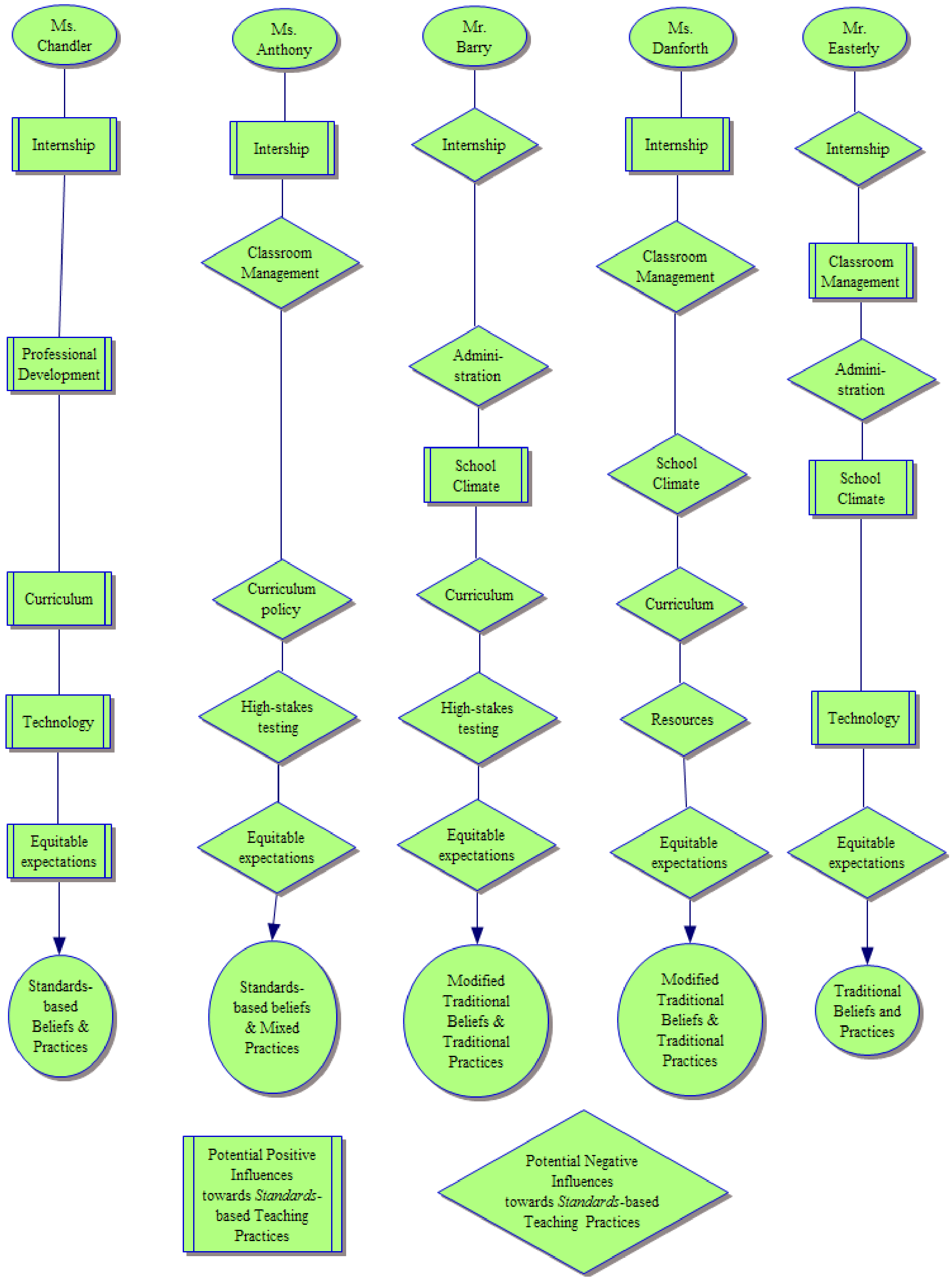

Figure 1 Flowchart Summarizing Case Studies Influences

Implications

The results of this study open the door for implications that apply to numerous stakeholders in the education process. This section will discuss implications that are relevant for teacher education programs, administrators, and teachers.

Teacher Education Programs

Teachers' beliefs are crucial to the incorporation of *Standards*-based teaching practices. Pre-service programs have a strong impact on mathematics teachers' beliefs and practices (Adams & Krockover, 1997; Brown & Borko, 1992; Cady et al., 2006; Van Zoest & Bohl, 2002). Teacher educators need to take great care to model *Standards*-based teaching strategies and provide pre-service education students with opportunities to observe effective secondary teachers implementing *Standards*-based teaching practices. According to research, the methods courses are a very important piece of pre-service mathematics education programs (LaBerge & Sons, 1999; Wilkins & Brand, 2004). Teacher educators also need to include adequate field experiences for pre-service mathematics teachers to practice incorporating *Standards*-based lessons (Brown & Borko, 1992). Adams and Krockover (1997) reported on the lack of adequate field experiences for most pre-service programs. The internship experience is the most important aspect of the fieldwork during pre-service education (Van Zoest & Bohl, 2002).

In this study, Ms. Danforth was positively affected by her methods classes and her internship, but the climate of her initial teaching placement negated her *Standards*-based beliefs and practices. Ms. Chandler had a very positive experience in her methods classes and her internship, and both had a lasting effect on her beliefs and practices. For Ms.

Anthony, her methods classes had the most impact on her beliefs and practices, but factors inhibited her ability to implement *Standards*-based practices. Mr. Barry adjusted his traditional beliefs and practices because of influences from his pre-service *Standards*-based education. However, his beliefs and practices became more traditional after he entered his own classroom. The adjustments these teachers exhibited after becoming classroom teachers show us that their support system cannot end with their pre-service education.

Teacher educators can continue to encourage pre-service teachers to incorporate *Standards*-based practices after they enter their own classrooms. Teacher educators can assure mathematics education graduates that they are available for advice and information to help make the transition into the classroom smoother. The new graduates who are geographically close may have the opportunity to participate in professional development opportunities or continue graduate studies provided by their former teacher educators. Like the professional development used in the Atlanta Mathematics Project (Hart, 2002b), teacher educators can provide onsite and offsite support. Teacher educators can make supportive workshops available throughout the school year and more extensive opportunities during the summer. Finally, teacher educators can also mentor their former students in several ways. They can set up opportunities for teachers to form discussion groups, they can offer advice for teachers with specific difficulties that they may be facing in their classrooms, they can collaboratively plan lessons, and they can observe the teachers during a lesson in order to provide constructive suggestions for improvements.

Administrators

Once mathematics teachers arrive in their own classroom, the most influential person is their immediate supervisor or administrator. The administrator holds the future of the employment of non-tenured teachers. Administrators can vastly improve the chances that mathematics teachers will incorporate *Standards*-based practices. Ms. Anthony felt the pressure from her administrators to cover the curriculum in seven months and administer monthly benchmark tests. The time pressure to cover the curriculum and the composition of the benchmark tests impeded Ms. Anthony's ability to incorporate *Standards*-based teaching practices. Choosing a curriculum that aligns with the guidelines of the *Standards* makes the incorporation of *Standards*-based teaching much more manageable for transitioning teachers. Providing professional development in conjunction with a *Standards*-based curriculum is an effective combination. The study by Roehrig and Kruse (2005) provided a positive example of this combination.

Another component to aid teachers in improving *Standards*-based teaching practices is to offer release time for teachers to collaborate with their colleagues. Gutierrez (1999) reported an example of how the administration at a school provided time for teachers to meet together and offered release time for professional development. Observing and being observed also helps teachers to support each other to implement *Standards*-based teaching practices and become reflective teachers. Another aspect of collaboration is providing an effective mentoring program for transitioning teachers. Cwikla (2004) suggested that a mentoring program is hampered by a lack of content knowledge coupled with a lack of exposure to *Standards*-based methods from more experienced teachers. None of the case studies had a mentor who aided them in implementing *Standards*-based practices.

If administrators react favorably to teachers using inquiry-based activities, teachers will not be afraid that their classroom will seem unruly or unstructured when facilitating *Standards*-based activities. Allowing mathematics teachers the freedom to experiment with *Standards*-based teaching strategies gives them “room” to breathe. Mr. Barry openly told me that his administration expected his room to be orderly, and this impacted his use of inquiry-based activities. Mr. Easterly understood that his administrators wanted a routine that students expected every day, and this routine did not include investigative activities, or students getting out of their desks. As in the collaborative efforts of the Algebra Project (Silver & Stein, 1996) and QUASAR (Silva & Moses, 1990), supportive administrators contribute to the success of reform efforts. Conversely, Kitchen’s research (2003) showed that administrators can hinder the incorporation of *Standards*-base practices.

Teachers

Established teachers who incorporate *Standards*-based strategies can act as mentors for novice mathematics teachers. Cwikla (2004) emphasized the advantages for novice teachers to have a fellow teacher with which to collaborate. Conversely in Kitchen’s research (2004), veteran teachers acted as barriers for less experienced teachers who were attempting to incorporate *Standards*-based teaching practices. For example, more experienced teachers encouraged novice teachers to incorporate a direct teaching method similar to their own and discouraged an investigative approach that is in alignment with the guideline of the *Standards.* The positive support of knowledgeable teachers who implement *Standards*-based teaching practices can help novice teachers transition into their own classrooms using *Standards*-based approaches. Unfortunately, none of the five case study participants had the opportunity to collaborate with teachers at their school who were attempting to incorporate the *Standards.*

As new teachers select their first school, they should look for a climate that is favorable for them to implement the guidelines of the *Standards.* They should consider the administration's attitude toward *Standards*-based methods, the curriculum, the current mathematics faculty's beliefs and practices, collaborative efforts, and professional development opportunities. However, if new teachers find themselves in a school climate that is not supportive of the *Standards,* they can seek their own support system and implement the *Standards* in spite of their surroundings. Alice in Van Zoest and Bohl's (2002) research and Ms. Chandler in this study are excellent examples of the impact that one teacher can have on a mathematics department at a school.

Collective Implications

I have given implications for teacher educators, administrators, and teachers. If new teachers' preservice programs, professional development, school curricula, and administrative policies are in alignment with the *Standards* guidelines, then they have a much better opportunity for successful implementation of *Standards*-based practices. Therefore, new teachers entering the workforce should carefully weigh these influences at prospective job opportunities if they want to use the guidelines of the *Standards* as a basis for teaching.

Possibilities for Future Research

This study added to the base of knowledge of mathematics teachers who have experienced a *Standards*-based pre-service education. The study was used to explore the extent to which these teachers were incorporating *Standards*-based teaching practices and influences that affected their teaching beliefs and practices. The emergent nature of qualitative research produced new questions to research. Since four of the teachers were not really using *Standards*-based practices, this shows that transitioning teachers need some vehicle for support. The future research should explore various types of assistance or combinations of encouragement to find an effective support system for transitioning teachers. To what extent would transitioning teachers' *Standards*-based practices be improved by a mentoring teacher or teacher educator? In other words, a novice teacher enters a new school with a mentor teacher who strongly supports *Standards*-based teaching practices, and this mentor aids the new teacher with helpful observations, lesson plans, manipulatives, and a positive attitude. To what extent does a novice teacher use the support of mentors to implement *Standards*-based strategies? If transitioning teachers teach in a school system with an effective mentoring program that supports the guidelines of the *Standards*, would that teacher effectively implement *Standards*-based teaching strategies? To what extent would a combination of a *Standards*-based curriculum in combination with professional development based on the *Standards'* guidelines help new teachers effectively implement the methods that they learned in their pre-service education?

Additionally, none of the case study teachers had acquired tenure. Their teaching practices might change after they attained tenure because teachers would no longer have the added pressure of not being tenured. When teachers are granted tenure, they have a great deal of job security that allows them more latitude in their teaching methods. How will the acquisition of tenure by teachers affect their practices in light of the *Standards*? Would the teachers be more willing to attempt more investigative activities that required students moving into groups and getting out of their seats for supplies or presentations? If non-tenured teachers were strongly encouraged to incorporate a more direct approach of teaching the first few years, will this experience have caused them to solidify their traditional beliefs about teaching?

Ms. Chandler was able to incorporate *Standards*-based teaching strategies with virtually no support from her school. However, her colleagues and administrators are aware of her teaching practices. After observing Ms. Chandler in her own classroom, it would also be informative to examine the impact that one strong *Standards*-based teacher has on other teachers' practices in a mathematics department.

Four of the teachers lowered expectations of their students based on student demographics. Students who have been labeled as "low-achieving" or "low socioeconomic" do not need any more barriers to their success. Projects that are designed to improve teachers' expectations of their students could promote equitable teaching practices in these teachers. Future research could include schools or professional development initiatives that provide support for teachers to instill high expectations for *all* students.

Concluding Remarks

As we have seen from this study, an effective *Standards*-based pre-service education does not offer any guarantees that teachers will promote the guidelines of the *Standards* when they become classroom teachers. The school climate is a powerful influence on mathematics teachers. An administration can set the tone for the school climate and provide support for beginning teachers such as a *Standards*-based curriculum, meaningful professional development, and release time for collaboration with their peers. Fellow teachers willing to offer assistance or advice about implementing the *Standards* can further encourage teachers. New teachers face the difficulty of adjusting into the world of keeping attendance records, dealing with parents, grading papers, and learning all the policies at their school. A supportive environment may promote implementation of *Standards*-based teaching methods. This study provided examples of teachers who were not entering a friendly atmosphere that encouraged them to employ the guidelines of the *Standards.*

The *Principles and Standards* (NCTM, 2000) describes a vision for all students. “Students exhibit different talents, abilities, achievements, needs, and interests in mathematics. Nevertheless, all students must have access to the highest-quality mathematics instructional programs” (p. 4). One teacher provided a successful example of this vision. What made her different from other teachers? Ms. Chandler had a strong beliefs system in alignment with the tenets of the *Standards* coupled with the determination to implement those beliefs. Her pre-service experience, her coursework completed to attain her master’s degree, and her deep commitment to participating in a systemic professional development project provided a combination that helped her to continually improve her implementation of the pedagogy advocated by the *Standards.* She considered each student's total environments--school, home, and extracurricular activities--when trying to connect mathematically in a conceptual way. She had confidence in her students, and lowering the bar for her students was never an option in her mind. Instead, she made the necessary adjustments to her teaching strategies and provided needed scaffolding to her students to insure their success. She invited the challenge of teaching students who were labeled "low-achieving" in a student-centered, investigative atmosphere, and she conquered it.

REFERENCES

Adams, P., & Krockover, G. (1997). Concerns and perceptions of beginning secondary science and mathematics teachers. *Science Education, 81*(1), 29–50.

Alabama Department of Education. (2008). *Algebraic connections course of study.* Retrieved July 19, 2008, from http://alex.state.al.us/standardAll.php?subject=MA&ccode=ALC&summary=3

Alper, L., Fendel, D., Fraser, S., & Rosek, D. (2003). *Interactive mathematics program.* Emeryville, CA: Key Curriculum Press.

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

Arbaugh, F., Lannin, J., Jones, D., & Park-Rogers, M. (2006). Examining instructional practices in Core-Plus lessons: Implications for professional development. *Journal of Mathematics Teacher Education, 9*(6), 517–550.

Artzt, A. (1999). A structure to enable preservice teachers of mathematics to reflect on their teaching. *Journal of Mathematics Teacher Education, 2(2)*, 143–166.

AzTEC. (2002). *About RTOP*. Retrieved February 13, 2008, from http://physicsed.buffalostate.edu/AZTEC/rtop/RTOP_full/about_RTOP.html

Ball, D. (1990). Prospective elementary and secondary teachers’ understanding of division. *Journal for Research in Mathematics Education, 21*, 132–143.

Ball, D. (1996). Teacher learning and the mathematics reforms. *Phi Delta Kappan, 77*(7), 500–508.

Ball, D. L. (2003). *Mathematical proficiency for all students: Toward a strategic research and developmental program in mathematics education*. Santa Monica, CA: RAND.

Ball, D., Ferrini-Mundy, J., Kilpatrick, J., Milgram, J., Schmid, W., & Schaar, R. (2005). Reaching for common ground in K-12 mathematics education. Retrieved July 18, 2008, from http://www.maa.org/common-ground/cg-report2005.html

Baroody, A., & Coslick, R. (1998). *Fostering children's mathematical power: An investigative approach to K-8 mathematical power.* Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Battista, M. (1994). Teachers' beliefs and the reform movement in mathematics education. *Phi Delta Kappan, 75*(6), 462–467.

Beswick, K. (2007). Teachers' beliefs that matter in secondary mathematics classrooms. *Educational Studies in Mathematics, 65*(1), 95–120.

Biological Science Curriculum Study. (2005). *BCBS biology: A human approach.* Dubuque, IA: Kendall/Hunt Publishing.

Boaler, J. (2002). Learning from teaching: Exploring the relationship between reform curriculum and equity. *Journal for Research in Mathematics Education, 33,* 239–258.

Bogdan, R., & Biklan, S. (1998). *Qualitative research for education: An introduction to theory and methods.* Needham Heights, MA: Allyn & Bacon.

Brown, C., & Borko, H. (1992). Becoming a mathematics teacher. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 209–239). New York: Macmillan Publishing Co, Inc.

Bruner, J. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Cady, J. (2006). Implementing reform practices in a middle school classroom. *Mathematics Teaching in the Middle School, 11*(9), 460–466.

Cady, J., Meier, S., & Lubinski, C. (2006). Developing mathematics teachers: The transition from preservice to experienced teacher. *Journal of Educational Research, 99*(5), 295–305.

Carpenter, T., & Fennema, E. (1988). Research and cognitively guided instruction. In T. Carpenter & S. Lamon (Eds.), *Integrating research on teaching and learning mathematics* (pp. 2–17). Madison, WI: University of Wisconsin, Wisconsin Center for Educational Research.

Carpenter, T., Fennema, E., Peterson, P., Chiang, C., & Loef, M. (1989). Using knowledge of children's mathematics thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26*(4), 499-531.

Chapman, O. (2002). Belief structure and inservice high school mathematics teacher growth. In G. Leder, E. Pehkonen & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 177–193). Dordrecht, Netherlands: Kluwer Academic Publishers.

Clarke, D. (1997). The changing role of the mathematics teacher. *Journal for Research in Mathematics Education, 28*(3), 278–308.

Cooney, T., Shealy, B., & Arvold, B. (1998). Conceptualizing belief structures of preservice secondary mathematics teachers. *Journal for Research in Mathematics Education, 29*(3), 306–333.

Coxford, A., Fey, J., Hirsch, C., Schoen, H., Burrill, G., Hart, E., et al. (1997). *Contemporary mathematics in context: A unified approach (Course I)*. Chicago, IL: Everyday Learning.

Coxford, A., Fey, J., Hirsch, C., Schoen, H., Burrill, G., Hart, E., et al. (1998). *Contemporary mathematics in context: A unified approach (Course 2)*. Chicago, IL: Everyday Learning.

Coxford, A., Fey, J., Hirsch, C., Schoen, H., Burrill, G., Hart, E., et al. (1999). *Contemporary mathematics in context: A unified approach (Course 3)*. Chicago, IL: Everyday Learning.

Coxford, A., Fey, J., Hirsch, C., Schoen, H., Burrill, G., Hart, E., et al. (2001). *Contemporary mathematics in context: A unified approach (Course 4)*. Chicago, IL: Everyday Learning.

Cresswell, J. (2007). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications.

Creswell, J., & Plano Clark, V. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.

Cwikla, J. (2004). Less experienced mathematics teachers report what is wrong with their professional support system. *Teachers & Teaching, 10*(2), 181–197.

Darling-Hammond, L. (2003). Keeping good teachers. *Educational Leadership, 60*(8), 6–13.

DeBellis, V., & Goldin, G. (2006). Affect and meta-affect in mathematical problem solving: A representational perspective. *Educational Studies in Mathematics, 63*(2), 131–147.

Department for Education. (1995). *Mathematics in the national curriculum.* HMSO, London: Author.

Department for Education and Employment. (2001). *Key stage 3 national strategy framework for teaching mathematics: Years 7, 8 and 9.* London: Author.

Eisner, E. (1998*). The enlightened eye*. Upper Saddle River, NJ: Prentice-Hall.

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*(6), 1013–1055.

Fendel, D. (1999). *Interactive mathematics program: Cookies.* Emeryville, CA: Key Curriculum Press.

Ferrini-Mundy, J. (2004). What does it mean to be standards-based? Issues in conceptualizing, measuring, and studying alignment with standards. In F. Lester and J. Ferrini-Mundy (Eds.), *Proceedings of the NCTM Research Catalyst Conference* (pp. 25–32). Reston, VA: NCTM.

Fey, J., & Graeber, A. (2003). From the New Math to the *Agenda for Action.* In G. Stanic, G & J. Kilpatrick (Eds.)*, A history of school mathematics* (pp. 521–558). Reston, VA: National Council of Teachers of Mathematics.

Friel, S., Rachlin, S., & Doyle, D. (2001). *Navigating through algebra in grades 6–8*. Reston, VA: National Council of Teachers of Mathematics.

Frykholm, J. (2004). Teachers' tolerance for discomfort: Implications for curricular reform mathematics. *Journal of Curriculum & Supervision, 19*(2), 125–149.

Furinghetti, F., & Pehkonen, E. (2002). Rethinking characterization of beliefs. In G. Leder, E. Pehkonen & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 39–57). Dordrecht, Netherlands: Kluwer Academic Publishers.

Goldin, G. (2002). Affect, meta-affect, and mathematical beliefs structures. In G. Leder, E. Pehkonen & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 59–72). Dordrecht, Netherlands: Kluwer Academic Publishers.

Gómez-Chacón, I. (2000). Affective influences in the knowledge of mathematics. *Educational Studies in Mathematics, 43*(2), 149–168.

Green, T. (1971). *The activities of teaching.* New York: McGraw-Hill.

Green, S., Salkind, N., & Akey, T. (2000). *Using SPSS for Windows: Analyzing and understanding data.* Upper Saddle River, NJ: Prentice-Hall.

Grouws, D. (Ed.). (1992). *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics*. New York, NY: Macmillan Publishing Co, Inc.

Gutierrez, R. (1999). Advancing Urban Latina/o Youth in Mathematics: Lessons from an Effective High School Mathematics Department. *Urban Review*, *31*(3), 263–281.

Gutstein, E. (2003). Teaching and Learning Mathematics for Social Justice in an Urban, Latino School. *Journal for Research in Mathematics Education, 34*(1), 37–73.

Gutstein, E., Lipman, P., Hernandez, P., & de los Reyes, R. (1997). Culturally relevant mathematics teaching in a Mexican American context. *Journal for Research in Mathematics Education, 28*(6), 709–737.

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

Hargreaves, A., & Fullan, M. (1992). *Understanding teacher development*. New York: Falmer Press.

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

Hart, L. (2002a). Preservice teachers' beliefs and practice after participating in an Integrated Content/Methods Course. *School Science and Mathematics, 102*(1), 4–14.

Hart, L. (2002b). A four year follow-up study of teachers' beliefs after participating in a teacher enhancement project. In G. Leder, E. Pehkonen & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 161–176). Dordrecht, Netherlands: Kluwer Academic Publishers.

Hart, L., & Najee-ullah, D. (1997). *The reflective teaching model*. Atlanta, GA: Galileo, Inc. CDrom.

Hirsch, C., Coxford, A., Fey, J., & Schoen, H. (1995). The Core-Plus Mathematics Project: Teaching sensible mathematics in sense-making ways. *Mathematics Teacher, 88*, 694–700.

Huntley, M., Rasmussen, C., Villarubi, R., Sangtong, J., & Fey, J. (2001). Effects of *Standards*-based mathematics education: A study of the Core-Plus mathematics project algebra and functions strand. *Journal of Research for Mathematics Educators, 31(3)*, 328–361.

Irwin, K. (2001). Using everyday knowledge of decimals to enhance understanding. *Journal of Research in Mathematics Education, 32*(4), 399–420.

Johnson, B., & Christensen, L. (2004). *Educational research: Quantitative, qualitative, and mixed approaches* (2nd ed.). Boston, MA: Pearson Education., Inc.

Jones, W., & Kottler, J. (2006). *Understanding research: Becoming a competent and critical consumer.* Upper Saddle River, NJ: Pearson Education.

Keiser, J., & Lambdin, D. (1996). The clock is ticking: Time constraint issues in mathematics teaching reform. *Journal of Educational Research, 90*(1), 23–31.

Key Curriculum Press. (2007). *A brief description of IMP*. Retrieved May 11, 2008, from http://www.mathimp.org/general_info/intro.html

Key Curriculum Press Technologies. (*2008*).*Welcome to the Geometer's Sketchpad resource center.* Retrieved May 11, 2008, from http://www.dynamicgeometry.com/

Kitchen, R. S. (2003, April). *Transforming Mathematics Education: Barriers to Reform in High Poverty, Diverse Schools*. Paper presented at the Third International Conference on Mathematics Education and Society, Helsingor, Denmark.

Klein, D. (2000). Math problems: Why the U.S. Department of Education's recommended math programs don't add up. *American School Board Journal, 187*(4), 52–57.

LaBerge, V., & Sons, L. (1999). First-year teachers' implementation of the NCTM *Standards*. *Primus, 9*(2), 139.

Lambdin, D., & Walcott, C. (2007). Changes through the years: Connections between psychological learning theories and the school mathematics curriculum. In W. G.

Martin M. E. Strutchens (Eds.), *The learning of mathematics, Sixty-Ninth Yearbook* (pp. 3–26). Reston, VA: National Council of Teachers of Mathematics.

Lappan, G., Fey, J., Fitzgerald, W., Friel, S., & Phillips, G. (2004). *Connected mathematics.* Upper Saddle River, NJ: Pearson Education.

Larson, N., Hake, S., & Wrigley, P. (2007). *Saxon math.* Orlando, FL: Saxon Publishers.

Leatham, K. (2006). Viewing mathematics teachers' beliefs as sensible systems. *Journal of Mathematics Teacher Education, 9*(1), 91–102.

Leder, G. (1993, July). *Reconciling affective and cognitive aspects of mathematics learning: Reality or a pious hope?* Paper presented at the 17th annual meeting of International Conference for the Psychology of Mathematics Education, Tsukuba, Japan.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage Publications.

Lloyd, G. (1999). Two teachers' conceptions of a reform-oriented curriculum: Implications for mathematics teacher development. *Journal of Mathematics Teacher Education, 2*(3), 227–252.

Lloyd, G., & Wilson, M. (1998). Supporting innovation: The impact of a teacher's conceptions of functions on his implementation of a reform curriculum. *Journal for Research in Mathematics Education, 29,* 248–274.

Lubienski, S. (2000). A clash of social class cultures? Students' experiences in a discussion-intensive seventh-grade mathematics classroom. *Elementary School Journal, 100*(4), 377–403.

Lubienski, S. (2002). Research, reform, and equity in U.S. mathematics education. *Mathematical Thinking & Learning, 4*(2/3), 103–125.

Lutwiller, B. (2002). *Making sense of fractions, ratios, and proportions: Classroom activities, 2002 Yearbook of the National Council of Teachers of Mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Ma, X. (1999). A meta-analysis of the relationship between anxiety towards mathematics and achievement. *Journal for Research in Mathematics Education, 30*(5), 520–540.

Mathematically correct. (2008). Retrieved August 15, 2008, from http://mathematicallycorrect.com/

Mathematically sane: Promoting the rational reform of mathematics education. (2008). Retrieved August 15, 2008, from http://mathematicallysane.com/home.asp

McKnight, C., Travers, K., & Dossey, J. (1985). Twelfth grade mathematics in U.S. high schools: A report from the Second International Mathematics Study. *Mathematics Teacher, 78*(4), 292–300.

McLeod, D. (1992). Research on affect in mathematics education: A reconceptualization. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 575–596). New York, NY: Macmillan Publishing Co, Inc.

McMillan, J., & Wergin, J. (2006). *Understanding and evaluating educational research* (3rd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Means, B., & Knapp, M. (1991). Cognitive approaches to teaching advanced skills to educationally disadvantaged students. *Phi Delta Kappan, 73,* 282–289.

Mehrens,W., & Lehmann, I. (1987). *Using standardized tests in education* (4th ed.). New York: Longman.

Merriam, S. B. (1998). *Qualitative research and case study applications in education.* San Francisco: Jossey-Bass Publishers.

Michigan State University. (2006). *Connected mathematics project.* Retrived May 11, 2008, from http://connectedmath.msu.edu/ataglance.html

Muhr, T., & Friese, S. (2004). *User's Manual for Atlas.ti (v. 5.0)*. Bohemia, NY: Research Talk.

Nathan, M., & Koedinger, K. (2000a). Teachers' and researchers' beliefs about the development of algebraic reasoning. *Journal for Research in Mathematics Education, 31*(2), 168–190.

Nathan, M., & Koedinger, K. (2000b). An investigation of teachers' beliefs of students' algebra development. *Cognition & Instruction, 18*(2), 209–237.

Nathan, M., & Petrosino, A. (2003). Expert blind spot among preservice teachers. *American Educational Research Journal, 40*(4), 905–928.

National Center for Educational Statistics. (2003). *The nation's report card: Mathematics highlights 2003.* Washington DC: U. S. Department of Education.

National Center for Research in Mathematical Sciences Education & Freudenthal Institute. (Eds.). (1995). *Mathematics in context: A connected curriculum for grades 5–8*. Chicago: Encyclopedia Britannica Educational Corporation.

National Council of Teachers of Mathematics. (1980). *An agenda for action*. Reston, VA: Author.

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

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

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

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2008). *Equity in mathematics education.* Retrieved August 31, 2008, from http://www.nctm.org/about/content.aspx?id=13490

National Council on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Government Printing Office.

National Research Council. (1989). *Everybody counts*: *A report to the nation on the future of mathematics education*. Washington, DC: National Academy Press.

Nichols, S., & Berliner, D. (2008). Testing the joy out of learning. *Educational Leadership, 65(6),* 14–18.

No Child Left Behind Act of 2001, Pub. L. No. 107-110, 115 Stat. 1425. (2002). Retrieved May 5, 2008, from http://www.ed.gov/legislation/ESEA02/

Noddings, N. (2005). What does it mean to education the whole child? *Educational Leadership, 63*(1), 8–13.

Pajares, F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62,* 307–332.

Pehkonen, E. (1998). On the concept ‘mathematical belief’. In E. Pehkonen & G. Töner (Eds.), *The state-of-art in mathematics-related belief research. Results of MAVI activities* (pp. 37–72). University of Helsinki. Department of Teacher Education. Research Report 195.

Peterson, P., Fennema, E., Carpenter, T., & Loef, M. (1989). Teacher’s pedagogical content beliefs in mathematics. *Cognition & Instruction, 6*(1), 1–40.

Philipp, R. (2007). Mathematics teachers’ beliefs and affect. In F. Lester (Ed.), *Second handbook of research on mathematices teaching and learning* (Vol. 1, pp. 257–318). Reston, VA: National Council of Teachers of Mathematics.

Phillippou, G., & Christou, C. (1998). The effects of a preparatory mathematics program in changing prospective teachers’ attitudes towards mathematics. *Educational Studies in Mathematics, 35,* 189–206.

Quirk, B. (2005) *Understanding the original NCTM* Standards*: They’re not genuine math standards.* Retrieved July 18, 2008, from http://192.220.64.102/TruthK12.html

Reeves, D. J., Boyle, W. F., & Christie, T. (2001). The relationship between teacher assessments and pupil attainments in standard test tasks at Key Stage 2, 1996–98. *British Educational Research Journal, 27*(2), 141–160.

Reyes, R. (2002). *Reform math education.* Retrieved July 18, 2008, from http://www.csmonitor.com/2002/1115/p09s01-coop.html

Riordan, J., & Noyce, P. (2001). The impact of two *Standards*-based mathematics curricula on student achievement in Massachusetts. *Journal of Research for Mathematics Education, 32*(4), 368–398.

Roehrig, G., & Kruse, R. (2005). The role of teachers' beliefs and knowledge in the adoption of a reform-based curriculum. *School Science & Mathematics, 105*(8), 412–422.

Rokeach, M. (1968). *Beliefs, attitudes, and values: A theory of organization and change.* San Francisco: Jossey-Bass.

Romberg, T. A. (1992). Further thoughts on the standards: A reaction to Apple. *Journal for Research in Mathematics Education*, *23*(5), 432–437.

Ross, J., McDougall, D., & Hogaboam-Gray, A. (2002). Research on reform in mathematics education, 1993–2000. *Alberta Journal of Educational Research*, 48(2), 122–138.

Rousseau, C., & Powell, A. (2005). Understanding the significance of context: A framework to examine equity and reform in secondary mathematics. *High School Journal, 88*(4), 19–31.

Rousseau, C., & Tate, W. (2003). No time like the present: Reflecting on equity in school mathematics. *Theory into Practice*, 42(3), 210–216.

Saxon Publishers. (2007). Saxon: A Harcourt Achieve imprint. Retrieved April 20, 2008, from http://saxonpublishers.harcourtachieve.com/

Schoenfeld, A. (1998). Toward a theory of teaching-in-context. *Issues in Education, 4(1),* 1–94.

Schoenfeld, A. (2002). Making mathematics work for all students: Issues of standards, testing, and equity. *Educational Researcher, 31*(1), 13–25.

Schoenfeld, A. (2004). Math wars. *Educational Policy, 18*(1), 253–286.

Schubert, W., & Ayers, W. (1992). *Teacher lore: Learning from our own experiences.* New York: Teachers College Press.

Schwandt, T. (2007). *The Sage dictionary of qualitative inquiry*. Thousand Oaks, CA: Sage Publications.

Secada, W. (2003) Conceptions of equity in the teaching of science. Unpublished manuscript.

Shannon, D., & Davenport, M. (2001). *Using SPSS to solve statistical problems: A self-instruction guide.* Upper Saddle River, NJ: Prentice-Hall.

Shiang, C., & McDaniel, E. (1989). *The effects of questioning on thinking processes.* Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Shulman, L., and Sykes, G. (1983). *The handbook of teaching and policy*. New York: Longman.

Silva, C., & Moses, R. (1990). The Algebra Project: Making middle school mathematics count. *Journal of Negro Education*, 59(3), 375–391.

Silver, E., & Stein, M. (1996). The QUASAR project: The “revolution of the possible” in mathematics instructional reform in urban middle schools. *Urban Education*, 30, 476–521.

Singh, K., & Ozturk, M. (2000). Effect of part-time work on high school mathematics and science course taking. *The Journal of Educational Research, 94*(2), 67–74.

SMART Technologies. (2008). *The SMART Board interactive whiteboards*. Retrieved May 12, 2008, from http://www2.smarttech.com/st/en-US/Products/SMART+Boards/

Smith, J. P. (1996). Efficacy and teaching mathematics by telling: A challenge for reform. *Journal for Research in Mathematics Education, 27*(4), 387–402.

Stake, R. (2006). *Multiple case study research*. New York: The Guilford Press.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Sztajn, P. (2003). Adapting reform ideas in different mathematics classrooms: Beliefs beyond mathematics. *Journal of Mathematics Teacher Education, 6(1),* 53–75.

Tate, W. (2004). What is a standard? In F. Lester and J. Ferrini-Mundy (Eds.), *Proceedings of the NCTM Research Catalyst Conference* (pp. 25–32). Reston, VA: NCTM.

Texas Instruments. (2008). *TI-SmartView emulator software.* Retrieved May 11, 2008, from http://education.ti.com/educationportal/sites/US/productDetail/us_smartview.html

Thomas, T. (1994). *Current reform efforts in mathematics education. ERIC/CSMCC.* Columbus, OH: ERIC Clearinghouse for Science Mathematics and Environmental Education. (ERIC Document Reproduction Service No. ED 3726 969)

Thomas, S., Madaus, G., Raczek, A., & Smees, R. (1998). Comparing teacher assessment and standard task results in England: The relationship between students' characteristics and attainment. *Assessment in Education: Principles, Policy & Practice, 5*(2), 213–254.

Thompson, A. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A* *project of the National Council of Teachers of Mathematics* (pp. 127–146). New York, NY: Macmillan Publishing Co, Inc.

Van de Walle, J. (2007). *Elementary and middle school mathematics: Teaching developmentally, sixth edition.* New York: Longman.

Van Zoest, L., & Bohl, J. (2002). The role of reform curricular materials in an internship: The case of Alice and Gregory. *Journal of Mathematics Teacher Education, 5*(3), 265–288.

Von Glasersfeld, E. (1990). An exposition of constructivism: Why some like it radical. In R. Davis, C. Maher & N. Noddings (Eds.), *Constructivist views on the teaching and learning of mathematics* (pp. 19–29). Reston, VA: National Council of Teachers of Mathematics.

Watson, A., & de Geest, E. (2005). Principled teaching for deep progress: Improving mathematical learning beyond methods and materials. *Educational Studies in Mathematics, 58*(2), 209–234.

Weiss, I., Pasley, J., Smith, P., Banilower, E., & Heck, D. (2003). *Looking inside the classroom: A study of K-12 mathematics and science education in the United States*. Chapel Hill, NC: Horizon Research Incorporated.

West, M., & Davis, F. (2005). *Research related to the Algebra Project's intervention to improve student learning in mathematics* [Electronic Version]. Retrieved November 4, 2006, from http://thealgebraproject.org/files/05AP_Eval_Report.pdf

Wilkins, J., & Brand, B. (2004). Change in preservice teachers' beliefs: An evaluation of a mathematics methods course. *School Science & Mathematics*, 104*(5)*, 226–232.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Zollman, A., & Mason, E., (1992). The Standards' beliefs instrument (SBI): Teachers' beliefs about the NCTM Standards. *School Science and Mathematics,* 92(7), 359–364.

APPENDICES

APPENDIX A

TEACHERS' PRACTICES AND BELIEFS SURVEY (TPBS)

Teacher Survey

Note:
In order to maintain the confidentiality of the university reform initiative program along with its participants, identifying information has been intentionally deleted from the following survey.

Survey to Study the Beliefs and Practices of Secondary Mathematics Teachers

The purpose of this survey is to research the beliefs and practices of secondary mathematics teachers. Section A - B survey questions about your teaching and learning beliefs and practices. Section C gathers background information. This survey is part of a research project studying secondary mathematics education graduates.

This survey should take 20-30 minutes. If you feel that a question does not apply to you, simply leave the question blank.

SECTION A – Your Beliefs About Teaching and Learning Mathematics

The following questions are to be answered according to the degree to which you agree or disagree with each of the sentences.

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a.	I feel relaxed and confident when teaching mathematics.	○	○	○	○	○
b.	Teachers should ensure that students experience success in mathematics by clearly explaining and modeling how to complete each day's assignment to their students.	○	○	○	○	○
c.	Teachers should ensure that students experience success in mathematics by continually providing feedback including, if necessary, supplementary detailed explanation of how to solve a problem.	○	○	○	○	○
d.	It is important for students to figure out how to solve mathematics problems for themselves.	○	○	○	○	○
e.	Time should be spent practicing mathematical procedures before students spend much time solving mathematics problems.	○	○	○	○	○
f.	If the class is going to use a model of a mathematical situation, I usually prefer first to show my students how to use the model.	○	○	○	○	○
g.	In a mathematics class, each student's solution process should be accepted and valued.	○	○	○	○	○
h.	Students learn mathematics best from their teacher's demonstrations and explanations.	○	○	○	○	○
i.	Students should have many informal experiences with a mathematical concept before they are expected to master that concept.	○	○	○	○	○

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
j.	Teachers must provide a variety of mathematics problems addressing that idea and challenge the students to figure out how to solve those problems.	○	○	○	○	○
k.	No student should associate mathematics with frustration, so a teacher should limit the questions he or she asks of the student to those that the teacher is reasonably confident that the student can answer correctly.	○	○	○	○	○
l.	When planning a mathematics lesson, I know that I am able to provide mathematics activities that are relevant to my students' lives.	○	○	○	○	○
m.	If a student is going to be a good problem solver, then it is important for that student to know how to follow directions.	○	○	○	○	○
n.	Students should understand the meaning of a mathematical concept before they memorize the definitions and procedures associated with that concept.	○	○	○	○	○
o.	Teachers should model and demonstrate mathematical procedures and then, ideally, time should be allowed for the students to have the opportunity to practice those procedures.	○	○	○	○	○
p.	I feel confident that I can produce a solution to any mathematical question a student may have without referring to the textbook's solution.	○	○	○	○	○
q.	I feel most comfortable when I first model an activity, then provide some practice, immediate feedback, clarify what the assignment is and how I expect it to be completed.	○	○	○	○	○
r.	Students achieve mathematical understanding through the direct personal experience of figuring out their own solutions to problems and then verifying their thinking for themselves.	○	○	○	○	○
s.	When students are grouped for instruction on the basis of their past mathematical performance, each student may then receive the level of mathematics instruction that is most appropriate for that student.	○	○	○	○	○
t.	Rather than demonstrating how to solve a problem, a teacher should allow students to figure out their own ways of solving mathematics problems and to explain their own ways of solving mathematics problems, including word problems.	○	○	○	○	○
u.	Students will not understand a mathematical concept until they have memorized the definitions and procedures associated with that concept.	○	○	○	○	○

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
v.	When I work with a small group of students during a mathematics lesson, I know that I will be able to assess their understanding as I observe them working on mathematical problems and interacting with each other to complete a mathematics task.	○	○	○	○	○
w.	I feel that most mathematics teachers in my grade level have a better understanding of mathematics than I have.	○	○	○	○	○
x.	Teachers should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages greater student-student and student-teacher interaction.	○	○	○	○	○

SECTION B - Information About The Mathematics Classes You Teach

For this section of the survey, I would like you to report on a specific MATHEMATICS class that you teach. This class will be called your TARGET CLASS. To identify your TARGET CLASS, please read the following instructions carefully. Your **FIRST CLASS OF THE DAY** is your TARGET CLASS (e.g., 1st period Monday, 3rd period Monday, etc.).

Class Information

1. How many different subject or course preparations are you responsible for?

1	2	3	4	5 or more
O	O	O	O	O

2. What courses will you teach during the 2007-08 school year. (mark all that apply)

O	Math-7	O	Geometry
O	Math-8	O	Pre-Calculus
O	Pre-Algebra	O	Calculus (AP or regular)
O	Algebra I	O	Statistics
O	Algebra I-A	O	Finite Math
O	Algebra I-B	O	Career Math or equivalent
O	Algebra II	O	Other (please list) __________________

Please answer the following questions regarding your TARGET MATH CLASS.

3. What is the grade level(s) of the students in your TARGET MATH CLASS?

7	8	9	10	11	12
O	O	O	O	O	O

4. On a typical day, which choice better describes your TARGET MATH CLASS?

O 7-period day
O Block
O Alternating block
O Other List ___________________________________

5. How many students are in your TARGET MATH CLASS?

For example, if you had 18 students: Number of students in your class:

1	8			
0 O	0 O		0 O	0 O
1 ●	1 O		1 O	1 O
2 O	2 O		2 O	2 O
3 O	3 O		3 O	3 O
4 O	4 O		4 O	4 O
	5 O			5 O
	6 O			6 O
	7 O			7 O
	8 ●			8 O
	9 O			9 O

6. Please describe the range of student ability in your TARGET MATH CLASS. (mark only one)

O Mostly below grade level
O Mostly below or at grade level
O A balance of students at, below, and above grade level
O Mostly at or above grade level
O Mostly above grade level

7. Approximately the number of students in this TARGET MATH CLASS are:

	None	1-2	3-5	6-9	10 or more	Not sure
Title 1 Math	O	O	O	O	O	O
Students with disabilities	O	O	O	O	O	O
ESL students	O	O	O	O	O	O
Gifted and talented	O	O	O	O	O	O
African-Americans	O	O	O	O	O	O

8. Approximately what proportion of students in this TARGET MATH CLASS do you expect to:

	None	Some	About half	Most	Almost all	Not sure
Graduate from high school	O	O	O	O	O	O
Attend a trade school or technical school	O	O	O	O	O	O
Attend a junior college	O	O	O	O	O	O
Attend a four-year college or university	O	O	O	O	O	O

9. Think about how you teach the students in this TARGET math class. For each sentence, please darken the circle that says how true the sentence is for you.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. I make a special effort to recognize students' individual progress	O	O	O	O	O
b. I give special privileges to students who do the best work.	O	O	O	O	O
c. I call attention to students' work that is incorrect or poorly written as an example of what not to do.	O	O	O	O	O
d. I consider how much students have improved when I give them report card grades.	O	O	O	O	O

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
e.	I display the work of the highest achieving students as an example.	O	O	O	O	O
f.	I make an example of students who are not prepared to answer questions in class.	O	O	O	O	O
g.	I emphasize the importance of learning from mistakes.	O	O	O	O	O
h.	I help students understand how their performance compares to others.	O	O	O	O	O
i.	I tell my students it is important not to be the worst at doing math.	O	O	O	O	O
j.	I stress to students that it's important to understand each concept, not just get the right answer.	O	O	O	O	O
k.	I encourage students to compete with each other.	O	O	O	O	O
l.	I stress to students how important it is to avoid making mistakes on their work.	O	O	O	O	O
m.	I encourage students to find several ways to solve each problem.	O	O	O	O	O
n.	I point out students who do well as a model for the other students.	O	O	O	O	O
o.	I tell students it is important to show others they can do the work in math.	O	O	O	O	O
p.	I tell my students that learning should be fun.	O	O	O	O	O

10. Think about your TARGET CLASS **THIS PAST WEEK**. About how often do students in the TARGET CLASS take part in each of the following types of activities as part of their mathematics instruction?

Never
Rarely (a few minutes one or two days)
Sometimes (a major activity for one day or a few minutes for several days)
Often (the activity is used most days in a significant way)
All or almost all math lessons

		Never	Rarely	Some-times	Often	All or Almost All
a.	Use a computer to practice their math	○	○	○	○	○
b.	Use a calculator or computer to explore a concept or extend the understanding of a concept or skill	○	○	○	○	○
c.	Promote student participation in small group discussions to help them make sense of mathematics	○	○	○	○	○
d.	Listen to me lecture about math	○	○	○	○	○
e.	Copy notes or problems off the board	○	○	○	○	○
f.	Give a written explanation about how they solved a math problem	○	○	○	○	○
g.	Present how they solved a problem to the class	○	○	○	○	○
h.	Use wooden or plastic blocks, rods, shapes or other objects to solve a math problem	○	○	○	○	○
i.	Work on one math problem or question for more than 10 minutes	○	○	○	○	○
j.	Do 10 or more practice problems by themselves	○	○	○	○	○
k.	Memorize formulas and rules for a test or quiz	○	○	○	○	○
l.	Do math problems that require critical thinking	○	○	○	○	○
m.	Think about why something in math class is true	○	○	○	○	○
n.	Do math projects or investigations that take several days to complete	○	○	○	○	○

	Never	Rarely	Some-times	Often	All or Almost All
o. Apply math situations to life outside of school	O	O	O	O	O
p. Take tests where they have to explain their answers	O	O	O	O	O
q. Take multiple-choice tests	O	O	O	O	O
r. Complete many math problems quickly	O	O	O	O	O
s. Practice to take a standardized-test, like the SAT-10 or AHSGE	O	O	O	O	O

11. How much time ***in the last week*** did you spend preparing students in your TARGET MATH CLASS for standardized tests, such as the SAT-10 or the HSGE? (mark only one)

O 1 day or less O 2 days O 3 days O 4 days O Every day

12. For each of those days spent preparing students in your TARGET MATH CLASS for standardized tests, how much time on average was spent each day?

O Less than 5 minutes O 5–10 minutes O 11–30 minutes O More than 30 minutes

13. Please indicate the extent to which you agree with each of the following regarding the influence you have on student learning in your class.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a. When a student does better than usual, many times it is because I exerted a little extra effort.	O	O	O	O	O
b. The hours in my class have little influence on students compared to the influence of the home environment.	O	O	O	O	O
c. The amount a student can learn is primarily related to family background.	O	O	O	O	O
d. If students aren't disciplined at home, they aren't likely to accept discipline at school.	O	O	O	O	O

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
e.	When a student is having difficulty with an assignment, I am usually able to adjust it to his/her level.	○	○	○	○	○
f.	When a student gets a better grade than he/she usually gets, it is because I found better ways of teaching.	○	○	○	○	○
g.	When I really try, I can get through to most difficult students.	○	○	○	○	○
h.	A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on achievement.	○	○	○	○	○
i.	When the grades of my students improve, it is usually because I found more effective teaching strategies.	○	○	○	○	○
j.	If a student masters a new concept quickly, this might be because I knew the necessary steps in teaching that concept.	○	○	○	○	○
k.	If parents would do more for their children, I could do more.	○	○	○	○	○
l.	If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.	○	○	○	○	○
m.	If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him/her quickly.	○	○	○	○	○
n.	The influence of a student's home experiences can be overcome by good teaching.	○	○	○	○	○
o.	If one of my students couldn't do a class assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty.	○	○	○	○	○
p.	Even a teacher with good teaching abilities may not reach many students.	○	○	○	○	○

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
q. When it comes right down to it, a teacher can't do much because most of a student's performance depends on his/her home environment.	○	○	○	○	○
r. If I really try, I can get through to even the most difficult or unmotivated students.	○	○	○	○	○

14. To what extent do the following factors influence your selection of teaching methods and activities:

	Guides my teaching practices	Significantly influences	Influences only slightly	Not at all
a. Administrators	○	○	○	○
b. Amount of class time to cover essential topics	○	○	○	○
c. Amount of teacher preparation time	○	○	○	○
d. Curriculum	○	○	○	○
e. Colleagues	○	○	○	○
f. SRMT Testing	○	○	○	○
g. HSGE	○	○	○	○
h. Socioeconomic status of students	○	○	○	○
i. Academic level of class (Honors, inclusion, etc.)	○	○	○	○
j. Professional development that I have attended	○	○	○	○

15. In two or three sentences, describe some of your specific strategies for teaching mathematics that are the most effective. Include any negative or positive influences that affect your ability to implement the strategies that you described.

____
____
____
____

SECTION C – Background Information

1. How many years have you: (round up to the nearest year)

Example:		**Years taught at your current school?**		**Total years as a teacher?**	
2	5				
0 O	0 O	0 O	0 O	0 O	0 O
1 O	1 O	1 O	1 O	1 O	1 O
2 ●	2 O	2 O	2 O	2 O	2 O
3 O	3 O	3 O	3 O	3 O	3 O
4 O	4 O	4 O	4 O	4 O	4 O
	5 ●		5 O		5 O
	6 O		6 O		6 O
	7 O		7 O		7 O
	8 O		8 O		8 O
	9 O		9 O		9 O

2. What is the highest level of education you have completed?
   - O Bachelor's degree
   - O Bachelor's with additional graduate credits
   - O Master's degree
   - O Master's with additional graduate credits
   - O Specialist
   - O Doctorate

3. Are you: O Female O Male

4. Are you:
   - O African-American (Black)
   - O Asian-American
   - O Biracial/Multiethnic
   - O Hispanic
   - O Native American
   - O White, Non-Hispanic
   - O Other (please specify): _________________________

5. Approximately how much time overall have you spent in professional development during the past year?

Less than 20 hours	20–40 hours	41–80 hours	81–120 hours	121–160 hours	Over 160 hours
O	O	O	O	O	O

6. Briefly describe any professional development in which you have participated in the last two years that was not inhouse:

APPENDIX B

INTERVIEW QUESTIONS

Initial Interview with Case Study Teachers

How have your beliefs and practices toward mathematics changed since your preservice education?

1. How has your philosophy toward teaching mathematics changed since the completion of your degree?
2. Describe the daily events in a typical learning block in your classroom. (For example, help me visualize what's going on in your Algebra I class on Wednesday.)
3. How do you describe your role as a teacher?
4. How do you feel that students learn best?
5. What is the best teaching approach to use in order to cover all of the content required in the State Course of Study? If there is a difference in these last two questions, explain.
6. What teaching strategies do you feel "pressured" to employ that are in conflict with your teaching philosophies? Why?
7. Give the types of assessments you administer, and the role that they play in your instructional decisions?
8. What impact has high stakes testing (such as SHGE) had on your teaching style?
9. Briefly describe your school climate in terms of teaching philosophies (include coworkers, administrators, etc.). To what extent has that school climate influenced your teaching style?
10. Describe the types of professional development that you have participated in during the last two years. How have they influenced your beliefs and practices towards mathematics instructional strategies?
11. Have you participated in a mentoring or collaboration program? How did it affect your beliefs and practices towards the teaching of mathematics?
12. How does your current teaching style compare with what you learned in your pre-service education?
13. What are other factors that affect your teaching style? What changes have you made in your teaching approach because of these factors? Why.

APPENDIX C

REFORMED TEACHING OBSERVATION PROTOCOL (RTOP)

Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada — External Evaluator
Michael Piburn — Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Technical Report No. IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher ______________________ Announced Observation? ______________________ (yes, no, or explain)

Location of class ____ (district, school, room)

Years of Teaching ______________________ Teaching Certification ______________________ (K-8 or 7-12)

Subject observed ______________________ Grade level ______________________

Observer ______________________ Date of observation ______________________

Start time ______________________ End time ______________________

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

2000 Revision

Record here events which may help in documenting the ratings.

Time	Description of Events

2000 Revision

III. LESSON DESIGN AND IMPLEMENTATION

		Never Occurred				Very Descriptive
1)	The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0	1	2	3	4
2)	The lesson was designed to engage students as members of a learning community.	0	1	2	3	4
3)	In this lesson, student exploration preceded formal presentation.	0	1	2	3	4
4)	This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	0	1	2	3	4
5)	The focus and direction of the lesson was often determined by ideas originating with students.	0	1	2	3	4

IV. CONTENT

Propositional knowledge

6)	The lesson involved fundamental concepts of the subject.	0	1	2	3	4
7)	The lesson promoted strongly coherent conceptual understanding.	0	1	2	3	4
8)	The teacher had a solid grasp of the subject matter content inherent in the lesson.	0	1	2	3	4
9)	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	0	1	2	3	4
10)	Connections with other content disciplines and/or real world phenomena were explored and valued.	0	1	2	3	4

Procedural Knowledge

11)	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	0	1	2	3	4
12)	Students made predictions, estimations and/or hypotheses and devised means for testing them.	0	1	2	3	4
13)	Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	0	1	2	3	4
14)	Students were reflective about their learning.	0	1	2	3	4
15)	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	1	2	3	4

2000 Revision

Continue recording salient events here.

Time	Description of Events

2000 Revision

APPENDIX D

INFORMATION LETTERS AND CONSENT FORMS

Note:
In order to maintain the confidentiality of the university reform initiative program along with its participants, identifying information has been intentionally deleted from the following letters and forms.

INFORMED CONSENT
for a Research Study entitled
"Exploring Beliefs and Practices of Teachers of Secondary Mathematics who Participated in a *Standards*-based Preservice Education"

You are being invited to participate in a research study project aimed at adding to the body of knowledge about the beliefs and practices of secondary mathematics teachers. The study is being conducted by Mary Alice Smeal, graduate assistant in the Department of Curriculum and Teaching at . You were selected as to participate because you are a secondary mathematics teacher who has graduated from the department of education after 2000.

If you decide to participate, I will ask you to complete a survey about beliefs and attitudes related to the teaching and learning of mathematics. Completion of the survey should take approximately 20 minutes. You may also be chosen to participate as one of the cases in the second phase of the research. For this part of the research, you will be asked to participate in a combination of interviews and observations. Each of the interviews will take approximately 30 minutes. The observation will take place in a 90-minute block class or two 50-minute classes. A trained investigator (the primary researcher) will observe you teaching a mathematics classroom in order to assess the pedagogical methods used.

Any information obtained in connection with this study that can be identified with you will remain confidential. No information will be shared with anyone who has supervisory responsibilities over you nor will it be shared with any of your colleagues. To minimize the potential risk that any information gathered will be inadvertently divulged, a unique code will be used to identify you, and any identifying information will be stored in a secure location, and the key linking codes with identifying information will be stored in a separate, secure location. Your responses to the interviews, observations, or surveys will not be discussed with anyone associated with your school, including administrators or teachers. Information collected through your participation may be used to meet dissertation requirements of the graduate student associated with this project, published in a professional journal, and/or presented at a professional meeting. If so, none of your identifiable information will be included. All data that might identify you, including the list of codes, will be destroyed one year after the conclusion of the study.

____
Participant's initials

Your decision whether or not to participate will not jeopardize your future relations with Note that you may withdraw from participation at any time, without penalty, and that any data which has been collected may be withdrawn, as long as that data is identifiable.

As a result of your participation in this project, you may experience increased effectiveness in carrying out your duties related to mathematics teaching and learning, resulting in increased mathematics achievement and learning by your students. I cannot, however, promise that you will receive any or all of the benefits described. No compensation will be offered in the research study.

If you have any question now or at a later point in time, you can contact me at or by e-mail at You will be provided a copy of this form to keep.

If you have questions about your rights as a research participant, you may contact the of Human Subjects Research or the Institutional Review Board by phone or email at

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

______________________ ______________________________

Participant's signature Date Principal investigator's signature Date

______________________ ______________________________

Print name Print Name

Interview and classroom observations may be audio taped. The tapes will only be used for research purposes, allowing qualified researchers to review the event after the fact. In no case will a tape be used for any commercial enterprise, or used in any way designed to cause a negative perception. Please sign below if you agree to allow audio taping.

____

Participant’s signature

The Institutional Review Board has approved this document for use from 10/23/2007 to 10/22/2008 Protocol #07-207EP0710

UNIVERSITY

Office of Human Subjects Research

October 25, 2007

MEMORANDUM TO:	Mary Alice Smeal Curriculum & Teaching
PROTOCOL TITLE:	"Exploring Beliefs and Practices of Teachers of Secondary Mathematics who Participated in a Standards-Based Preservice Education"
IRB AUTHORIZATION NO:	07-207 EP 0710
APPROVAL DATE: EXPIRATION DATE:	October 23, 2007 October 22, 2008

The above referenced protocol was approved by IRB Expedited procedure under 45 CFR 46.110 (#7):

> "Research on individual or group characteristics or behavior (including, but not limited to, research of perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies."

You should report to the IRB any proposed changes in the protocol or procedures and any unanticipated problems involving risk to subjects or others. Please reference the above authorization number in any future correspondence regarding this project.

If you will be unable to file a Final Report on your project before October 22, 2008, you must submit a request for an extension of approval to the IRB no later than October 8, 2008. If your IRB authorization expires and/or you have not received written notice that a request for an extension has been approved prior to October 22, 2008, you must suspend the project immediately and contact the Office of Human Subjects Research for assistance.

A Final Report will be required to close your IRB project file. You are reminded that you must use the stamped IRB-approved consent form and information sheet when you consent your participants. You are also reminded that consent forms must be retained at least three years after completion of your study.

If you have any questions concerning this Board action, please contact the Office of Human Subjects Research at

Sincerely,

Subjects in Research

Enclosures

cc:

October 25, 2007

Dear Teacher,

I hope that your school year has gotten off to an excellent start. I am sending this letter to alert you that I will be sending you a survey in about a week. The survey is part of the research that I am conducting for my dissertation on secondary mathematics teachers who graduated from   from 2001 to 2007. Your input will be invaluable to my research. Your responses to this survey will serve as the first phase of my research on secondary mathematics teachers' beliefs and practices. The enclosed survey will contain a code that can link your responses with further research, but your responses will be completely anonymous and confidential.

Thank you in advance for your cooperation and precious time. If you have any questions about the survey, please feel free to email me at   or call my cell at

Thanks so much for your assistance and helpful input,

Mary Alice Smeal
Graduate Assistant

October 25, 2007

Teacher Name--Code #000

Dear Teacher

Enclosed is the survey that I referred to last week. Your input will be invaluable to my research. Your responses to this survey will serve as the first phase of my research on secondary mathematics teachers' beliefs and practices. The second phase of my research will study a sample of the teachers who responded to the survey as cases. The enclosed survey contains a code that can link your responses with further research, but your responses will be completely anonymous and confidential.

I want to emphasize the importance of this research. The research only involves recent graduates from the secondary mathematics education program, so the pool of participants is small. The response from every graduate is very important! The research on secondary mathematics teachers is limited, and your educational experience is especially crucial to my research because of you specific preservice education.

Thank you in advance your cooperation and precious time. Click on this link to complete the survey and electronically sign the consent form. **Please make sure that you include your personal code (located at the beginning of the letter) on the survey.** Please complete the survey and electronically sign the consent form by November 15, 2007. Your survey will add to the body of knowledge concerning the beliefs and methods of secondary mathematics teachers. If you have any questions about your survey, please feel free to email me at or call my cell at

Thanks so much for your assistance,

Mary Alice Smeal
Graduate Research Assistant

APPENDIX E

CODE NAMES AND DESCRIPTIONS

Code Names and Descriptions

Code Name	Description	Example
Main categories		
Teachers' Beliefs	This code was used to identify any attitude, philosophy, or feelings about teaching.	T: I think this (*Standards*-based teaching) would work better in the middle grades, elementary level I think it would work too.
Teachers' Practices	This code was used to identify actual happenings instigated by the teacher in the classroom.	T: What we're going to be doing is getting into your groups and I'm going to give you a piece of that poster paper there. I would like for you to write down all of the conditions that have to be met.
Questioning	Questioning referred to any question asked By the teacher in the classroom.	T: Does anybody have any reason not to do it this way?
Factors that affected Teachers' practices	This code was identified by any situation, factor, or aspect of the school climate that affected the strategies that teachers used.	T: The impact of high-stakes testing is pretty big—it's a daily reminder. I would try to bring in a lot more of the exploration stuff as a supplement to the regular curriculum.
Subcategories		
Pre-service	This code was used to identify any philosophies connected with pre-service education.	T: My internship didn't align with the rest of my pre-service education.
Philosophy toward Teaching	This code was used about any belief that a teacher expressed about the practice of teaching.	T: I like discovery learning but I don't think it's possible to do it for everything. I think the long and short of it is that is good to be used as a supplement to the regular curriculum.

Code Names and Descriptions (continued)

Code Name	Description	Example
Subcategories		
Expectations	This code was used anytime a teacher expressed the beliefs about the ability of certain classes, students, or groups of students to accomplish homework, curriculum, etc.	T: It is hard to get as excited about my second block class. I do have different expectations—I hate to admit it, but it's there. It's hard to feel the same way about the two classes.
Traditional Practices	This code occurred when the emphasis was on the teacher or not considered student-centered.	T: Students learn best by giving them the rules and the steps, and just say do that.
Standards-based teaching	Items were coded *Standards*-based Practices when they aligned with the *Principles and Standard for School Mathematics.*	S1 reads problem. T: How far did she travel? S2: 150 miles. T: How do you solve it? S3: By dividing the miles by the time. T: Read what the question is asking for. If you were going on a trip, you traveled for 3 hours and were going for 50 mph, how far would you go? S4: 150 miles. T: Would that make sense? Draw a picture.
Equity	When teachers' practices involved the equitable or inequitable treatment of students in the classroom, Equity was used as the code.	T: I've tried to show them a few things this year, and I just get that blank stare. I always tried to show them where this formula came from. The difference is the makeup of the class.
High-order questioning	Questions that required analyzing, synthesizing, evaluating, or justification were coded as High-Order Questioning.	T: What do you think it means to have a system of equations?
Low-order questioning	Questions that only required a yes/no answer or a numerical answer were coded as Low-Order Questioning.	T: What is 5x + 4x?

Code Names and Descriptions (continued)

Code Name	Description	Example
School Climate Factors	This code was used when teachers had no control over such as curriculum, administration, or school climate.	T: Our school has a 7-month curriculum plan. We have benchmarks we have to give. It's ridiculous!
Teacher Factors	This code was used when a scenario affected the teacher's practices but could be addressed by the teacher in the classroom.	T: I guess I'm not a strong enough classroom manager yet to enjoy. None of the classes sit in groups because of behavior.
Emergent Codes		
Activity as Part of Lesson	This code was used when an activity was used during a lesson.	T: Today we have a very nice activity, we have two different kinds of paper ...
Administration	This code was used when any reference was made to school administration.	T: Our administration—they want to make sure you class is structured.
Advice to Students	This code was used when a teacher gave any kind of advice to students.	T: This colored sheet of paper is going to help you—not today, but maybe tomorrow, the next day and after you graduate. Don't throw it away.
Connections	This code was used when a teacher or student made connections between mathematics concepts.	T: Especially in algebra II, I don't see how they could get away with not using the calculator. That helps them see the connection between the table and the graph.
Curriculum	This code was used when any reference was made to mathematics curriculum.	T: Teaching from Saxon is a pretty good swing from the curriculum that we focused on in pre-service.
Fill-in-the-Blank Discourse	This code was used when a teacher employed the use of fill-in-the-blank discourse.	T: The area of the whole triangle is _____?

Code Names and Descriptions (continued)

Code Name	Description	Example
High-stakes testing	This code was used when any reference was made to high-stakes (standardized) testing.	T: The impact of high-stakes testing is pretty big—it's a daily reminder. I would try to bring in a lot more of the exploration stuff as a supplement to the regular curriculum.
Individual Attention to Students	This code was used when a teacher gave individual attention to students.	T: The 352 is the area code of the cell phone number of a college quarterback coach. The coach gave me his cell phone number. If I want to get the football player back on task, I just remind him 352. (T was observed saying 352 to the football player on several occasions.)
Interruption	This code was used when an interruption by the teacher, student, or other phenomena occurred.	T: Listen to me, please listen. We waste so much time because I have to get you quiet.
Intimidation	This code was used when intimidation to a student or a group of students occurred.	T: If your process of getting homework done is just to write down answers, that's not going to do any good. My four-year-old nephew could do that.
Lack of Wait Time	This code was used when a teacher displayed a lack of wait time by not allowing students enough time to answer a question that was posed.	T: What's another reason? What we get when multiplying 9 inches by 3 inches? What do you get when you multiply inches by inches?
Notes Taken in Class	This code was used when students were observed taking notes or asked specifically by the teacher to take notes.	T: Everyone get out your notebooks and take down these notes.
Off-task	This was coded when off-task behavior was displayed by teachers or students	S1: How do you say "acre"? T: Acre: S2: S3 pronounces it funny, get him to say "acre." T: Say it S3. S3: Acre.

Code Names and Descriptions (continued)

Code Name	Description	Example
Patient with Students	This code was used when a teacher displayed patience toward a student or group of students.	Observation: Teacher is very patient when students see individual help.
Praise	This code was used when a teacher praised a student of group of students.	T: Good job, S1.
Professional Development	This code was used when a reference was made to any type of professional development.	T: All my professional development has verified and encourage the way I went into the profession of teaching.
Real Life Problems	This code was used when a mathematics problems incorporated real-life scenarios.	T: If we're talking about a back yard, are we talking about fencing or how much grass we have to mow?
Repeat Question	This code was used when a teacher repeated a question.	T: What do we mean in kph? What do we mean by kph?
Revoices	This code was used when a teacher or student revoiced a statement made by a student.	T: What does perpendicular mean? S: There has to be a 90 degree angle involved. T: Right, there has to be a 90 degree angle involved.
Scaffolds	This code was used when a teacher used scaffolding to bridge the gap between students' actual knowledge and the knowledge needed.	T: I had already done graphing with inequalities, but it was clear that there was not a good understanding, so I took a different approach and had them draw to picture to help understanding.
Students Actions Changed Lesson	This code was used a student question or some other form of communication by student(s) caused the teacher to change the direction of the lesson.	T: Yesterday, I wanted all of you just to graph your inequality. We are going to change because that was what all of you were wanted to do.
Technology	This code was used when any reference was made to technology was used.	T: Please, take out your calculators. Everybody have a graphing calculator? Everybody needs a graphing calculator right in front of them.

Code Names and Descriptions (continued)

Code Name	Description	Example
Time Element	The code was used when any reference was made to time or the lack of time.	T: It has a lot to do with time—especially in algebra II.

APPENDIX F

MEANS AND STANDARD DEVIATIONS OF TEACHERS' BELIEFS

FORTY-TWO TEACHERS’ RESPONSES TO TEACHERS’ PRACTICES AND BELIEFS SURVEY

Descriptive Statistics—Beliefs (n=42) (From Section A on TPBS)

Item	Mean	SD
Aa. I feel relaxed and confident when teaching mathematics.	3.55	.550
Ad. It is important for students to figure out how to solve mathematics problems for themselves.	3.36	.759
Ag. In a mathematics class, each student's solution process should be accepted and valued.	3.29	.673
Ax. Teachers should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages greater student-student and student-teacher interaction.	3.24	.617
Ac. Teachers should ensure that students experience success in mathematics by continually providing feedback including, if necessary, supplementary detailed explanation of how to solve a problem.	3.21	.842
Aj. Teachers must provide a variety of mathematics problems Addressing that idea and challenge the students to figure out how to solve those problems.	3.17	.581
Ar. Students achieve mathematical understanding through the direct personal experience of figuring out their own solutions to problems and then verifying their thinking for themselves.	3.09	.617
Ab. Teachers should ensure that students experience success in mathematics by clearly explaining and modeling how to complete each day's assignment to their students.	3.07	.745

Descriptive Statistics—Beliefs (n=42) (continued)

Item	Mean	SD
Av. When I work with a small group of students during a mathematics lesson, I know that I will be able to assess their understanding as I observe them working on mathematical problems and interacting with each other to complete a mathematics task.	3.07	.513
Ai. Students should have many informal experiences with a mathematical concept before they are expected to master that concept.	3.02	.680
Ap. I feel confident that I can produce a solution to any mathematical question a student may have without referring to the textbook's solution.	2.93	.947
An. Students should understand the meaning of a mathematical concept before they memorize the definitions and procedures associated with that concept.	2.91	.759
At. Rather than demonstrating how to solve a problem, a teacher should allow students to figure out their own ways of solving mathematics problems and to explain their own ways of solving mathematics problems, including word problems.	2.76	.692
Ao. Teachers should model and demonstrate mathematical procedures and then, ideally, time should be allowed for the students to have the opportunity to practice those procedures.	2.74	.734
Aq. I feel most comfortable when I first model an activity, then provide some practice, immediate feedback, clarify what the assignment is and how I expect it to be completed.	2.74	.857
Al. When planning a mathematics lesson, I know that I am able to provide mathematics activities that are relevant to my students' lives.	2.71	.835

Descriptive Statistics—Beliefs (n=42) (continued)

Item	Mean	SD
Af. If the class is going to use a model of a mathematical situation, I usually prefer first to show my students how to use the model.	2.59	.828
Ae. Time should be spent practicing mathematical procedures before students spend much time solving mathematics problems.	2.24	.969
As. When students are grouped for instruction on the basis of their past mathematical performance, each student may then receive the level of mathematics instruction that is most appropriate for that student.	2.14	.843
Ah. Students learn mathematics best from their teacher's demonstrations and explanations.	1.88	.772
Ak. No student should associate mathematics with frustration, so a teacher should limit the questions he or she asks of the student to those that the teacher is reasonably confident that the student can answer correctly.	1.67	1.004
Am. If a student is going to be a good problem solver, then it is important for that student to know how to follow directions.	1.64	1.340
Au. Students will not understand a mathematical concept until they have memorized the definitions and procedures associated with that concept.	1.21	.871
Aw. I feel that most mathematics teachers in my grade level have a better understanding of mathematics than I have.	1.14	.843

APPENDIX G

MEANS AND STANDARD DEVIATIONS OF TEACHERS' PRACTICES

FORTY-TWO TEACHERS’ RESPONSES TO TEACHERS’ PRACTICES

AND BELIEFS SURVEY

Descriptive Statistics—Teaching Practices (n=42)
(From Section B—Question 10 on TPBS)

Item	Mean	SD
B10m. Think about why something in math class is true.	2.74	0.885
B10h. Use wooden or plastic blocks, rods, shapes or other objects to solve a math problem.	2.69	0.811
B10g. Present how they solved a problem to the class.	2.64	0.906
B10l. . Do math problems that require critical thinking.	2.62	0.731
B10d. Listen to me lecture about math.	2.48	0.594
B10o. Apply math situations to life outside of school.	2.48	0.890
B10j. Do 10 or more practice problems by themselves.	2.45	0.803
B10e. Copy notes or problems off the board.	2.43	0.703
B10c. Promote student participation in small group discussions to help them make sense of mathematics.	2.31	1.047
B10b. Use a calculator or computer to explore a concept or extend the understanding of a concept or skill.	2.29	1.195
B10i. Work on one math problem or question for more than 10 minutes.	2.21	1.423

Descriptive Statistics—Teaching Practices (n=42) (continued)

Item	Mean	SD
B10p. Take tests where they have to explain their answers.	2.19	1.018
B10f. Give a written explanation about how they solved a math problem.	2.02	0.924
B10q. Take multiple-choice tests.	2.98	1.903
B10s. Practice to take a standardized-test, like the SAT-10 or HSGE	2.88	1.064
B10k. Memorize formulas and rules for a test or quiz.	1.69	0.975
B10n. Do math projects or investigations that take several days to complete.	1.45	1.017
B10r. Complete many math problems quickly.	1.38	0.795
B10a. Use a computer to practice their math.	1.05	1.209

APPENDIX H

MEANS AND STANDARD DEVIATIONS OF TEACHERS' EQUITABLE BELIEFS AND PRACTICES

FORTY-TWO TEACHERS' RESPONSES TO TEACHERS' PRACTICES AND BELIEFS SURVEY

Descriptive Statistics—Equitable Beliefs and Teaching Practices (n = 42)
(From Section A and Section B from TPBS)

Item	Mean	SD
Ag. In a mathematics class, each student's solution process should be accepted and valued.	3.29	0.673
Ax. Teachers should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages greater student-student and student-teacher interaction.	3.24	0.617
B13d. If students aren't disciplined at home, they aren't likely to accept discipline at school.	2.54	1.027
B13n. The influence of a student's home experiences can be overcome by good teaching.	2.45	0.550
B13k. If parents would do more for their children, I could do more.	2.40	0.767
B13p. Even a teacher with good teaching abilities may not reach many students.	2.40	0.964
As When students are grouped for instruction on the basis of their past mathematical performance, each student may then receive the level of mathematics instruction that is most appropriate for that student.	2.14	0.843
B13b The hours in my class have little influence on students compared to the influence of the home environment.	2.02	0.897
B13h A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on achievement.	1.74	0.798

Descriptive Statistics—Equitable Beliefs and Teaching Practices (n = 42) (continued)

Item	Mean	SD
B13q. When it comes right down to it, a teacher can't do much because most of a student's performance depends on his/her home environment.	1.38	0.697
B13c. The amount a student can learn is primarily related to family background.	1.31	0.643

APPENDIX I

CASE STUDY TEACHERS' RESPONSES TO TEACHERS' PRACTICES AND BELIEFS SURVEY

Case Study Teachers' Responses to Teachers' Beliefs Portion of the Survey

Case Study Number	#1	#2	#3	#4	#5
A.a. I feel relaxed and confident when teaching mathematics.	SA	A	SA	SA	SA
A.b. Teachers should ensure that students experience success in mathematics by clearly explaining and modeling how to complete each day's assignment to their students.	A	A	N	A	SA
A.c. Teachers should ensure that students experience success in mathematics by continually providing feedback including, if necessary, supplementary detailed explanation of how to solve a problem.	N	A	A	A	A
A.d. It is important for students to figure out how to solve mathematics problems for themselves.	SA	SA	A	A	D
A.e. Time should be spent practicing mathematical procedures before students spend much time solving mathematics problems.	SD	N	D	SA	A
A.f. If the class is going to use a model of a mathematical situation, I usually prefer first to show my students how to use the model.	D	N	D	D	A
A.g. In a mathematics class, each student's solution process should be accepted and valued.	SA	N	A	A	SA
A.h. Students learn mathematics best from their teacher's demonstrations and explanations.	SD	D	D	A	N

Case Study Teachers' Responses to Teachers' Beliefs Portion of the Survey (continued)

Case Study Number	#1	#2	#3	#4	#5
A.i. Students should have many informal experiences with a mathematical concept before they are expected to master that concept.	A	N	A	A	A
A.j. Teachers must provide a variety of mathematics problems addressing that idea and challenge the students to figure out how to solve those problems.	SA	A	A	A	A
A.k. No student should associate mathematics with frustration, so a teacher should limit the questions he or she asks of the student to those that the teacher is reasonably confident that the student can answer correctly.	D	D	D	D	A
A.l. When planning a mathematics lesson, I know that I am able to provide mathematics activities that are relevant to my students' lives.	A	A	D	A	A
A.m. If a student is going to be a good problem solver, then it is important for that student to know how to follow directions.	N	N	A	SA	SA
A.n. Students should understand the meaning of a mathematical concept before they memorize the definitions and procedures associated with that concept.	A	A	A	SA	SA
A.o. Teachers should model and demonstrate mathematical procedures and then, ideally, time should be allowed for the students to have the opportunity to practice those procedures.	A	A	A	SA	SA
A.p. I feel confident that I can produce a solution to any mathematical question a student may have without referring to the textbook's solution.	A	A	D	N	SA

Case Study Teachers' Responses to Teachers' Beliefs Portion of the Survey (continued)

Case Study Number	#1	#2	#3	#4	#5
A.q. I feel most comfortable when I first model an activity, then provide some practice, immediate feedback, clarify what the assignment is and how I expect it to be completed.	D	A	A	N	SA
A.r. Students achieve mathematical understanding through the direct personal experience of figuring out their own solutions to problems and then verifying their thinking for themselves.	SA	A	SA	A	A
A.s. When students are grouped for instruction on the basis of their past mathematical performance, each student may then receive the level of mathematics instruction that is most appropriate for that student.	SD	A	D	A	A
A.t. Rather than demonstrating how to solve a problem, a teacher should allow students to figure out their own ways of solving mathematics problems and to explain their own ways of solving mathematics problems, including word problems.	SA	N	A	N	A
A.u. Students will not understand a mathematical concept until they have memorized the definitions and procedures associated with that concept.	SD	D	D	D	SA
A.v. When I work with a small group of students during a mathematics lesson, I know that I will be able to assess their understanding as I observe them working on mathematical problems and interacting with each other to complete a mathematics task.	SA	A	A	A	A
A.w. I feel that most mathematics teachers in my grade level have a better understanding of mathematics than I have.	SD	D	D	N	A
A.x. Teachers should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages greater student-student and student-teacher interaction.	SA	A	A	A	A

Case Study Teachers' Responses to Teachers' Practices Portion of the Survey

Case Study Number	#1	#2	#3	#4	#5
B.10.a. Use a computer to practice their math.	S	N	S	N	N
B.10.b. Use a calculator or computer to explore a concept or extend the understanding of a concept or skill.	S	N	S	O	A
B.10.c. Promote student participation in small group discussions to help them make sense of mathematics.	A	S	R	S	R
B.10.d. Listen to me lecture about math.	S	O	O	R	S
B.10.e. Copy notes or problems off the board.	S	S	S	O	S
B.10.f. Give a written explanation about how they solved a math problem.	O	O	S	O	N
B.10.g. Present how they solved a problem to the class.	O	O	S	S	O
B.10.h. Use wooden or plastic blocks, rods, shapes or other objects to solve a math problem.	R	N	R	N	N
B.10.i. Work on one math problem or question for more than 10 minutes.	A	O	N	A	N
B.10.j. Do 10 or more practice problems by themselves.	S	S	O	S	A
B.10.k. Memorize formulas and rules for a test or quiz.	N	O	S	N	N

Case Study Teachers' Responses to Teachers' Practices Portion of the Survey (continued)

Case Study Number	#1	#2	#3	#4	#5
B.10.l. Do math problems that require critical thinking.	O	O	S	A	O
B.10.m. Think about why something in math class is true.	O	O	S	O	O
B.10.n. Do math projects or investigations that take several days to complete.	S	S	N	S	N
B.10.o. Apply math situations to life outside of school.	O	S	S	A	S
B.10.p. Take tests where they have to explain their answers.	O	R	S	A	N
B.10.q. Take multiple-choice tests.	R	S	R	N	R
B.10.r. Complete many math problems quickly.	N	O	N	N	R
B.10.s. Practice to take a standardized-test, like the SAT-10 or HSGE	A	S	N	N	S

Case Study Teachers' Responses to Teachers' Equity Portions of the Survey

Case Study Number	#1	#2	#3	#4	#5
A.g. In a mathematics class, each student's solution process should be accepted and valued.	SA	N	A	A	SA
A.s. When students are grouped for instruction on the basis of their past mathematical performance, each student may then receive the level of mathematics instruction that is most appropriate for that student.	SD	A	D	A	A
A.x. Teachers should incorporate students' diverse ideas and personal experiences into mathematics instruction that encourages greater student-student and student-teacher interaction.	SA	A	A	A	A
B.13.b The hours in my class have little influence on students compared to the influence of the home environment.	D	A	D	D	A
B.13.c. The amount a student can learn is primarily related to family background.	D	A	D	N	A
B.13.d. If students aren't disciplined at home, they aren't likely to accept discipline at school.	A	D	D	SA	SA
B.13.h When a student is having difficulty with an assignment, I am usually able to adjust it to his/her level.	D	A	N	N	A
B.13.k. If parents would do more for their children, I could do more.	A	A	A	N	A
B.13.n. The influence of a student's home experiences can be overcome by good teaching.	N	A	A	N	D

Case Study Teachers' Responses to Teachers' Equity Portions of the Survey (continued)

Case Study Number	#1	#2	#3	#4	#5
B.13.p. Even a teacher with good teaching abilities may not reach many students.	N	N	SA	SA	A
B.13.q. When it comes right down to it, a teacher can't do much because most of a student's performance depends on his/her home environment.	A	A	SD	N	A

Case Study Teachers' Responses to the Influence of the Factors on Teachers' Practices

Case Study Number	#1	#2	#3	#4	#5
Curriculum	4	4	3	3	4
Time	3	3	3	3	3
Academic Level of Students	2	4	3	3	4
Professional Development	3	3	3	4	1
Colleagues	2	3	3	2	3
Testing	3	3	2	3	4
Administration	2	3	1	3	3
Socioeconomic Status	2	2	2	3	3