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The Impact of Secondary Mathematics Methods Courses on Preservice Secondary Teachers' Beliefs about the Learning and Teaching of Mathematics

Ronald Gene Smith II
University of Tennessee - Knoxville, rsmith70@utk.edu

To the Graduate Council:

I am submitting herewith a dissertation written by Ronald Gene Smith II entitled "The Impact of Secondary Mathematics Methods Courses on Preservice Secondary Teachers' Beliefs about the Learning and Teaching of Mathematics." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

Vena Long, Major Professor

We have read this dissertation and recommend its acceptance:

P. Mark Taylor, JoAnn Cady, Charles Collins

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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A Dissertation
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Abstract

The Comprehensive Framework for Teacher Knowledge provides a model that describes an approach to the secondary mathematics methods course, as described by Robert Ronau and P. Mark Taylor. The model includes the orientation of preservice teachers toward mathematics and the teaching of mathematics, which includes the beliefs of the preservice teachers. The first questions deal with identifying the methods used in the methods course to address beliefs. The second set of questions deal with the effects of the methods course on the beliefs that preservice teachers hold on the learning and teaching of mathematics.

The study included 16 different universities in the United States. The students completed the Mathematics Beliefs Instrument (MBI) before and after the course. The data used for analyses included the MBI, course syllabi and interviews with instructors and course textbooks. Qualitative analysis was conducted on the syllabi and interviews to assist in creating a rubric to score the syllabi, interviews and textbooks. Correlation and linear regression analysis was used along with the Wilcoxon signed-ranks test for the statistical analysis.

A significant positive relationship was found between the number of methods used in the methods course to challenge student beliefs and the improvement between pre and post tests. Preservice teachers' beliefs about the learning and teaching of mathematics were found to become more reform-oriented during the course of the methods course.

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Chapter 1: Background of the Study

Introduction

Mathematics education in the United States has seen numerous developments over the past 100 years. These changes have been precipitated by groups such as the National Council of Teachers of Mathematics (NCTM), Association of Mathematics Teacher Educators, and the National Science Foundation. In their efforts to reform mathematics education, the NCTM published a list of goals for students to learn during their kindergarten through twelfth grade years of schooling in 1989 (National Council of Teachers of Mathematics, 1989). These goals became known as the standards for mathematics education and were modified in 2000 (National Council of Teachers of Mathematics, 2000). The purpose of these standards for mathematics education is to provide teachers with the frameworks upon which to reform their mathematics teaching.

The reforms addressed in the NCTM documents require a change in the fundamental beliefs about how students learn mathematics. Beliefs about how students learn and understand mathematics are "undoubtedly a driving force behind the nature of a teacher's instructional practice" (Artzt & Armour-Thomas, 2002, p. 23). These beliefs act as filters that regulate what a teacher believes and does in the classroom (Ambrose, Clement, Philipp, & Chauvot, 2004; Thompson, 1992) Beliefs can also be seen to act as lenses through which a teacher views research, learning and practice(Philipp, 2007; Putnam & Borko, 2000; Yadav & Koehler, 2007). Due to this fundamental change in learning mathematics, there exists a need for preservice teachers to identify their current beliefs. This can only be accomplished when teacher educators intentionally provide situations that challenge students' existing belief systems, which have been developed during the previous thirteen years of exposure to teaching from the viewpoint of a

student. Once a preservice teacher's beliefs have been questioned, then the future teacher is ready to consider various approaches to teaching and learning that construct or at least significantly revise their beliefs.

In order for reform to occur, teachers need to learn not only the standards contained in the NCTM documents, but teachers also need to learn how to incorporate a new approach to learning mathematics that is encouraged by these standards. The standards incorporate a learning style that aligns very closely to the constructivist philosophy of learning. An obvious opportunity for learning this approach to teaching mathematics is during the preparation phase in a university setting, especially in the mathematics methods course. Current reformers in education are calling for the faculty in teacher education programs to implement and model instructional strategies that are consistent with the constructivist theory of learning (Shapson & Smith, 1999), the underlying theory of learning espoused in the NCTM standards. Secondary teachers typically major in mathematics and then prepare for a teaching career. In an ideal educational experience, preservice teachers would experience content courses that reflected best practices of teaching. For many preservice teachers, the reality is that a reform-oriented learning experience does not occur until the methods course (Goubeaud & Yan, 2004). The methods course is one course that many future secondary mathematics teachers take in preparation for their future careers. This course would appear to be a prime location for integrating the reform ideas and challenging the current belief systems of preservice teachers. If done properly, the methods course could provide a perfect segue into a reform-oriented career of teaching mathematics.

Reform Teaching

The idea of teaching in a reform manner requires that one knows the tenets of constructivism as they apply to teaching. Teachers making instructional decisions based on the

students' knowledge is a key component of a constructivist approach to teaching (Draper, 2002). Draper also stated that constructivism involves the learner and the teacher working together to solve problems. A constructivist teacher will create a learning environment that enables the student to be in charge of her own learning (Andrew, 2007). Constructivist teachers ensure that their classrooms are characterized by students who are engaged (Driscoll, 2000). Andrew (2007) identified nine traits that he labeled as the "nine components of constructivist instruction". These nine traits are (a) teaching to help students "develop, reflect on, evaluate, and modify" their personal conceptual frameworks; (b) creating a classroom environment that enables students to be in charge of their own learning; (c) negotiating possible solutions to problems; (d) attempting to identify each student's conceptual framework; (d) providing opportunities for students to engage in activities; (e) encouraging and supporting interactions between students; (f) agitating "weak mathematical constructs" of students through designed activities; (g) "structure learning tasks within relevant, realistic environments"; and (h) reveal multiple solutions and approaches to problems. Andrew is not alone in identifying characteristics that can be used to indicate a constructivist approach to teaching. Lubienski, Camburn and Shelly (2004) identified nine "instruction-related factors" (p. 26) that could help identify a teacher's instructional preferences in regards to reform-oriented methods.

Draper (2002) stated that

> "With the newest wave of reform, some mathematics educators have called for teachers to move away from teaching by telling (the school mathematics tradition) and move toward the constructivist teaching paradigm." (p. 520)

Due to the learning environment, teacher educators have the opportunity to model constructivist teaching to preservice teachers (Goubeaud & Yan, 2004). Research has shown that other

educators in the higher educational institution cannot be expected to provide models of constructivist teaching because teacher educators are more likely than other higher education faculty to use student-centered instructional techniques according to Goubeaud and Yan (2004).

Mathematics Methods Course Framework

The purpose and structure of a mathematics methods course is generally in the hands of the teacher educator preparing the course. No general guidelines or frameworks for all mathematics methods courses exist. One proposed framework for mathematics methods courses has been offered by Ronau and Taylor (2008). This model is referred to as the Comprehensive Framework for Teacher Knowledge (CFTK). The framework can be seen in Figure 1 below. The framework provides for a core consisting of teacher practice, student achievement and pedagogical content knowledge, as suggested by Shulman (1986). From this core, extend three main dimensions. These dimensions can be thought of as the knowledge of the "what", "how" and "where" of learning. Each dimension is then broken down into two aspects. The "what", referred to as the field dimension, is broken down into both the subject matter knowledge and the pedagogical knowledge necessary for the particular field, in this case mathematics. The "how", referred to as the mode dimension, represents how cognition and orientation, or thinking and feeling, impact teaching and learning. The "where", referred to as the context dimension, refers to the local context in terms of a micro-scale, the individual, and a macro-scale, the environmental context. Each of these aspects can be viewed by examples that are representative of their various attributes. For instance, orientations are broken down into beliefs, dispositions, attitudes and other characteristics that can fit into this aspect. The model is best viewed as a multilevel with three levels and two aspects at each level. This multilevel characteristic allows for each aspect to be connected to each of the other aspects in addition to the aspect that

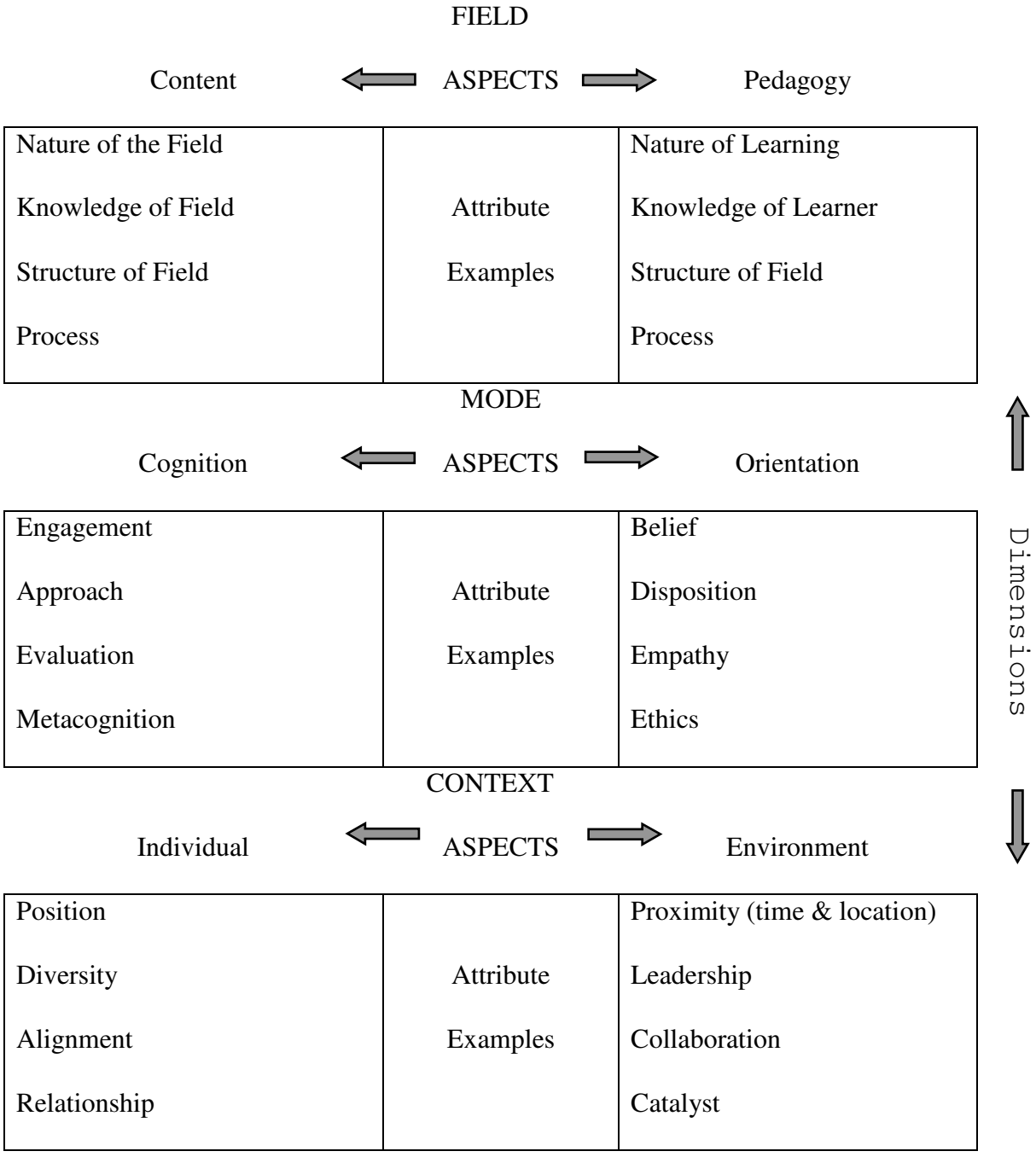

Figure 1: *Summary of Comprehensive Framework for Teacher Knowledge*

occupies the same level as the aspect itself. Each of the aspects is dependent upon the other aspects, thus showing a symbiotic relationship amongst the aspects.

Statement of the Problem

The literature on secondary mathematics methods courses is very limited. There are studies that have examined individual courses, instructors or institutions (Buehl, Alexander & Murphy, 2002; Fernandez, 2005; Geddis & Wood, 1997; Kinach, 2002a; Kinach, 2002b; Manouchehri & Enderson, 2003; Quinn, 1997). Some studies have examined the effect of an individual course on the students in that course (Geddis & Wood, 1997). There have been few, if any studies of what is being taught in the secondary mathematics methods courses across multiple institutions of higher learning. Ball (1988) points out that little is known about what students will learn or encounter in our education classes. If future mathematics teachers are going to learn about reform-oriented teaching, then the community of mathematics educators needs to know how common this type of teaching is across multiple schools.

Due to the lack of research about the content of the secondary mathematics methods courses, there exists a dearth of information about how the content of methods courses impacts the beliefs of preservice secondary teachers. Research about activities or methods that lead to changes in the fundamental beliefs about how students learn and understand mathematics promises to be very valuable to teacher educators.

Research Questions

This study will address the following research questions:

1. What characteristics of the methods courses challenge traditional beliefs and encourage the development of beliefs aligned with reform teaching practice?
    a. Which of the identified methods support the purpose of generating dilemmas for the purpose of challenging preservice teachers' existing belief systems?

b. Which of the identified methods stimulate preservice teachers to incorporate reform teaching practices into their teaching?

c. To what degree do the methods courses incorporate the multilevel model of teacher knowledge as posited by the Comprehensive Framework for Teacher Knowledge proposed by Ronau and Taylor (2008)?

2. In what way are the beliefs about the learning and teaching of mathematics held by preservice teachers changed, if any change occurs?

    a. Are the beliefs of preservice teachers changed to demonstrate more alignment with a reform-oriented view of teaching mathematics?

    b. Does the degree of incorporating a multilevel model of teacher knowledge correlate positively with the subsequent alignment of preservice teacher's beliefs with a reform-oriented view of teaching mathematics?

Significance

In the mathematics education community, much effort is being expended on promoting and encouraging teachers to incorporate standards-based reform. Teachers are encouraged to do this at workshops, professional development, national conferences, etc. An ideal time to start teachers on the path toward reform teaching is during their education and training period prior to their immersion in the existing culture that is inundated with traditional ideas, beliefs, methods and curriculum. Smith (2007) pointed out that

> "If we, as teacher educators, expect our students to create classroom environments that engage students in high-level tasks and inquiry-based learning, we must model this type of instruction in college classrooms." (p. 563)

Currently there has been little research to suggest that this reform effort is being practiced at our colleges and universities in the preparation of secondary preservice teachers. Another problem is that there is little research on preservice secondary teachers' beliefs about the learning and teaching of mathematics. In order to study the practices that occur in secondary mathematics methods courses and the accompanying beliefs of secondary preservice teachers, research must be conducted in these areas. To shed light on this situation, I will examine the efforts of secondary mathematics teacher educators and the change in beliefs of the preservice secondary teachers in regard to the learning and teaching of mathematics. Once research is conducted in this area, then future research can begin to identify additional methods of addressing the beliefs of preservice secondary mathematics teachers.

Limitations and Delimitations

This study is dependent upon the cooperation of the professors who teach the secondary mathematics methods courses at colleges and universities. In order to determine what is being taught and the manner in which the class is taught I will survey teacher educators as to their beliefs about and practices in teaching the mathematics methods courses. I will compare the approaches being used to a list of factors that are characteristic of reform-oriented teaching such as those offered by Andrew (2007) and Lubienski et al. (2004). In order to provide triangulation of the analysis, I will also call on randomly selected professors, selected from the surveys used for analysis. These calls will be for the purpose of comparing the survey with the actual course delivery and content.

Definitions of Terms

In order to determine if standards-based reform instruction is being used in the mathematics methods courses, one needs to know what is meant by standards-based and reform.

For the purpose of this study, standards-based refers to mathematics instruction that is based on the standards that were introduced by the National Council of Teachers of Mathematics in 1989 and updated in 2000. Reform refers to changing the traditional approach to mathematics and mathematics teaching (Cady, Meier, & Lubinski, 2006; Cooney, 2003), although Cooney does point out that "In the United States, reform in mathematics education is best represented by the Principles and Standards for School Mathematics and its three predecessors" (p. 1). In this paper, reform and reform-oriented will both refer to teaching that addresses the ideas and standards set forth in the NCTM documents, primarily in the Principles and Standards of School Mathematics (National Council of Teachers of Mathematics, 2000).

For the purpose of this study, secondary mathematics methods courses will refer to classes offered at universities and colleges that are designed to instruct preservice teachers on how to teach mathematics to students in grades nine through twelve. The secondary mathematics methods course normally includes topics in content, pedagogy, pedagogical content knowledge and clinical experiences. In order for a college to be considered, that college or university needs to offer a program that results in the certification of teachers for teaching secondary mathematics.

Belief structures and belief systems refer to a structure or system that exists in someone's mind to assist in organizing beliefs (Green, 1971; Muijs & Reynolds, 2002; Thompson, 1992). For the purpose of this study, the term belief structures will refer to structures that are formed by finding relations between a group of beliefs(Cooney, Shealy, & Arvold, 1998), but the structures, or clusters of beliefs, are frequently isolated from other structures (Cooney, et al.). Similarly for the purpose of this study, belief systems are a larger body of beliefs that contain the collective set of belief structures and beliefs (Chapman, 2002). While belief systems are a set of belief

structures which are held together in a psychological sense, the exact relationship between the various belief structures and beliefs is not based upon a logical pattern.

Chapter 2: Literature Review

Introduction

The purpose of this chapter is to provide relevant information that is available in the existing literature. The chapter will begin with a discussion of the beliefs and the importance of beliefs to teaching. This discussion will be followed by a reason for addressing beliefs in the secondary mathematics methods courses. Finally, there will be a discussion about the secondary mathematics methods course. Initially, in order to develop the need for addressing beliefs in the secondary methods course, the need to examine teachers' beliefs will be addressed first.

Beliefs

Understanding a teacher's beliefs is very important in trying to understand how a teacher makes decisions about content, pedagogy, lessons, homework, and many aspects of what is normally considered teaching. The reason that understanding beliefs is vitally important is that beliefs represent the ideas and values that lie at the root of much of what a teacher does, or the teacher's practice (Pajares, 2002; Pratt, 1998). Hart clearly states her views on the importance of beliefs in saying that "teachers' beliefs drive their teaching of mathematics" (Hart, 2002, p. 4). Additionally, beliefs are extremely important because beliefs that are held for a long time become a part of a person (Pajares, 1992). An additional reason for the benefit that results from studying teachers' beliefs is that researchers have found a positive relationship between a teacher's beliefs and the learning that is observed in teacher's students (Carpenter, Fennema, Peterson, & Carey, 1988). Before an understanding of beliefs can be achieved, the definition of beliefs must be examined.

Definitions of Beliefs from Research

The exact meaning of the term "beliefs" is not easy to derive from the available research. Beliefs are defined in terms of their relationships to other concepts. For example, Pajares (1993) defines beliefs as the attitudes and values that a teacher has about the teaching profession, students and the entire educational process. Other researchers view beliefs and attitudes as being different concepts (Philipp, 2007). One example that describes the differences between beliefs and attitudes claims that beliefs, attitudes and emotions lie on a continuum where beliefs require the least emotional attachment and emotions require the most emotional attachment (Owens, Perry, Conroy, Geoghegan, & Howe, 1998). The continuum of beliefs, attitudes and emotions also exhibits an increasing amount of cognitive basis, with emotions needing little cognitive basis to be held and beliefs requiring a greater degree of cognitive basis. Still other researchers suggest that a teacher's beliefs affect the teacher's attitudes and orientations (Grossman, Wilson, & Shulman, 1993). A teacher's orientations affect everything they do in a classroom, including lessons, goals, assignments and assessments. Teacher's attitudes include how they feel about their subject and their teaching (Ernest, 1989; Quinn, 1997).In all of these descriptions, there exists a relationship between beliefs, attitudes, emotions and orientations. The nature of these relationships is the reason these concepts are all tied together in one aspect of the Comprehensive Framework for Teacher Knowledge model by Taylor and Ronau (2008).

The definitions provided by researchers tend to focus on different aspects of beliefs. Some definitions focus on attitudes (Ernest, 1989, Quinn, 1997). Other researchers suggest that beliefs refer to how one thinks about something, or a more cognitive approach to beliefs (Owens, et al., 1998). Furinghetti and Pehkonen (2002) suggest that a third common definition for beliefs

is “conative” (p. 41) in nature, which relates to actions that stem from a belief. Yet, many of these definitions fail to provide clear definitions of beliefs.

The definitions of beliefs that are provided in much of the available research do not provide enough information to develop a definition of beliefs that is suitable for this study. In order to develop a definition of beliefs, existing definitions are not adequate in and of themselves to provide a definition. In order to expand upon the idea of a belief, the descriptions of beliefs can be used to gain an idea of what is meant by the term “beliefs”.

Descriptions of Beliefs

Pajares (1992) suggests that a definition must include the type of evidence upon which the belief is based. His view of belief refers “to an individual’s judgment of the truth or falsity of a proposition, a judgment that can only be inferred from a collective understanding of what human beings say, intend, and do” (p. 316). Harvey (1986) describes belief systems as “a set of conceptual representations” (p. 660) that provide the holder of the belief with a particular reality based on the particular belief. Harvey goes on to discuss how these belief systems influence how one reacts to, feels about and interprets a given situation. Rokeach (1960) supports the idea that a belief will tend to influence how one will react to a given situation. Beliefs have this effect on teachers because beliefs help teachers to simplify the classroom environment and provide an orientation from which to approach problem situations (Calderhead, 1996). These definitions and descriptions of beliefs do not adequately incorporate the way that beliefs are held in a teacher’s mind. The degree to which beliefs are held by a teacher suggest the nature of those beliefs to that teacher.

Nature of Beliefs

Due to the idea that deeply held beliefs actually become a part of a teacher, these beliefs help define who that teacher is. Therefore, determining how firmly entrenched a belief is to the teacher and how the teacher came to accept a particular belief (Cooney, et al., 1998) is important to the study of the nature of beliefs. Some beliefs, referred to as central (Philipp, 2007; Thompson, 1992), are deeply ingrained in a teacher and become central to one's being and who the teacher is (Pratt, 1998).

Not all beliefs are held so firmly in one's mind. Some beliefs, referred to as peripheral, are less firmly held than central beliefs. Beliefs can be maintained in a teacher's mind at varying levels of conviction (Thompson, 1992). Some beliefs are formed without any evidence or direct reason. Beliefs formed in this manner are referred to as nonevidential beliefs (Cooney, et al., 1998; Merry, 2005). When beliefs are formed nonevidentially, then the holder of the beliefs has a dilemma over how to evaluate or judge which beliefs are of most importance or of greater value (Thompson, 1992).

Belief formation can also depend on the context in which that belief was created and the context to which the belief is connected in a belief system (Beswick, 2005). Beswick reports that "context is thus relevant to both the development and the enactment of teachers' beliefs" (p. 41). She states that there is a relationship between a teacher's beliefs and that teacher's perception of the classroom environment. Beswick is not alone in her assessment of the effect of context on the enactment of beliefs (Ajzen & Fishbein, 1980).

Another attribute of beliefs that has been studied is the source of authority of beliefs. In order to see the impact of the source of authority on beliefs, then a brief review of the literature on sources of authority must be examined.

Source of Authority of Beliefs

The study of teachers' beliefs must consider how a teacher views the source of authority for knowledge. The reason that the source of authority must be examined is that how a teacher views the source of knowledge gives insight into the teacher's intellectual and cognitive development. Cady et al. (2006) find the preservice teacher's source of authority as being critical to the teacher changing their beliefs and practice to accept reform-oriented teaching. Many students entering college view knowledge as being something to be received from an expert (Baxter Magolda, 1992), in the case of teacher education this expert would be the teacher educator. This source of authority is referred to as voices (Belenky, Clinchy, Goldberger, & Tarule, 1986; Cady, et al., 2006; Cady & Rearden, 2007).

The idea of voices refers to whose voice the teacher is listening when gaining knowledge. Teachers can hold an absolute view of knowledge where they listen to the voices of experts and hold a right/wrong view of knowledge, which is similar to Perry's position 1 of basic duality (Perry, 1999). As teachers develop intellectually, they begin to listen to the voice of others, which Baxter Magolda (1999) sees as a level of development where teachers coconstruct their knowledge with the help of others. As the preservice teachers progress in their intellectual development, they reach the level where they begin to look at knowledge more critically. The teachers begin to create their own knowledge based on the contexts and their own experiences (Baxter Magolda, 1992; Cady & Rearden, 2007). This is referred to as listening to one's own voice (Belenky, et al., 1986) and is viewed as an internal locus of authority (Cady & Rearden, 2007; Perry, 1999).

This internal locus of authority is characterized by an increased sense of reflection and use of logic to support their conclusions about their acquired knowledge. Baxter Magolda and

King (2004) state that teachers reach cognitive maturity when their epistemological views include an internal locus of authority where they develop their own belief system through the processes of construction, evaluation and interpretation. In order to change a teacher's beliefs and practice, the teacher educator must find methods of moving the preservice teacher from an external locus of authority to an internal locus of authority in order to affect sustained changes. These changes may not be present in a teacher's first year in the classroom, as Cady, Meier and Lubinski (2006) found. But, if the proper groundwork is laid, then teachers can build on this foundation and become teachers who practice reform methods in their classrooms much as Cady et al. found.

In order to develop a working definition of beliefs, consideration must be given to how beliefs are categorized. Categorizing beliefs is not only an academic pursuit, conducted for the purpose of classifying a teacher's beliefs, but categorizing is a process that occurs in the mind of every teacher. Now that beliefs have been described, the interaction between beliefs must be considered. This interaction can be understood through the manner in which beliefs are categorized and the degree of interaction between various categories of beliefs.

Categorizing Beliefs

Beliefs are frequently categorized into primary or primitive beliefs and derivative beliefs (Breiteig, Grevholm, & Kislenko, 2005; Chapman, 2002; Green, 1971; Johnson, 2004; Thompson, 1992). Primary beliefs are discussed by Rokeach (1960) as being the most basic tenets upon which belief systems are built. Green (1971) suggests that primary, or primitive beliefs are the foundation for other beliefs in a belief structure. These primitive beliefs include the ideas of the physical realities around us such as shapes, colors, numbers, time, etc. Some primitive beliefs focus more on the societal aspects of the world around us. Other primitive

beliefs are about one's self and one's own identity. These primitive beliefs act as axioms to form axiomatic systems upon which other beliefs are then created and combined to form belief structures, which were defined in chapter one.

Beliefs do not function independently (Breiteig, et al. 2005; Green, 1971), but instead form belief structures and systems, which are a conglomeration of beliefs. As was stated in chapter one, the ideas of a belief structure and a belief system are simply ways to describe how an individual arranges her/his beliefs into clusters, which tend to be dynamic structures that change due to the experiences of the individual (Thompson, 1992). Cooney, Shealy and Arvold (1998) and Breiteig et al. identified three characteristics of belief systems. They found that belief systems have a quasilogical relationship between the incorporated beliefs. They also found that beliefs are related based on their order, such as centrally held beliefs or peripherally held beliefs. Additionally, they suggest that clusters, or belief structures, of beliefs tend to be isolated from other clusters. This isolation can lead to apparent contradictions in belief systems. These systems of beliefs are important to the level of attachment that one feels to a belief. If a belief is added to a belief system very quickly, then that belief is much harder for a person to change (Pajares, 1992). These beliefs then are used to make decisions about future information that is processed. Cooney et al. (1998) point out that belief systems are the basis for what people believe, and as such are important to understand when trying to challenge preservice teachers' beliefs.

Many researchers have attempted to categorize beliefs. Beliefs about mathematics education have been broken down into categories such as learners and how they learn, the act of teaching, content specific beliefs, the act of learning to teach, and beliefs about one's self and how one fits into the role of a teacher (Calderhead, 1996). These categories are frequently broken down further. Beliefs about the act of teaching can be broken down into the type of teaching that

one views as appropriate. Calderhead identifies these types of teaching as including transmission of facts and knowledge, guided learning, social contexts or teaching mathematics as a social construct, or even treating mathematics as a purely academic subject with no connections to other disciplines. Beliefs about content are very important in that these beliefs strongly influence what is taught by a teacher and what type of delivery is best for that material (Calderhead, 1996; Grossman, Wilson, & Shulman, 1993; Philipp, 2007). Calderhead includes a teacher's beliefs about what it means to really know a subject in the category of subject, or content, beliefs.

Beswick (2007) identified nine beliefs that she grouped into three main categories. The three main categories are the nature of mathematics, mathematics learning, and the role of the teacher. Beswick's three categories are in agreement with other researchers (Raymond, 1997; Swan, 2006). Beswick (2005) included Table 1 below to explain her categories of beliefs. Beswick used research from both Ernest (1989) and Van Zoest et al. (1994) to construct her table. The columns represent continua as you progress from the top to the bottom of each column. The rows represent three ideas that are theoretically similar to each other. The actual impact of any individual column continues to be undetermined. Raymond (1997), as a result of her research, suggests that the nature of mathematics has stronger associations to a teacher's actual practice than the more pedagogical beliefs, but the results were inconclusive.

Beswick and Ernest are not the only researchers to categorize beliefs. Other researchers have categorized beliefs in broad groups. One classification of beliefs, which is very similar to Beswick's, includes epistemic, normative and procedural beliefs (Pajares, 1993; Pratt, 1998). Normative beliefs include how a teacher views their own role as a teacher. Normative beliefs would also include a teacher's beliefs about how they fit into the mathematics education

Table 1: *Comparison of Beliefs about the Nature, Teaching and Learning of Mathematics*

Beliefs about the nature of mathematics (Ernest, 1989)	Beliefs about mathematics teaching (Van Zoest et al., 1994)	Beliefs about mathematics learning (Ernest, 1989)
Instrumentalist	Content-focused with an emphasis on performance	Skill mastery, passive reception of knowledge
Platonist	Content-focused with an emphasis on understanding	Active construction of understanding
Problem-solving	Learner-focused	Autonomous exploration of own interest

community. Procedural beliefs include what Pratt (1998) refers to as tactical knowledge and strategic beliefs. Pratt identifies tactical knowledge as the knowledge of the proper time and manner to adjust one's teaching actions to accommodate for a change in the circumstances in the environment. Pratt refers to strategic beliefs as knowing why the adjustments are needed.

Beliefs are categorized by researchers in order to examine various beliefs. Individuals categorize beliefs in order to make sense of the world around them. The act of categorizing creates consistency amidst many beliefs that at times do not appear consistent with each other.

Consistency of Beliefs

Teachers, as other people, have a need to see themselves as consistent beings. This need for consistency is not unique to teachers. The need for consistency creates problems for all people who hold beliefs that are inconsistent. One example of contradictory beliefs is that a person may believe that all people should be free, but the same person holds the belief that criminals should go to prison (Rokeach, 1960). Rokeach states that in order for a person to deal with this discontinuity in beliefs, the person must isolate the beliefs in question from other beliefs that might be contradictory. This isolation is not limited to individual beliefs, but can apply to entire belief structures (Cooney, Shealy, & Arvold, 1998; Green, 1971; Rokeach, 1960). This isolation can occur when beliefs, belief structures or belief systems, are developed without the benefit of comparison to other beliefs. This isolation of beliefs and belief structures causes apparent inconsistencies in teachers' beliefs and practices. In order to advance the study of beliefs beyond the basic idea of what beliefs are considered to resemble, a definition of beliefs is imperative.

Definition of Beliefs

The term "beliefs" refers to a wide array of connotations. Some consider beliefs to be

very similar, and almost indiscernible, to knowledge (Calderhead, 1996). Other researchers consider beliefs and knowledge separately. The separation between beliefs and knowledge is apparent in research looking at domain specific beliefs regarding knowledge in a particular content area (Buehl, Alexander, & Murphy, 2002; Muis, Bendixen, & Haerle, 2006). Others see beliefs as based on affective evidence and personal experiences (Borko, et al., 1992; Grossman, Wilson, & Shulman, 1993; Pajares, 1992/ Thompson, 1992). The meaning assigned to the term "beliefs" varies depending on the research and researcher. Op't Eynde, De Corte and Vershaffel (2002) propose a definition for beliefs that states

> Students' mathematics-related beliefs are the implicitly or explicitly held subjective conceptions students hold to be true, that influence their mathematical learning and problem solving. (p.16)

This definition will be modified slightly for this study. For the purpose of this study the definition of mathematics-related beliefs includes the implicitly or explicitly held subjective conceptions preservice teachers hold to be true that influence their own personal mathematical learning and the preservice teachers' views on the mathematical learning of others. A qualification of the definition is important since the manner in which these beliefs are formed, or the degree to which they are formed is not implied by the term belief in this study.

This study will consider beliefs that consist of beliefs about the nature of mathematics, especially in regard to what is important to learn in mathematics and how students, or the preservice teachers themselves, learn mathematics and beliefs about how to teach mathematics. For any definition of beliefs, the definition is tied to knowledge. Therefore, in order to discuss beliefs, a review of the research on the relationship between beliefs and knowledge is necessary.

Beliefs and Knowledge

The relationship between knowledge and beliefs is stated frequently in the research. Knowledge and beliefs are considered determining factors for reform teaching to occur (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997; Borko & Putnam, 1996; Frykholm, 2005; Staub & Stern, 2002) and for what happens in the classroom (Borko, 1997; Mizell & Cates, 2004; Peressini, Borko, Romagnano, Knuth, & Willis, 2004). Ernest (1989) claims that theoretical knowledge is composed of content knowledge combined with beliefs and attitudes about mathematics. Knowledge and beliefs both must be addressed for meaningful change to occur. Meaningful change can occur when teachers have the knowledge necessary to implement the change supported by the beliefs to sustain the change throughout the difficult periods (Borko, et al., 1997) and the period of time referred to as the "Learning Dip" (Barkley, 2005, p. 44) where the learning drops a little at first due to the use of new pedagogical approaches, but then the learning increases and exceeds the initial level.

The research is not always consistent on the distinction between knowledge and beliefs. For some researchers, there is little difference between knowledge and beliefs (Calderhead, 1996) and the two are hard to separate (Friedrichsen & Dana, 2003). Pajares (1992) claims that "knowledge and beliefs are inextricably intertwined" (p. 325) in his research. The title of Pajares' 1992 article shows the problem with the relationship between knowledge and beliefs because the title refers to this relationship as a "Messy Construct". Grossman, Wilson and Shulman (1993) suggest that teachers "treat their beliefs as knowledge" (p. 31). Richardson (1996) sees little difference between the use of knowledge and beliefs in the teacher and teacher education literature.

Some researchers do consider beliefs and knowledge as separate from each other (Calderhead, 1996; Pajares, 1992). Other researchers continue to try to separate knowledge from beliefs. Some researchers suggest four features that can be used to distinguish beliefs from knowledge (Calderhead, 1996; Nespor, 1987; Pajares, 1992). The first of these features is existential presumption, which is truth that one holds as deeply personal. Existential presumptions represent reality to an individual. These beliefs are considered unchangeable. They are beliefs that just exist. The second feature is alternativity. Alternativity refers to an individual creating an alternative environment, though the environment may not exist in reality, but the created environment does represent the ideal environment to that individual. The third feature of beliefs is affective and evaluative loading. Affective and evaluative loading refers to the idea that beliefs are based more on affective bases than knowledge, which tends to have a more objective base (Grossman, Wilson, & Shulman, 1993). The evaluative aspect of this feature refers to the idea that many beliefs are based on judgments and evaluations of individuals or situations. The fourth feature of beliefs is episodic structure. Episodic structure refers to how beliefs are stored in memory. This feature suggests that beliefs are stored as episodes or situations that occurred in the past and continue to be used as a basis for a particular belief. Another view on differentiating between beliefs and knowledge is put forth by Beswick. Beswick (2007) takes the view that beliefs are "distinguishable from knowledge only in terms of the degree of consensus they attract as a result of the quality and quantity of evidence upon which they are based and their power to make sense of the world" (P. 96). Her view combines the features of the previous method.

The separation between beliefs and knowledge continues to challenge researchers. The difference between the ideas of beliefs and knowledge becomes challenging when considering the viewpoint, held by some constructivist followers, that there is no absolute truth (Philipp,

2007). If there is no absolute truth, then separating beliefs from knowledge based on the degree of truth does not have any basis. Philipp suggests that an idea is a belief if the holder of that idea can accept someone holding a different or opposing view of the same general idea. If the holder of the idea cannot accept any opposing views of that idea, then for that individual that is no longer a belief but becomes knowledge. Another view is that beliefs that are justified become knowledge (Breiteig, et al., 2005). In these definitions there are no requirements for the existence of any universal truth that can make any one belief more factual than another. This lack of precise definitions has resulted in situations where concepts that were once thought to be beliefs are now believed to be knowledge and what was once considered to be knowledge is now considered belief (Thompson, 1992).

Some researchers continue to try to separate beliefs from knowledge. In an effort to study beliefs by themselves, Raymond (1997) tries to separate knowledge and beliefs in her research. She concludes that knowledge, beliefs and practice contain links that cannot be separated. These researchers have all recognized that knowledge and beliefs are woven together, which agrees with the Comprehensive Framework for Teacher Knowledge model suggested by Ronau and Taylor (2008). Their model suggests that all aspects are connected in some fashion and therefore cannot be taught in isolation.

Therefore, in order to ensure that knowledge and beliefs are not taught in isolation, an examination of the components of each of these topics is necessary. Since the manner of how beliefs are categorized and held has already been discussed, the manner in which knowledge can be broken down into different types of knowledge needs to be discussed. The focus is on the types of knowledge that are necessary for the teaching of mathematics.

Types of Knowledge

Knowledge is broken down into domains much like beliefs were broken down earlier in this chapter. Some researchers suggest that there are three main domains of knowledge for mathematics education. These three domains are mathematics content, pedagogy specific to mathematics, and the professional identity of the mathematics educator (Borko, Peressini, et al., 2000; Peressini, et al., 2004). Other researchers have suggested a different breakdown of knowledge, which consists of content knowledge, general pedagogical knowledge, and pedagogical content knowledge (Borko & Putnam, 1996; Shulman, 1986). Shulman (1986) proposes that content knowledge has three categories. These three categories are the subject matter knowledge of a particular content area, knowledge about curricular interests of a particular content area, and the pedagogical content knowledge that is unique to a particular content area. This does not represent the final breakdown of knowledge, as Grossman, Wilson and Shulman (1993) further dissect pedagogical content knowledge into four areas. These four areas include teachers' overarching conceptions as to why they teach a subject, knowledge about how students understand and misunderstand topics within a subject area, knowledge about the various types of curriculum associated with a content area, and knowledge about various teaching strategies for various topics in a particular content area. Ball, Lubienski and Mewborn (2001) include another division, which they refer to as mathematical knowledge for teaching. This category includes knowledge about mathematics that is essential for teaching mathematics effectively. This would include ideas such as possessing knowledge about mathematics that is essential for the proper sequencing of mathematical topics.

How a teacher's knowledge and beliefs relate to a teacher's practice are important topics to discuss. In order to address the idea of teachers' practices, the first issue that needs to be

addressed is the importance of how a teacher's beliefs influence a teacher and how that teacher executes her/his teaching activities.

Influences of Beliefs on Practice

Beliefs influence how a teacher responds in a given situation (Ambrose, et al., 2004) due to the manner in which the beliefs are derived. Some researchers view the source of beliefs to be events and experiences that have occurred in a person's past (Calderhead, 1996; Nespor, 1987; Pajares, 1992; Thompson, 1992). Events that occur and leave a vivid memory tend to be used as the seeds of future beliefs and belief systems. This poses problems for teacher educators in that all future teachers have years of experiences that shape not only their view of teaching but also their views of what it means to be a teacher. Lortie (1975) labeled this phenomenon as the "Apprenticeship of Observation". Beliefs derived in this manner do not require objective evidence to entrench them firmly in the holders mind (Grossman, et al., 1993). As was discussed earlier in this chapter, these types of beliefs are known as nonevidential because they fail to be based upon evidence. These beliefs do not require facts or other sources of external validity in order to convince the holder that the belief is valuable. A belief does not need to be held by others, nor does a belief require a consensus in order to be considered valuable (Nespor, 1987; Pajares, 1992; Thompson, 1992). Since a belief can exist without regard to its validity, a belief can be very challenging to identify and change (Borko & Putnam, 1996). Although these beliefs may be challenging to change, the potential rewards exist because these beliefs can have a dramatic influence on how a teacher practices her/his trade (Chapman, 2002).

The relationship between beliefs and practice is not a precise science where there exists an identifiable cause-and-effect relationship (Thompson, 1992). Researchers do suggest that beliefs have an influence on the instructional practices of teachers (Borko & Putnam, 1996;

Calderhead, 1996; Grossman, et al., 1993; McMullen, et al., 2006; Pajares, 1992; Richardson, 1996; Wilkins & Brand, 2004). For example, teachers' epistemic beliefs influence what teachers choose to teach from their content and how they choose to teach the content (Grossman, et al., 1993). A teacher's beliefs have a strong effect over her/his perceptions and judgments, which results in behavior that is seen in the classroom (Pajares, 1993). Borko and Putnam make their stance very clear in saying "teachers' knowledge and beliefs – about teaching, about subject matter, about learners – are major determinants of what they do in the classroom" (Borko & Putnam, 1996, p. 675). In the relationship between beliefs and reform teaching practices, Wilkins (2002) agrees that beliefs have a positive effect on a teacher's classroom practices, but also states that content knowledge has a negative effect on teachers' beliefs and practices.

The reason for the apparent paradox on increased content knowledge having a negative effect on beliefs comes from a study conducted by Nathan and Koedinger (2002a) and a study by Nathan and Petrosino (2003). Both of these studies look at what the researchers have labeled an "expert blind spot". This blind spot is similar to the blind spot on the retina of an eye where one's brain cannot see a spot but fills in the image by blending the surrounding image to complete the spot. Similarly, when a teacher has a high degree of content knowledge, then the teacher tends to have trouble seeing where students will struggle and tend to fill in the missing part of that learning picture with the expertise from the teacher's particular content area. This practice tends to give the teacher an image of learning that follows very closely to the principles of the discipline being taught.

The manner in which teachers think about their subject matter depends on their beliefs (Grossman, et al., 1993). Grossman et al. found that the teachers' beliefs about their subject matter had powerful affects on their teaching practice. This may be due in part to the fact that

teachers must make many instructional decisions every day. These instructional decisions are guided by procedural knowledge, which is influenced very heavily by a teacher's beliefs (Pajares, 1992). Not only are a teacher's decisions influenced by the teacher's beliefs, but the actual approach that a teacher implements in the teaching of mathematics is highly dependent upon that teacher's beliefs (Thompson, 1992). Ernest (1989) states that the model of mathematics teaching that a teacher adopts is the primary determinant of how that teacher will teach mathematics. He also states that the model that is adopted is strongly influenced by the teacher's conception of the nature of mathematics, which is part of every teacher's belief system. Not only the model of teaching, but the actual learning tasks and assessments that are selected by the teacher are influenced by the teacher's belief system (Nathan & Koedinger, 2000b; Staub & Stern, 2002).

The relationship between beliefs and practice is not always clear due to inconsistencies that exist between what teachers claim to believe and their actual teaching practices. Therefore, a necessary area to examine is why inconsistencies occur between a teacher's beliefs and practices.

Inconsistencies between Beliefs and Practice

The relationship between teachers' beliefs and their classroom practice has shown some inconsistency in studies (Ernest, 1989; Mizell & Cates, 2004; Swan, 2006). This may stem in part from the findings of Beswick (2005), which indicate that many teachers possess beliefs that are in line with reform-oriented ideologies and beliefs that do not conform to reform-oriented ideologies. Researchers have tried to explain these inconsistencies. One possible explanation is that the degree of centrality of one's beliefs is context specific (Beswick, 2007). Therefore, a belief that is very important in one teaching context is viewed as less important in a different teaching context. This would cause teachers to have an apparent inconsistency in their belief

systems, when there may actually be no inconsistency. For example, a teacher may possess reform-oriented belief in science, but fail to hold the same belief in the area of mathematics. If researchers fail to take the context into consideration, then apparent inconsistencies may arise in the results of the research. These contexts may also be more social in nature (Ernest, 1989; Swan, 2006; Thompson, 1992). Social contexts could include parents', colleagues', administrators', or students' expectations.

Another source of inconsistencies comes from the teachers themselves. Some teachers have an idealized vision of what type of teacher they want to become. If they lack the necessary skills and knowledge that are required to fulfill this vision, then the teachers may find themselves holding a belief that they are incapable of fulfilling (Thompson, 1992). Teachers also find themselves in a dilemma when they feel they must choose between coverage and reform practices of teaching (Swan, 2006). Swan discusses the idea of coverage to be challenging and controversial to teachers.

Ernest (1989) suggests that another potential source of inconsistencies between beliefs and practice is the amount of metacognition that a teacher practices. If teachers fail to examine their practices, then they may develop practices that do not achieve the type of practice which is consistent with their beliefs. Increasing the level of metacognition in preservice teachers is very important in the methods course since examining one's own practices and metacognition are critical elements in becoming reform-oriented teachers who implement constructivist ideas (Cooney, et al., 1998; Thompson, 1992).

The influence of legislative action on education produces inconsistencies between teachers' beliefs and practices (Thompson, 1992). State mandated testing and standards have caused teachers to feel the need to enact practices that differ from their beliefs. The need to cover

material for a state test causes teachers to feel pressure to repress their reform practices in exchange for the faster transmission style of teaching (Swan, 2006).

Thompson (1992) identifies three scenarios that describe how teachers respond to inconsistencies when they exist between a teacher's beliefs and practice. The first possibility is that no real inconsistency exists, only a perceived difference. The second possible situation is that teachers learn to live with differences between their beliefs and their actual practice. The final possible situation is where teachers actually change their beliefs and reorder their belief structures in order to eliminate the inconsistency.

In an effort to encourage students to approach the teaching of mathematics from a reform perspective, then the teacher educators must create inconsistencies between the preservice teachers' prior beliefs and the beliefs that are being formed in the methods course. When these inconsistencies occur, change can begin to occur in the preservice teachers' beliefs and practices.

Changing Preservice Teachers' Beliefs

What needs to occur for teachers to incorporate reform practices in their classrooms? Some researchers believe that teachers' beliefs need to change first in order to produce changes in their practice (Pajares, 1992; Shulman, 1986; Thompson, 1992). This idea is evident in the statement that "it is unreasonable to attempt to change the practice of teachers without changing their beliefs" (Beswick, 2005, p. 40). The order of the change is not a universally agreed upon constant in the field of mathematics education. Some researchers feel that beliefs can only change after teachers have changed their practice and see the benefit of the new instructional model (Gusky, 1986). Still other researchers do not view the changes that occur in beliefs and practice as a timeline where you begin making changes in either beliefs or practice and the result is a change in the other. Instead of beliefs changing prior to changes in practice or practice

changing prior to beliefs, changes in both areas occur more simultaneously and work together to bring about changes in both beliefs and practice (Borko, 1997; Cobb, Wood, & Yackel,1990; Fennema, et al., 1996; Franke, Fennema, & Carpenter, 1997; Philipp, 2007). The change in beliefs cannot occur in isolation from changes in knowledge or from changes in practice (Franke, et al., 1997). In this model, the exact order is not important because both beliefs and practices are changing together. This model suggests that the order of change is not what is important, but instead what is important is that educators focus on both beliefs and practices (Borko, Davinroy, Bliem, & Cumbo, 2000; Borko & Putnam, 1996).

Regardless of the order, researchers do tend to agree that changing the beliefs or practice of a teacher is difficult (Ball, 1988; Calderhead, 1996; Frykholm, 2005; Pajares, 1993; Simon & Schifter, 1991). Pajares (1993) states that:

> The process of belief change is difficult and threatening for insiders, for they have made commitments to prior beliefs and see little reason to adjust them. Accommodating new information and adjusting existing beliefs under these familiar circumstances can be nearly impossible. (p. 46).

For many preservice teachers, their beliefs have been formed over many years of observing other teachers (Ball, 1990; Frykholm, 2005; Lortie, 1975; Thompson, 1992), which has ingrained the beliefs in their minds (Bramald, Hardman, & Leat, 1995). An example of a belief that many preservice teachers bring with them to teacher education is the idea that teaching is telling, or a transmission method of teaching (Calderhead, 1996). This view of teaching produces problems for teacher educators who are encouraging preservice teachers to adopt a reform-oriented vision of teaching.

Changing beliefs and practices may be difficult, but this task must be addressed. For professional development providers, this task is incorporated during the professional development sessions. For teacher educators, this task must be embedded in the teacher education program. One obvious course to address changes in preservice teachers' beliefs and practices in mathematics education would be the mathematics methods course. Preservice teachers' existing beliefs and knowledge play a role in shaping what the preservice teachers will learn and how they will learn during their teacher education program (Borko & Putnam, 1996). The preservice teachers' existing epistemological beliefs affect how the preservice teacher views teaching and learning situations (Yadav & Koehler, 2007). Existing beliefs act as a filter, through which new learning is screened (Borko, 1997; Cady, et al., 2006; Frykholm, 2005; Pajares, 1993). Therefore, teacher education programs, and methods courses in particular, must provide opportunities for preservice teachers to examine and challenge their beliefs (Grossman, et al., 1993). This will only happen if opportunities to challenge and change their beliefs are presented to the preservice teachers (Lappan & Theule-Lubienski, 1994).

The issue of exactly how to change the beliefs of preservice teachers continues to be examined by researchers. Teachers' beliefs are often deeply embedded in the teachers' mind, practice and being. Therefore, changing these beliefs is challenging. In order to facilitate a change in beliefs, teacher educators must find ways to challenge the primitive beliefs that preservice teachers hold about learning, teaching and learning to teach (Borko, et al., 1992). One way to challenge these fundamental beliefs is by creating doubt in the preservice teacher's existing beliefs (Cooney, et al., 1998; Thompson, 1992; Wilson & Cooney, 2002). Doubt can be introduced to preservice teachers through using activities to create a dilemma in the teachers' beliefs and belief systems (Wilcox, Schram, Lappan, & Lanier, 1991). Pajares (1992) states that

the best way to create a change in beliefs is to introduce information that the preservice teacher can see as an anomaly. Once an anomaly is observed, then the educator must provide opportunity for the preservice teacher to reconcile the new information into an existing belief system. This will produce an inconsistency in the preservice teacher, which will provide opportunity to allow the preservice teacher to attempt to regain consistency by reducing the inconsistencies that have been created in their belief system. When the inconsistencies are identified, then the educator must ensure that the preservice teacher sees the process of assimilating the new information with the old beliefs as being unsuccessful in order to create the need for a change to an existing, or creation of a new, belief or belief system.

The entire process of creating a dilemma can be achieved by encouraging preservice teachers to act in a manner that is inconsistent with their beliefs about teaching (Pajares, 1993). Another method that can create a dilemma is by using the findings of significant experts, including the teacher educator, that contradict the preservice teachers' beliefs. Teacher educators have a very critical role in the process of challenging the beliefs of preservice teachers. Teacher educators must recognize the importance of their being able to identify the beliefs of preservice teachers in order to adequately challenge those beliefs (Hollingsworth, 1989). Not only do teacher educators need to identify the beliefs of the preservice teachers, but the teacher educator must enable the preservice teachers to identify their own beliefs before any change can begin to occur (Freeman, 1991).

Identification of their personal beliefs is not enough. Preservice teachers must also understand those beliefs and recognize how their beliefs act as filters thus limiting what they learn in the teacher education program or how their beliefs act as lenses through which they view the teaching and learning of mathematics (Borko, 1997; Borko, et al., 1997; Cady, et al., 2006;

Pajares, 1993). Kinach (2002b) recognizes that this must occur in the methods course, but acknowledges that the identification and subsequent challenging of existing beliefs and belief systems in order to promote epistemological changes toward reform teaching, will be a difficult task. Once the beliefs are identified, then the teacher educator must challenge the preservice teacher's beliefs in a manner that is contextually based (Geddis & Wood, 1997; Wilson & Cooney, 2002) in order to provide additional motivation for the need to change a belief. The needs to challenge preservice teachers' beliefs and to create dilemmas that will result in changed beliefs provide a challenging task for teacher educators. This is a task that can, and must, be addressed by the teacher educator in the methods course.

Role of the Teacher Educator

The role of the teacher educator is critical in the mathematics methods course. The teacher educator must make a conscious effort to address both knowledge and beliefs. Both knowledge and beliefs must be considered as targets of change and as filters of change (Borko, et al., 1997). In order to act as a catalyst in the process of changing the beliefs of preservice teachers, the teacher educator must create dilemmas that create inconsistencies in the belief systems of preservice teachers that will produce change. Not only does the teacher educator need to create dilemmas, but the educator must also model the reform teaching that is being encouraged (Ernest, 1989; Frykholm, 2005; Pajares, 1993). Preservice teachers' beliefs about using reform pedagogical approaches to teaching will not change because the preservice teachers sit through extensive lectures on the benefits of hands-on inquiry learning. Instead, preservice teachers will need to attend courses that model reform practices. This will require teacher educators to examine their own beliefs and practice (Pajares, 1993). Until the practice of teacher educators matches the belief systems that are being encouraged in the preservice teachers, the

results of mathematics methods courses will continue to have only sporadic success, at best, in creating reform-minded mathematics teachers (Cooney, et al., 1998).

Researchers of mathematics education are finding that the mathematics methods course can have benefits in regard to teachers' attitudes about mathematics (Quinn, 1997; Robinson & Adkins, 2002; Wilkins, 2002). The degree to which the attitudes of secondary teachers are impacted by the methods course is not conclusive, as Quinn (1997) found that secondary teachers' attitudes do not change as a result of the methods course. The improvement of attitudes toward mathematics was not the only emotional consequence of the methods courses. Preservice teachers experience a high level of anxiety about mathematics (Cady & Rearden, 2007). Fortunately, the level of anxiety felt by preservice teachers about mathematics can be positively influenced by the methods course (Conrad & Tracy, 1992; Sloan, Vinson, Haynes, & Gresham, 1997; Tooke & Lindstrom, 1998). The level of anxiety is seen to decrease when preservice teachers participate in a methods course. With reduced levels of anxiety, the preservice teachers are better prepared to address their beliefs.

Therefore the role of the teacher educator is to begin the process of shaping the preservice teachers' attitudes and feelings about mathematics. The preservice teachers must also observe reform-oriented teaching from the teacher educators. This is critically vital due to the exposure of many preservice teachers to traditional teaching methods from very early in their formative years of education.

Apprenticeship of Observation

Teachers are introduced to the profession of teaching at a very early age. Every preservice teacher has observed many teachers perform the act of teaching, and through this observation formed beliefs about the act of teaching (Pajares, 1993). Deborah Ball (1989)

suggests that preservice teachers have experienced over 2,000 hours of teaching before they take their first teaching class. These hours of observation provide future teachers with many examples of presentation that are frequently not in line with the reform ideology. Lortie (1975) refers to the plethora of teaching experiences that preservice teachers have observed as the "apprenticeship of observation" (p. 61). This "apprenticeship of observation" is rather unique to teaching because few other professions provide children with the amount of exposure to the profession prior to entering formal training at the university level (Pajares, 1993). Therefore, candidates in other fields find fewer inconsistencies between their beliefs based on previous observations and the beliefs of those who educate them in preparation for their careers. The beliefs that are formed through this "apprenticeship of observation" form challenges for teacher educators to overcome in the methods courses. These challenges go beyond the methods course or even the teacher education program. The traditional methods of teaching mathematics are found in the very profession of teaching itself. Therefore, any effort to change preservice teachers must be an effort to make changes far beyond the methods classroom.

Problem Areas

Wilson and Ball (1996) are recommending that a reform movement in mathematics education must change the nature of the teaching of mathematics at its very roots. These changes are going to be challenging due to the immense amount of tradition that must be overcome in the field of mathematics education (Wilson & Ball). Another very challenging problem for preservice teachers to overcome is the development of an expert blind spot (Nathan & Petrosino, 2003).

Professional inertia. Taylor (2002) refers to the phenomena of tradition that must be overcome as "professional inertia". This inertia begins to work on teachers prior to any training

in colleges of education and is reinforced as soon as they enter a school to begin their teaching career. The preservice teacher has been exposed to this tradition since their earliest educational experiences. One area that exemplifies the concept of professional inertia is in how a mathematician deals with accepted statements. Mathematicians tend to accept statements that have been proven and are generally accepted by the mathematical community. This tendency must be addressed by mathematics educators in order to encourage teachers to unpack these generally accepted statements in order for students to justify the statements themselves (Ball, 1990). Since many secondary mathematics preservice teachers major in mathematics, they are being taught to be mathematicians. Borko, Eisenhart, Brown, Underhill, Jones, and Agard (1992) found that most university level mathematics content courses do not stress meaningful learning of mathematics until the third year of study. The upper level mathematics courses that do stress more conceptual understanding do so at such a high level of rigorous proof and abstract reasoning that the conceptualizing aspect is not apparent. In fact Borko et al. (1992) found that preservice teachers found the methods course to have the most direct impact on their teaching.

Peressini, Borko, Romagnano, Knuth and Willis (2004) suggest that knowledge and beliefs cannot be isolated from the situation in which they are embedded, or the context in which they were learned or developed. This indicates that if teachers are left to develop their beliefs once they are in a teaching position, then their beliefs will be very influenced by their surroundings, which implies that they will be heavily influenced by professional inertia. One opportunity to alter this inertia is to create some momentum in the opposite direction during the secondary methods course by embedding beliefs which are consistent with reform-oriented teaching in the context of the methods course.

Expert blind spot. Nathan and Petrosino (2003) describe how many content area teachers tend to take the structure of their content area and apply that to the learning of their subject. This is especially easy in mathematics, where structure and order are very much a part of the content. Many current teachers already use this structure as the foundation of their teaching. It is important to work with preservice teachers on how to include reform-oriented teaching principles in the teaching of mathematics that incorporate standards based practices prior to their first teaching position. Some researchers are attempting to incorporate reform-oriented content courses into the elementary education program (Hart, 2002), but for many programs the content courses do not offer reform-oriented approaches to the teaching and learning of mathematics. Since preservice teachers are not seeing reform teaching in the content courses, then where will they see a reform-oriented approach to teaching? The mathematics methods course is the most likely source for this type of experience for many preservice teachers.

Shulman's (1986) idea of pedagogical content knowledge and Ball's (Ball, et al., 2001; Hill, Rowan, & Ball, 2005) view of mathematical knowledge of teaching both state the need for knowledge in addition to content knowledge. If beliefs and knowledge are embedded in their contexts, then what contexts are used to address the beliefs and knowledge of preservice teachers outside of the content courses? Therefore, it is imperative that preservice teachers be exposed to reform-oriented ideas in the mathematics methods course before entering an environment that is saturated with professional inertia that is in contrast to reform ideas. Before examining how mathematics methods courses influence preservice teachers, a brief background of the methods course and reform efforts will provide support for the current condition of mathematics teacher education.

Secondary Methods Courses

Current Research on Mathematics Methods Courses

Researchers are finding that mathematics methods courses are effective in changing preservice teachers' beliefs (Benbow, 1993; Shaw, Dvorak, & Bates, 2007; Timmerman, 2004; Wilkins & Brand, 2004). Not only are the preservice teachers' beliefs changing, but the attitudes toward mathematics are changing as well (Robinson & Adkins, 2002). Research indicates that preservice teachers' beliefs change to a more constructivist view when the methods course takes on a more reform-oriented approach (Cady, et al., 2006), but when the methods class remains traditional in nature, then the beliefs are not shown to change. In methods courses that adopt a reform approach, the beliefs and attitudes of the preservice teachers are becoming more closely aligned with reform views of teaching mathematics. These changes include a change in viewing mathematics teaching as requiring a right or wrong answer approach. The preservice teachers also are seeing mathematics as being less rule-oriented (Benbow, 1993). These studies examined elementary preservice teachers. Quinn (1997) reports that elementary teachers' attitudes improve toward mathematics as a result of a methods course, but he also states that the attitudes of secondary teachers do not show improvement. He does suggest that this could be due to the fact that secondary preservice teachers already have favorable attitudes toward mathematics, which results in their attitudes not improving as a result of a methods course. The research on secondary methods courses can provide insight into secondary preservice teachers, the teacher educators and the methods courses.

Research on Secondary Methods Courses

Researchers in mathematics education realize that there is little known about secondary methods courses. This is an area that needs additional research (Lappan & Rivette, 2004; Wilson,

Floden, & Ferrini-Mundy, 2001; Wilson & Ball, 1996). Cooney (2003) points out that "there is a dearth of research about preservice secondary teachers' knowledge of mathematics" (p. 3). Although there is little research on secondary methods courses in mathematics, research is critical in this area. One reason that research on the secondary methods course is critical is because of the preservice teachers' exposure to traditional teaching methods. Ball, et al. (2001) believe that university courses are frequently insufficient to overcome the traditional experiences that have been "washed in" (p. 437) to the preservice teachers' minds though their years of schooling. So the question remains as to what is known about secondary methods courses.

Monk (1994) found that courses in content had less effect on student achievement and pupil performance than courses in mathematics pedagogy, which agrees with other researchers on the effect of additional content knowledge (Mizell & Cates, 2004; Nathan & Koedinger, 2000a; Nathan & Petrosino, 2003). Monk's conclusions indicate the importance of methods courses that include pedagogy, especially content specific pedagogical methods. The importance of the need to include specific pedagogical methods for future mathematics teachers has produced research by Deborah Ball and her associates. Ball, et al. (2001) state "that secondary teachers' conceptual knowledge of elementary mathematics is not significantly stronger than that of their elementary counterparts" (p. 446). This is in spite of the fact that many of the secondary teachers have completed bachelor's degrees in mathematics. This leads Ball et al. to conclude that preservice teachers need to learn the mathematical knowledge for teaching in addition to just content. The extent to which the mathematical knowledge for teaching is appearing in college mathematical methods courses has not been reported, except by studies looking at individual schools or professors. The content that is covered in the mathematics methods course depends on a wide array of influences which are frequently external to the course itself.

Stakeholders in Methods Courses

The content that is required in a secondary mathematics methods course is influenced by many stakeholders. These influences include, but are not limited to, the preservice teachers, mathematics education faculty, mathematics faculty, local school districts (who will serve as cooperating schools during the supervised teaching experience and who will be hiring the teachers), students who will be impacted by the new teachers, state boards of education, certifying agencies, National Council of Teachers of Mathematics, and the Mathematical Association of America. All of these groups have an idea of what is important to include in the methods course. Due to these varied and sometimes conflicting ideas, the content that should be included in a secondary mathematics methods course is not clearly defined. Attempts to identify the content necessary for a methods course and the entire course of study for preservice teachers have been attempted. An examination of these attempts will help understand the current status of the methods course.

Secondary Mathematics Methods Course Content

An early attempt to establish the mathematics necessary for secondary school teachers is recommended by a subcommittee of American commissioners to the International Commission on the Teaching of Mathematics in 1911 (NCTM 1970, pp. 311-312). This committee recommends a methods course that contains both observation and student teaching.

In 1940, the Joint Commission of the Mathematical Association of America and the National Council of Teachers of Mathematics makes recommendations in regard to the content of the mathematics coursework. Their report hints at their vision of the content of the secondary mathematics methods course (NCTM 1940). The commission envisions the methods course to include “the topics that are most intimately connected with the ideas, the concepts, and the basic

processes of mathematics" (p. 191). The commission also makes recommendations as to what mathematics courses should be included in the preparation of secondary mathematics teachers. A course in the history of mathematics is recommended as one of the most vital for all future teachers of mathematics (p. 197). The commission does believe that a course in the history of mathematics must be a very exciting class and not one that is "dry and sterile" (p. 197).

More recently, the Mathematical Association of America provides some input through The Conference Board of the Mathematical Sciences (2001), who published a document that delineates their idea of the important topics to include in a secondary mathematics teacher program. This report includes the mathematics content that should be included in programs that prepare mathematics teachers. The report did not define the pedagogical preparation that the preservice teachers would need in order to be adequately prepared for teaching, but the report contains suggestions that could easily be incorporated into a methods course for secondary mathematics teachers.

The actual mathematical content that should be covered in a secondary mathematics methods course is not definitively concluded in the research. For the purpose of this study, the actual mathematical content is not as much of a concern as the manner in which that content affects the beliefs of preservice teachers. Preservice teachers enter education programs with years of observing teachers, which was referred to earlier in this chapter as the "Apprenticeship of Observation", as described by Lortie (1975). This exposure to the teaching profession causes students to develop preconceptions about teaching and what it means to be a teacher (Bramald, et al., 1995; Cady & Rearden, 2007). Unfortunately, this conditioning of preservice teachers has convinced the future teachers that there is little to learn from the teacher education program (Geddis & Wood, 1997). The preconceived idea that many of the preservice teachers have

imagined as being good teaching consists of transmission (Bramald, et al., 1995; Cooney, 1999; Pratt, 1998). The beliefs that preservice teachers bring into the teacher education program acts as a lens that can influence what and how the teachers learn during their university experience (Borko, et al., 1992; Borko, Listen, & Whitcomb, 2007; Peressini, et al., 2004). In order to facilitate a change in the beliefs of preservice teachers, teacher educators need to find ways to challenge the existing belief structures and systems of the preservice teachers. In today's climate of moral relativism, many educators are not comfortable in challenging students' beliefs. Teacher educators must realize that the goal is not to create an army of teachers who all hold the same beliefs as the teacher educator, but instead the goal is to challenge belief systems that have been in place for many years (Pajares, 1993).

Therefore, the role of the teacher educator is to help preservice teachers identify and examine their beliefs through providing opportunities that challenge the preservice teachers' beliefs and that create dilemmas resulting in inconsistencies in the belief systems of preservice teachers (Grossman, et al., 1993). Bramald, Hardman and Leat (1995) state that "the examination of beliefs and how they relate to practice is crucial to growth and change" (p. 30). Opportunities to examine and change beliefs are provided through the use of a problem-centered approach that focuses on changing beliefs (Owens, et al., 1998). Fennema et al. (1996) suggest that using a model, such as Cognitively Guided Instruction (or CGI), for teaching that is based on research and that can be used by the preservice teachers in their classrooms can produce changes in beliefs. Using a model such as CGI introduces preservice teachers to a model of teaching that focuses on problem solving and engaging students in order to examine how students think and learn mathematics. The need to introduce preservice teachers to the reform-oriented teaching of mathematics is supported by Borko et al. (2000), who agree with the need to introduce teachers

to reform-oriented mathematics in the methods course. The need to create opportunities to change beliefs must be coupled with opportunities to examine their existing beliefs. The process of examining their beliefs and reflecting on activities that occur in the coursework must be intentional for the purpose of creating reflective practitioners.

Creation of Reflective Practitioners

One important ingredient which is necessary in the process of changing preservice teachers' beliefs is reflection. Teachers will not change their beliefs if they do not examine those beliefs, and reflect on the beliefs in light of experiences that challenge their current belief systems (Grossman, et al., 1993; Pajares, 1993; Wilson & Cooney, 2002). Reflection is not a natural process that preservice teachers bring into a teacher preparation program. Instead, reflection is a skill that must be developed and taught (Shulman, 1988). Cooper's study shows that preservice teachers who spend additional time in the university setting and less time in a classroom setting tend to have better reflection skills than their counterparts who spend more time in classroom settings (Cooper, 1996). Cooper's results also indicate that the students who reflect were more likely to implement reform methods in their classrooms. This finding is in contrast to the views of student teachers who believe that they receive better preparation during their time in actual classrooms (Geddis & Roberts, 1996; Geddis & Wood, 1997). In fact, research indicates that the ability to reflect can assist new teachers in resisting the professional inertia that exists in schools and tends to pull teachers away from using reform-oriented methods in their teaching (Pajares, 1993). Pajares states that it is this "emphasis on reflection that marks a difference between education and training" (p. 47) in the preparation of new teachers.

The act of reflection, or metacognition, is critical not only to reform, but also to creating consistency between a teacher's beliefs and practices (Cooney, et al., 1998; Thompson, 1992).

Creating teachers, who are reflective, needs to be a key topic in teacher education programs (Wilson & Cooney, 2002), especially in the methods course. The use of videos to encourage reflection can be a beneficial approach in a methods course (Capraro, Capraro, & Lamb, 2001). The videos can allow teacher educators to assist preservice teachers in developing skills of reflection that include examining beliefs and not merely summarizing the events of a lesson. Exposing preservice teachers to research is another method of creating reflective practitioners who are able to become reform-oriented teachers (Richardson, 1990). Muis (2007) makes the argument that metacognition requires preservice teachers to possess a set of epistemological standards to be used as inputs for the metacognitive process. These epistemological standards are derived from the preservice teachers' own beliefs. Therefore, it is imperative that the preservice teachers develop a set of beliefs that agree with a reform view of teaching and learning mathematics if they are to develop the metacognitive skills necessary to support their own reform teaching.

The practice of reflection allows preservice teachers to internalize the ideas that they are experiencing. Cooney et al. (1998) state that teachers cannot become reflective practitioners until their knowledge is constructed using their own voice as a partner in the process of internalizing the information. This process of internalizing not only changes their beliefs about the ideas, but internalizing also begins to change the view that the teacher holds about the source of the authority for these ideas. As teachers begin to internalize their beliefs, then they begin to develop an internal locus of authority. This internal locus of authority needs to be a goal of teacher preparation programs, but especially methods courses (Cady, et al., 2006).

A methods course cannot meet for a long enough period of time to completely transform preservice teachers into the type of reflective practitioners that are needed to become reform

teachers. The task of changing the beliefs of preservice teachers cannot fall on the methods course teachers alone, but must be accepted by the teachers of every course that the preservice teachers take. Preservice teachers need to be challenged in every mathematics course in order to create the cognitive dissonance that is necessary to begin the process of making meaningful changes to their belief systems.

The methods course consists of many aspects that are tied deeply to teacher education and to content. One cannot possibly get a complete picture of the mathematics methods course without examining how these courses have developed. In order to understand how the development of the mathematics methods course occurred, one must understand the historical foundation upon which the methods course has been built.

History of Mathematics Methods Courses

The history of mathematics education in the United States is inextricably tied to the history of educating teachers. Training teachers dates back to 1823 when the first school was opened for the purpose of preparing more competent teachers (NCTM, 1970, pp. 302-303). This was followed by formal teacher education programs at major universities as early as 1832 (p. 31).

In the mid 1800's, Textbooks began to appear for the purpose of teaching secondary methods to teachers. The first book written domestically was by Davies in 1850. The book might not fit the current idea of a mathematics methods course, but did include some content and some professional knowledge (NCTM, 1970, p. 31). The first textbook that addressed pedagogical approaches to the teaching of mathematics for elementary teachers did not appear until *The Philosophy of Arithmetic* by Edward Brooks in 1880. The increased attention on methods for

teaching mathematics is evident by how quickly textbooks began to proliferate in the Twentieth Century (p. 307).

In 1892, the commonly named Committee of Ten, which is an appointment of the Committee on Secondary School Studies, is formed (NCTM, 1970, p. 33). Under the Committee of Ten, subcommittees are formed, one of which is devoted to the field of mathematics. This subcommittee becomes the first national panel to consider mathematics education in light of a field of study requiring goals and curriculum.

The early 1900's brought about the beginning of educators specializing in teaching mathematics, who are recognized as "mathematics educators" (NCTM, 1970, p. 42). Many of the mathematics educators of the early 1900's are deeply rooted in the field of mathematics. These individuals see a need in improving the preservice education of mathematics teachers.

The years from 1900 to 1920 brought about many changes in mathematics education. In 1908, the International Commission on the Teaching of Mathematics is formed in Rome. One subcommittee to this commission is focused on elementary and secondary mathematics teaching in the United States (NCTM, 1970, p. 311). The reform efforts of the early 1900's precipitate the development of three groups who show an interest in the mathematical education of students in America's secondary and post-secondary schools. At that time, these groups are known as the Central Association of Science and Mathematics Teachers in 1903, the Mathematical Association of America in 1915, and the National Council of Teachers of Mathematics in 1920 (p. 314). These groups will have a tremendous impact on the advancement of the secondary mathematics program at the collegiate level.

By 1940, the mathematics methods course was already established. The future of the mathematics methods course will be greatly impacted by a 1940 report that is a joint project

including the Mathematical Association of America and the National Council of Teachers of Mathematics (NCTM, 1940). In this report, the commission set forth a challenge to create courses that address the methods necessary for teaching mathematics. The council suggests that the methods course should precede the student teaching experience (p. 191). The council also suggests that "Some phases of the work of the methods teacher should be carefully correlated with instruction that students receive in mathematics" (NCTM, 1970, p. 191).

These events begin a trend in creating mathematics methods courses across the United States. The growth was not immediate as the United States Office of Education report on a 1959 survey states that only about two-thirds of the secondary mathematics teachers completed a student teaching experience in their college preparation (NCTM, 1970, pp. 328-329). The same teachers report that they had received very little training in mathematics methods while in college. This poses a serious problem in the training of teachers, but according to a survey given in 1968 (p. 309, 342), universities are shown to be giving increased attention to mathematics methods courses during the 1960's. A focus on the methods course is not the only change in mathematics education during this time. The very nature of the teaching of mathematics is changing at the same time.

Reform Attempts to Teaching Mathematics

There have been many efforts to reform the teaching of mathematics. In the early 1900's, reform is beginning to occur in response to reports of how teaching was occurring in mathematics classrooms. The current state of teaching in the early 1900's is captured by Romiett Stevens, who writes about classrooms that she visited from 1907 – 1911 (Cuban, 1993, pp. 35-36). She found that teachers talk about 64% of the time. She also found that when students do talk, much of the talk consists of one-word responses. Just three years later, a report by the State

of New York reaches similar conclusions about the state of mathematics teaching at the time (p. 36). As a result of the formation of groups interested in mathematics education, many reform efforts begin to develop in the Twentieth Century.

The "new math movement" of the 1960's is one such attempt. Several events may have precipitated the movement, but the movement is frequently attributed to the success of Russia in launching Sputnik on October 4, 1957 (Garber, 2007; Herrera & Owens, 2001). Sputnik is not the only factor leading to the "new math movement". Efforts such as the University of Illinois Committee on School Mathematics and the College Entrance Examination Board also recommend changes to the existing mathematics curriculum in an effort to improve the teaching and content of mathematics at the secondary level (Herrera & Owens; Osborne & Crosswhite, 1970). The "new math movement" is remembered as being very popular in the 1960's and 1970's, but its influence begins to fade from the mainstream in the 1970's and 1980's. New theories about human learning begin to become popular concurrently with the demise of the new math movement.

During this time, the idea that people learn from experiences is beginning to change how many mathematics educators believe that mathematics should be taught to students. In the 1980's and 1990's, many mathematics educators are beginning to see a need to change the attitude that teaching consists of the "sage on the stage" (King, 1993, p. 30) and teaching by "'mimetic' tradition" or "imitative assimilation" (Ball, et al., 2001, p. 435). Mathematics is being viewed as a participatory learning experience instead of a passive spectator event. The method of teaching in a mathematics class is at the heart of the reform movement that is occurring today.

To many, the term "reform movement" refers to an ongoing change in mathematics education (Van de Walle, 2004). This change tends to pattern the recommendations of the

NCTM. In 1989 this trend begins with the introduction of the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), which was to be revised with the release of the Principles and Standards for School Mathematics (NCTM, 2000). In 2006, the latest adjustment to the standards by the NCTM is presented in the Curriculum Focal Points (NCTM, 2006), which attempt to point out the big ideas that should be addressed at each grade level in pre-kindergarten through eighth grade. A defining characteristic of the reform movement in mathematics is the role of the teacher and student. Ball, Lubienski and Mewborn (2001) state that "what teachers and students are able [to] do together with mathematics in classrooms is at the heart of mathematics education" (p. 433). The role of the teacher is no longer the "sage on the stage" in a reform-oriented classroom.

Summary

The beliefs, that a teacher holds, not only influence how the teacher views the learning of mathematics, but those same beliefs influence how the teacher will conduct her/his classroom. The teacher's beliefs do not act as a separate entity, but work together with other orientations as part of a larger model. This model includes six different aspects, including orientations, which are identified with three main dimensions. Considering this model, the role of the teacher educator resembles that of a conductor trying to conduct the methods class as a symphony where all of these various ideas are woven together in a fashion that will create a preservice teacher who is ready to take on the role of a reform-oriented mathematics teacher.

A problem that stands in the way of successfully accomplishing the goals of this model is that teachers' beliefs have been formed through years of observation of the profession of teaching. These conceptions are very difficult to overcome, but require attention from the teacher educator. In order to change these long-held beliefs, teacher educators must provide conditions

that challenge the existing beliefs, belief structures, and belief systems of the preservice teachers. Only when these beliefs are challenged will the preservice teachers begin the process of changing their beliefs. The opportunities that are provided for challenging the beliefs of preservice teachers cannot be isolated from the practices that coexist with the beliefs. The research favors the idea that beliefs and practice must change mutually. This change does not occur in a linear fashion where a change in beliefs precedes a change in practice, but instead changes in beliefs and practice occur together. Changing the beliefs of teachers does not guarantee that the teacher will implement these beliefs in the classroom. Preservice teachers also need to develop an internal locus of authority toward reform ideas in order for the teachers to develop a greater potential to affect change in their classrooms. These changes can only occur if teacher educators intentionally address these issues in the teacher preparation program. The secondary mathematics methods course is a great opportunity to address these issues while incorporating all of the various parts of the Comprehensive Framework for Teacher Knowledge model of Ronau and Taylor (2008).

The history of mathematics methods courses provides insight into the changes that have occurred in mathematics education over the past century. Many reform efforts have been undertaken during the past 100 to 150 years. Some of these, such as the New Math movement of the 1960's and 1970's, have become obsolete. The current reform effort faces similar challenges to its predecessors. In order for this reform to continue, teachers must overcome the current professional inertia (Taylor, 2002) that exists in teaching.

The current reform effort is based largely on the standards set forth by the National Council of Teachers of Mathematics (NCTM, 2000). These efforts will not be successful unless teachers accept them and implement them into their own classroom practices. The secondary

mathematics methods course is a great opportunity to provide preservice teachers with the exposure necessary to generate a favorable opinion about the standards while at the same time providing stimuli to generate a change in the beliefs and practices of these preservice teachers. The methods course also provides mathematics educators with a golden opportunity to model reform-based teaching practices. This method of teaching may be foreign to many preservice teachers, so the need is thrust upon mathematics educators to model these practices.

Little research has been conducted on secondary mathematics methods courses to determine if reform-oriented teaching is occurring in the methods courses. Small scale research studies have been conducted (Geddis & Wood, 1997; Kinach, 2002a; Quinn, 1997), but there has been little research on a large scale. The big picture of what constitutes a secondary mathematics methods course is still a nebulous image that is not consistent from institution to institution.

The research indicates that little work has been conducted in the area of secondary preservice teachers' beliefs. The impact of these beliefs on the children who will sit at the feet of these future teachers requires that the mathematics education community gain a greater understanding of the degree to which preservice teachers' beliefs are changed in the methods course. Additionally, the practices that generate these changes need to be identified in order to contribute to the body of knowledge that is available for the entire community of mathematics educators.

Chapter 3: Methodology

This chapter discusses the methods used to test the research questions from Chapter 1. Due to the nature of this study, a mixed-methods approach was used to address the need to examine what was taught in the methods courses and the beliefs of the preservice teachers. In order to examine what was taught in the methods course, a qualitative approach was used on syllabi collected from mathematics teacher educators' secondary methods courses. In order to triangulate this data, additional data was collected through interviews with randomly selected professors from the sample set and examination of the texts used in the methods courses. A quantitative approach was used to examine preservice teachers' beliefs. The data was collected through a beliefs survey. The unit of analysis for this study was the class. This allowed a comparison of the teaching methods for each class with the beliefs of the students in that class.

Qualitative Study

The first research question was to identify which methods were used in secondary mathematics methods courses that challenged preservice teachers' existing belief systems. In order to answer this question and its subsequent questions, a qualitative study was used to examine course syllabi along with interviews of randomly selected educators. The participants, the instrumentation and the methods of analysis all support the questions.

Participants

This study consisted of two groups of participants. The first group of participants was comprised of mathematics educators who teach secondary mathematics methods courses. This group was chosen purposefully (Patton, 2002). The reason for purposeful sampling in this sample is to ensure that educators were chosen who subscribe to reform methodologies in their methods courses. Due to the qualitative approach in this portion of the study, the sample size was

intentionally kept at a manageable size. In order to obtain a sample that represents the nature of reform in the methods course, the sample included a variety of educators from colleges and universities around the country. A sample size of least ten educators representing the West, Mid-West, North-East, South-East and South-Central parts of the county provided at least two educators from various parts of the country. The educators selected for this research represent colleges and universities representing diverse situations. The schools represented range from very small private colleges to very large state institutions. Although the educational backgrounds of the participants vary, an effort was made to select participants who have completed a terminal degree either in mathematics, mathematics education or education. In order to select educators who espouse reform-oriented ideologies, the educators were selected from the membership of the Association of Mathematics Teacher Educators (AMTE) organization. Therefore the population consisted of all teachers, or co-teachers, who were members of the AMTE at the time of the study.

Since this study is addressing how the methods used by these educators match the Comprehensive Framework for Teacher Knowledge model of Ronau and Taylor (2008) and how the incorporation of these methods in the individual courses impacts the preservice teachers' beliefs about mathematics, the unit of analysis was conducted at the classroom level. The unit could be considered either the educator or the course. For the purpose of this study, the course was used as the unit of study. As was mentioned in chapter 2, when the course is the unit of study, the sample sizes are generally very small. This study is seeking to increase the number of samples used in the analysis in order to gain a broader view of the teaching methods used in the secondary methods courses. Another important area that was considered is how to collect data on what methods are used in the secondary methods courses.

Instrumentation

Methods courses tend to vary greatly from school to school (Taylor & Ronau, 2006). Therefore the type of instruction that occurs in each of the courses needs to be identified. A method that has been used to do this is an analysis of course syllabi (Harder & Talbot, 1997; Taylor & Ronau). This process required obtaining course syllabi from the participants of the study. Once the syllabi were collected, then an analysis of the course goals, objectives, projects, activities and grading procedures was compared in order to identify common themes. The themes that emerged from the analysis of this data provided insight into the degree to which the courses were taught from a reform-oriented perspective. Possible indicators as to the degree of reform-oriented teaching that occurred can be the level of educator instruction and student exploration. Another possible indicator was the grading procedures. If grades were determined by a percentage correct or incorrect instead of rubrics examining the amount of learning on the part of the preservice teachers, then this indicated a lower level of reform-oriented teaching.

Course syllabi did not always provide sufficient evidence of the type of teaching that occurred in a course. Therefore, a potential benefit was considered from randomly selecting participants for the purpose of conducting an interview. The purpose of the interview was to determine the level of reform-oriented teaching that occurred in the course selected. The information from these interviews was analyzed and compared to the data from the syllabi in order to determine the amount of agreement between the syllabi and the interview.

Data Analysis

Due to the nature of the data obtained through the syllabus study, a qualitative analysis is required. Patton (2002) offers a procedure for analyzing qualitative data. He suggests that a content analysis of the data must be conducted in order to identify common themes and patterns.

In order to begin a content analysis of the syllabi data, the syllabi were read. While reading the syllabi, an initial coding scheme was developed that began to categorize the data by identifying themes that emerged from the data. Once the first round of coding was completed, then the data were analyzed again to ensure that all important points fit in the coding categories. When some data did not fit in an appropriate category or the categories were found to overlap, then a second round of coding was required. Since several potential category schemes were found, then the need arose to prioritize the categories in order to determine which were of most value.

In order to provide a degree of triangulation to the data analysis, teacher educator interviews were analyzed. The transcripts of these interviews were examined in a manner similar to the syllabi. The interviews were read for the purpose of coding and identifying emergent themes from the transcripts. Once themes were identified, then these themes were matched to the results of the syllabi analysis for each of the teacher educators who are selected. Since the interview data corresponded to the syllabi data, further interviews were not conducted.

Once the themes or categories were identified through analysis of both the syllabi and interviews, then the categories were evaluated to determine if each category represents a reform-oriented approach to teaching. The teacher educators were then identified by the degree to which they incorporate reform approaches in their methods courses. The methods of identifying any changes to students' beliefs about mathematics were then examined.

Quantitative Study

The second research question considered how the beliefs of preservice teachers have changed. The question and the subsequent questions attempted to identify if the preservice teachers' beliefs have become more in line with reform-oriented views of teaching and if a positive correlation exists between using a multilevel model of teacher knowledge and preservice

teacher beliefs. In order to identify and analyze students' beliefs about mathematics and the teaching and learning of mathematics, a quantitative approach was used. The participants, the instrumentation and the procedures used in this part of the study are outlined to provide information about the quantitative portion of the study.

Participants

In this part of the study, the beliefs of the students were examined. This incorporated the second group of participants for this study. The participants for this portion of the study were the students, or preservice teachers, who were enrolled in the secondary mathematics methods courses that were taught by the teacher educators from the previous section. The students were not randomly assigned to the methods courses being studied, but the students did represent a population of preservice teachers who were undergoing a treatment, which was their exposure to a methods course. The ages of the students varied due to the various ages present in the teacher education programs. There were some non-traditional students, but most students were traditional college students pursuing their initial teacher licensure in the area of secondary mathematics. For the purpose of this study, these two groups were treated as one group because the unit of analysis will be the class and not the individual student.

The gender makeup of the classes depended upon the classes that were used in the sample. The gender of the preservice teachers was not treated as a separate category due to the unit of analysis. The preservice teachers attended universities and colleges of various sizes and ideologies. Some of the universities were state institutions while others were small private schools. The purpose of using a variety of schools was to provide a broad representation of the preservice teachers who attended a secondary mathematics methods course.

In the process of this study, data was collected from the preservice teachers that identified their beliefs about mathematics, and identified their beliefs about the teaching and learning of mathematics. This required the use of an instrument to obtain a measure of the preservice teachers' beliefs.

Instrumentation

Numerous instruments have been used to assess teachers' beliefs. The Mathematics Belief Instrument (MBI) is used by researchers to assess the mathematics beliefs of preservice teachers (Furner, 2000; Hart, 2002; Wilkins & Brand, 2004). The MBI is comprised of 30 questions that incorporate a Likert scale type of answer to differentiate student responses. The first 16 questions (Section A) identify how the teachers' beliefs align with the NCTM standards. The next 12 questions (Section B) address the teachers' beliefs about the learning and teaching of mathematics. The final 2 questions (Section C) address teachers' sense of self-efficacy.

The first 16 questions of the MBI are an adaptation of the Standards Beliefs Instrument by Zollman and Mason (1992). Furner (2000) states that the purpose of the Standards Beliefs Instrument is to assess teachers' beliefs about mathematics in relation to the NCTM Standards. The MBI incorporates questions from the Standards Beliefs Instrument for the purpose of identifying how teachers' beliefs align with the NCTM Standards. This approach is necessary to identify preservice teachers' beliefs about the NCTM Standards and how those standards impact the teaching of mathematics.

The second 12 questions of the MBI are directed at identifying the teachers' beliefs about how students learn and how teachers teach. These questions attempt to identify the degree to which the teacher has adopted constructivist approaches to the learning and teaching of mathematics. The questions attempt to present reform and traditional approaches in such a way

that some questions lead with reform views and other questions lead with traditional views. This approach does not promote the preservice teachers' selecting all responses to be of the same value on the Likert scale. In order to evaluate the results, all questions were rearranged in order to provide scales that use the lowest value to represent the traditional views and the highest value to represent more constructivist views toward the teaching and learning of mathematics. In order to interpret the results, the procedures that were used to analyze the data will be discussed.

The MBI was designed to identify the beliefs held by teachers and pre-service teachers in the area of elementary education. In order to use the MBI, several of the questions required rewording to change from an elementary perspective to a secondary focus. There were two questions that required a major change in order to change the focus from elementary to secondary education. In order to ensure that the nature of the tool was not changed, the authors of the study involving the use of the MBI were consulted. The changes to the questions were made with their input and suggestions. Once these researchers agreed that the changes would not affect the nature of the MBI, then the tool was sent to the instructors for use with their methods courses.

Procedures

Analysis of the data was conducted by entering the data into the Statistical Package for the Social Sciences (SPSS). The preservice teachers were grouped by their teacher educators. The analysis consisted of examining the mean of the various sections of the MBI and comparing the means to the degree of reform approaches found in the qualitative analysis and resulting CFTK rubric. Since the unit of analysis for the study is the course or teacher, the results of the individual students were not used for analysis.

Since the purpose of this study is to identify if the degree of the preservice teachers' reform beliefs are related to the degree of implementation of CFTK used by the teacher educator, then a test was required that would identify if the difference in the pre and post MBI scores of the preservice teachers are related to the degree of implementation of CFTK as determined by the rubric. Since the data are not nominal or ordinal, a chi-square test of independence could not be used. Therefore, a linear-regression analysis was used to determine if there was a significant relationship between the differences in the MBI pre-tests and post-tests and the degree of implementation of CFTK.

If the preservice teachers' beliefs are found to have a significant correlation to the degree of reform methods used in the methods course, then an analysis was conducted to determine if the differences in the beliefs of the means of the various groups of classes was statistically different. Due to the number of samples being 16 and the lack of data indicating the normality of the MBI data when applied to courses, a non-parametric test was chosen. The test that was chosen for this analysis was a Wilcoxon signed-ranks test. If this results in a significant difference, then the methods used by the teacher educators will be shown to have a significant influence on the beliefs of preservice teachers in an educator's course.

For the second part of question two, analysis was conducted to identify the correlation between the independent variable, which is the degree of incorporation of the multilevel model of teacher knowledge, and the dependent variable, which consists of the preservice teachers' beliefs as found on the MBI. The data was analyzed using SPSS. The resulting correlation coefficient was used to identify if the correlation is positive or negative and the coefficient will be used to determine the strength of the correlation.

Sample Description

Data was collected from a diverse group of colleges and universities for this study. Instructors at fifty universities and colleges agreed to participate in distributing the surveys. In order to obtain permission from the majority of these universities, Institutional Review Board (IRB) protocol had to be completed at each institution. Due to challenges incurred through this process only twenty-four institutions actually participated in the initial survey. Of these twenty-four institutions, only 22 completed both the pre and post surveys. Of the 22 institutions that completed the pre and post surveys, only 16 submitted their syllabi.

These 16 institutions represent schools ranging in size from 1,950 students to over 42,000 students as can be seen in Table 2. The institutions are located in 12 different states representing the West, Mid-West, North-East, South-East, and South-Central sections of the United States. Of these 16 institutions, 5 are considered research institutions under the Carnegie Foundation classification system (The Carnegie Foundation for the Advancement of Teaching, 2010), 11 are listed as having master's degree programs with 2 being medium size and 9 being large size. Four of the institutions are private and the remainder is composed of public institutions, which can be seen in Table 3. The department offering the secondary methods course is mixed between the College of Education and the Mathematics Department with eight institutions offering the course through the Mathematics Department and eight institutions offering the course through the College of Education. The schools located in the South-Central part of the United States both offer their methods course through the College of Education while both schools in the West offer their methods courses through the mathematics department. Of the four private institutions, all four offer the methods course through the college of education. Table 4 shows the degree of research, according to Carnegie Foundation's data (The Carnegie Foundation for the

Table 2: *Size of Universities*

Number of Students	Number of Schools
1 – 10,000	7
10,001 – 20,000	6
20,001 – 30,000	2
Over 30,000	1

Table 3: *School Locations and Public vs. Private*

Location	Public	Private
Mid-West	3	1
North-East	2	2
South-East	3	1
South-Central	2	0
West	2	0

Table 4: *Degree of Research vs. Public or Private Institution*

Degree of Research	Private	Public
High Research	1	1
Very High Research	1	1
Doctoral Research		1

Advancement of Teaching), and the department where the methods class resides at each institution. The Carnegie Foundation lists the institutions' as H or high research activity, VH or very high research activity, or DRU as doctoral research universities.

The instructors of the methods courses have various backgrounds. Table 5 shows the type of terminal degree held by the instructors. Eleven of the professors hold doctorates in mathematics education. Two other professors hold doctorates in Curriculum and Instruction with an emphasis in either mathematics or mathematics education. Two other instructors hold doctorates in Curriculum and Instruction with no emphasis in mathematics or mathematics education, while the final doctorate is in the area of Educational Administration. The amount of secondary and middle school classroom experience for each instructor was found through the interview process. Therefore this data is available for the 7 interviewees and one additional instructor who provided such information. Of these instructors two had no teaching experience outside of student teaching. One instructor had taught for only one semester. The remainder of the instructors ranged from eight to 17 years of experience.

Table 5: *Doctorate Degree Held*

Doctorate Held By Professor	Number of Professors
Math Education	11
Curriculum & Instruction (emphasis in mathematics)	2
Curriculum & Instruction (emphasis not in mathematics)	2
Educational Administration	1

The instructors had class sizes that range from as few as 3 students to as many as 27. The students in these classes represented a mixture of traditional and non-traditional students. For the purpose of this study, non-traditional student refers to any student whose age was 24 years or above. The classes ranged from a low of no non-traditional students, which occurs in only 2 classes, to being completely comprised of traditional students, which occurs in only 1 class. The mean percentage of traditional students in the 16 courses was 66.0 percent (SD = 27.0). The placement of the class in the students' studies varied. In order to provide an idea of where the methods course occurred, the number of mathematics courses taken by the students prior to the methods course was examined. The mean of all 16 of the mean number of mathematics courses taken by students at each school is 9.6 courses (SD = 1.57). The range of the individual class means was from 6.5 mathematics courses to 11.9 mathematics courses.

Chapter 4: Findings

This chapter will address the research questions put forth in this paper. In order to answer the research questions, the sample data from the classes will be discussed. This will be followed by an analysis of the data obtained from this data set. Then the sample data from the students will be discussed. The student data will be followed by an analysis of that data. The final analysis will be to compare the class data and the student data.

Class Data

The class data were obtained through a combination of sources. The first source was the course syllabi from the various classes used in this analysis. The second source of data was taken from interviews with selected instructors of the various classes used for this analysis. The third source of data was the textbooks used for each of the courses. These three sources of data were used to triangulate the data used to identify the degree to which each class incorporated a reform approach to teaching the methods course.

The course syllabi were sent to the researcher either electronically or as a hardcopy included with the student surveys. The initial evaluation of these syllabi revealed many themes which were relevant in identifying how the instructors incorporated the NCTM's PSSM and aspects of CFTK. These themes were compared and common themes were combined, which reduced the number of themes from 28 to 10. The identified themes are shown in Table 6.

In order to create a rubric to be used in identifying the level of reform teaching in each class (based upon the syllabi); the themes were further broken down into levels of implementation. The levels of implementation were identified through a comparison of the

Table 6: *Themes Found in Syllabi*

Theme	Number of Schools
NCTM Membership	16
Readings	12
Use of the NCTM's PSSM	11
Unit Plans/Lesson Plans	11
Presentation of Lesson to Peers	11
Assessment Practices	11
Observation of Teaching	10
Technology	9
Manipulatives	6
Attention to Diversity	5

description of CFTK, as proposed by the principal designers of CFTK (Ronau & Taylor, 2008), and the ways that each of the components of CFTK were found to occur in the course syllabi. The instances where various courses addressed one of the aspects of CFTK were compared to identify how the implementation of that aspect matched the intent of the aspect as proposed by Ronau and Taylor. In order to ensure that the levels of implementation were comparable to the intent of CFTK, the rubric was sent to a designer of CFTK for his expert opinion about the rubric's effectiveness at examining the degree of implementation of the aspects of CFTK. He examined the rubric and made recommendations to ensure that this rubric followed the intent of CFTK. These recommendations were implemented in the rubric prior to the use of the rubric to

evaluate the degree of implementation of CFTK in each course. This was done in the same manner as the identification of the themes where each syllabus was read and read again to ensure that the key points in each syllabus would fit into one of the levels of implementation of each theme.

The way that these themes were used in creating the rubric required examining the way that the themes were used in each course. The manner that the theme was implemented indicated various levels of implementation of that theme. One example was the way in which NCTM membership was implemented in each course was used to identify the levels of involvement for the Environment aspect. The manner in which attention to diversity was implemented in each course was used to help identify the levels of involvement included in the Individual aspect. Similarly, the implementation of the assessment practices was used in determining the Cognition aspect. The various ways that the instructors used presentations by the teachers and preservice teachers in the courses were used to help create the pedagogy and content aspects of the rubric. The manner that instructors used manipulatives and technology provided some help in creating the content and pedagogy aspects of the rubric. The orientation section of the rubric required a synthesis of several themes. These themes included the readings, unit plans, lesson plans, presentations, and observations. The reason a synthesis of these themes was needed was that each of these themes included attempts at examining the beliefs of the preservice teachers. Finally, the ways that the readings and the PSSM were incorporated into the courses helped with several of the aspects, but were difficult due to the lack of information about the exact articles and the lack of detail about how the articles were used.

Once this was completed, then the rubric was ready to use for examining the syllabi. The same rubric was used to examine the interviews in order to draw a comparison between the

interviews and the syllabi. In order to use the rubric on the interviews, the transcripts of the interviews had to be read and analyzed in the same manner as the syllabi. The analysis of the interview transcripts included an initial reading to search for additional themes that were not present in the syllabi. This review did not provide insight into any new themes that did not appear in the syllabi of the various courses.

The third piece of information used to triangulate the degree of reform teaching in each class was the textbook used in the course. The name and author of the textbook was obtained from the course syllabi, where available. In other cases the course instructor was contacted in order to obtain this information. Copies of each of the textbooks were obtained for use in the analysis. A rubric was created in order to evaluate the degree to which the textbooks incorporated the ideas of the Comprehensive Framework for Teacher Knowledge (CFTK). This rubric produces a range of scores from 0 to 30 for each book where 0 represents no integration of CFTK in the textbook and 30 represents complete alignment between CFTK and the textbook. In determining how to derive a total score for textbooks, several options were considered. The mean of the scores was determined to not suffice as a course that used multiple books would not be differentiated from a course that used only one book. A rubric could have been developed to incorporate the number of books used in a course, but that rubric would need to be in addition to the CFTK rubric used to evaluate each book. Another approach was to use the sum of the rubrics for all books used in a course. This would allow courses using multiple books to have a higher score than a course using only a single book.

In comparing the data from the 3 sources of information (the syllabi, the interviews and the textbooks used), it was necessary to find a method to compare the data since the measures used to analyze the syllabi and interviews provided different ranges of possible scores than the

textbook analyses. The method used to compare these sources of data was to convert each score into a rank so that the ranks could be compared to identify if the course receiving the highest rank for the textbooks was the same as the rank for the course syllabi and the rank of the interviews. When comparing the ranks of the entire group of courses, the rank of the syllabi was found by taking the results of the syllabi, found by scoring the syllabi with the CFTK rubric designed to determine the degree of CFTK mentioned in the syllabi, and labeling the highest score with a 1, the second highest score with a 2 and likewise until the lowest score on the rubric resulted in a rank of 16. In the event of a tie, each score was treated as a separate ranked score and then the ranks of all of the positions occupied by the tied scores were used to find a median rank for the tied scores. For example, if there were three scores tied for a rank position of 2, then they were treated as ranks 2, 3 and 4 and the median of these three scores was 3. The rank for each of the tied scores was then replaced with this median. This was repeated for the results of the textbook and interview analyses. A similar process was then conducted on the MBI scores for both section A and section B to provide a ranking system for them. It was discovered that there was little similarity between the three sources of data from the courses. An example of this is that the school using the most books and the most reform-oriented books only ranked in a tie for 9^{th} and 10^{th} place in the rankings of the syllabi, out of a total of 16. Similarly, the course who used no reform textbooks and ranked last in that category was ranked 6^{th} for the course syllabus.

The ranks of each course's mean MBI score for Sections A and B were then used to conduct a correlation analysis to see if each score's relative standing provided any insight into the amount of correlation between the various scores on the syllabi, interviews and textbooks. Due to the nature of the data in these analyses, a Spearman's rho was calculated to identify the degree of linear correlation. The results of the correlation analysis using the entire group of courses and

section A of the MBI indicated a significant negative correlation between the syllabi rank and the results on section A of the MBI, $\rho(14)= -.608$, p =.012. The scatter plot of the data can be seen in Figure 2 below. This indicated that as the rank of the syllabi increased, the rank of the MBI score decreased. Another way to say this is that the syllabi that indicated the lowest degree of implementation of CFTK correspond to the highest MBI scores. The results of the textbook ranks did not show a significant correlation to the MBI scores on section A, $\rho(14)=-.156$, p=.563.

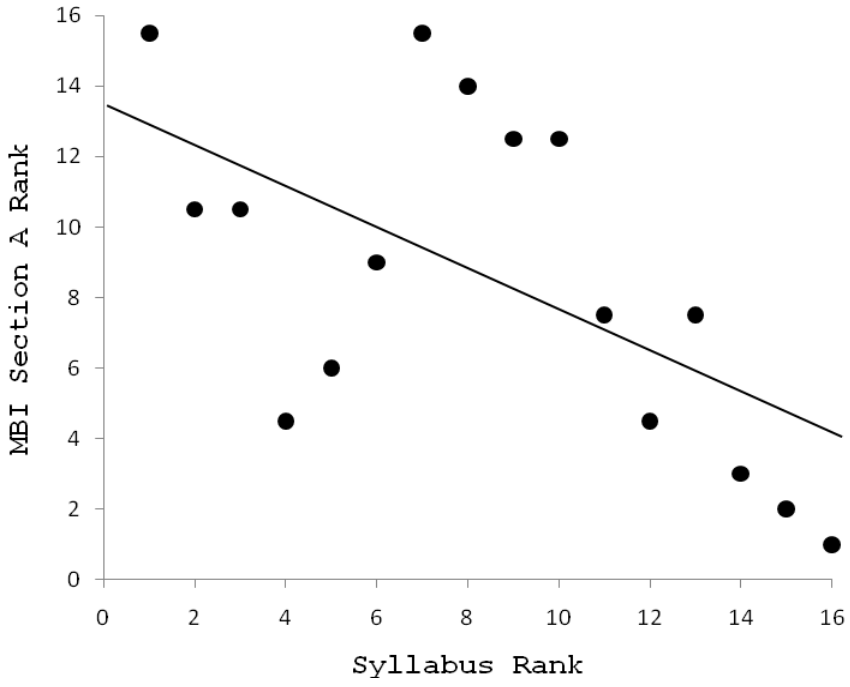

Figure 2: *Syllabus rank and MBI Section A rank*

The results of the correlation analysis using the entire group of courses and section B of the MBI indicated no significant correlation between the syllabi rank and the results on section B of the MBI, $\rho(14)=-.249$, p=.351. The results of the textbook ranks did not show any significant correlation to the MBI scores on section B, $\rho(14)=.086$, p=.753. As before, due to only 7

instructors participating in the interview process, the interview data is not included here, but instead discussed later.

When taking into consideration only the instructors who were interviewed, there is a significant correlation between the ranks of the results of the interviews and section B on the MBI. When ranking the interviews based on the results of the rubric used to evaluate the interviews and the ranks of the results of section B of the MBI there is a significant correlation, $\rho(7)=.826$, p=.022. These results indicated that there is a significant correlation between the rank of the results of the interview analysis and the results on section B of the MBI. For the same seven instructors, the correlation analysis comparing the ranks of the Syllabi, based on their rubric results, and the ranks of the textbooks, according to their rubrics, all showed no significant correlations. The correlation of the syllabi ranks and the MBI section B scores indicate a negative correlation that is not significant, $\rho(7)=-.444$, p=.323. The correlation of the textbook ranks and the MBI section B scores indicated that there is not a significant correlation between the ranks of the results of the textbook analysis and the rank of the results of section b of the MBI, $\rho(7)=.345$, p=.448. This indicates that only the interviews show a significant correlation with the ranked results of the MBI section B.

The results for section A of the MBI are less significant than for section B when comparing only the courses that included instructors who participated in the interviews. The correlation of the interview ranks and the MBI section A ranks also indicated that there was no significant correlation between the rank of the results of the interview analyses and the ranks of the results on section A of the MBI, $\rho(5)=.382$, p=.398. The correlation analysis of the course syllabi ranks compared to the ranks of the MBI section A scores indicated there was not a significant correlation, $\rho(5)=-.382$, p=.398. The correlation analysis of the textbook ranks and the MBI

section A scores indicated that there is not a significant correlation between the two variables, $\rho(5)=.108$, p=.818. These findings indicated that there is no correlation between the ranks of any of the collected data for the instructors who were interviewed and the ranks of the results on the MBI section A.

The analysis of the ranks did not find consistent results between the syllabi, the interviews and the textbooks. Therefore, the qualitative data is used to find commonalities among the three data sources. The syllabi analysis and interview analysis did reveal many common themes that can be seen in the qualitative analysis for Question 1.

Developing Reform Oriented Beliefs

Question 1: What characteristics of the methods courses challenge traditional beliefs and encourage the development of beliefs aligned with reform teaching practice?

In order to answer this question, the course syllabi were examined to identify methods that would challenge the beliefs of the preservice teachers. Of the 16 syllabi used in this study, none of the syllabi indicated that any methods were used for the express purpose of challenging the preservice teachers' beliefs. The syllabi did list many types of activities that were employed by the various instructors in the methods courses. The most frequently used assignment in the syllabi was having preservice teachers create lesson plans. Lessons plans were included in 12 of the 16 syllabi. The second most commonly used assignment was to have preservice teachers read journal articles. The use of these articles varied greatly in the class from just reading to writing a reflection paper to whole class discussions. There were two assignments that were included in seven of the syllabi. These two included membership in the NCTM and observing classroom teachers. The NCTM membership was necessary in some classes in order for the preservice teachers to access literature and on-line materials, while other instructors did not indicate the

reason for requiring membership. There were two instructors who encouraged attendance at NCTM events. The purpose of the classroom observations was not consistent from class to class. Some of the instructors required a written summary of the classroom observations while other instructors did not specify any writing on the observations.

Due to the challenge of determining which of these activities were designed to challenge the beliefs of the preservice teachers, the interviews were used to glean more information from the instructors on what activities were used in the individual courses for the purpose of challenging the beliefs of the preservice teachers. The interviews did list some of the same topics as the syllabi, but there were several topics that were used by the instructors that did not appear in the course syllabi. Due to the lack of evidence in the syllabi regarding the nature and purpose of the activities in regard to challenging the preservice teachers' beliefs, for the purpose of this section of this study, the interview information will be used to identify the methods used by the instructors for the express purpose of challenging the beliefs of the preservice teachers.

In order to examine the interview transcripts to identify what methods were used to challenge the preservice teachers' beliefs, the transcripts were read. Then each of the transcripts was reviewed to identify methods used by that instructor. Once the methods were identified in each of the transcripts, the lists of methods were compared. Common methods were identified and a list of methods was compiled. This list was then used to review the transcripts again in order to ensure that each method in every class fit one of the identified methods. This process indicated the original list did not sufficiently cover all of the methods used by the instructors. Therefore, the process was repeated. Once it was determined that all methods fit into a category, then the list of methods was examined for the number of times that each method on that list was used by the various instructors. This not only provided a list of methods used by these instructors

to challenge the preservice teachers' beliefs, but it also indicated how much overlap exists between these independently taught courses.

Dilemmas that Lead to Change

Question 1.a: Which of the identified methods support the purpose of generating dilemmas for the purpose of challenging preservice teachers' existing belief systems?

In order to address this question, it is necessary to identify the methods used to challenge preservice teachers' beliefs. The most common method identified in the interviews, which was used by 4 of the instructors, was to have the preservice teachers take on the role of a student as the teacher taught a class that would be similar to a class that the preservice teachers will teach once they are in the schools. In this manner, the preservice teachers were to assume the role of student in order to get a feel for the way that the class looks from that perspective, or as one instructor puts it "they can interact with the activity as in almost the same way as their students would". According to another instructor, this allows the preservice teachers "the opportunity to kind of engage in either the doing, the learning…" Typically these instructors used a reform-based curriculum to teach the lesson. One of the goals of this type of lesson for the instructors was to create dilemmas by challenging the preservice teachers because, although the activities incorporated mathematics that they already knew, "the activities are somewhat designed to bring forth ideas that they really don't understand or that they haven't thought about." One of the instructors summed this method up as:

> We just play school through that. And then we go back and talk about how that was different from what they traditionally see or have seen. And I think they often find that they don't know the mathematics they thought they knew.

Therefore, the purpose of having the preservice teachers assume the role of a student was to encourage a sense of confusion between what they know and what they are observing in the class with the intention of generating a desire for the preservice teachers to change their beliefs.

Another method that four of the instructors mentioned as a tool that they used in challenging their preservice teachers' beliefs was talking to them about the need for them to change the beliefs that they have held about the teaching and learning of mathematics. This encompasses a wide array of ideas and approaches. One instructor starts out by telling her class that:

> There is this perception that you have about teaching math that may or may not be in alignment with what we believe is best practices. And you might have some things that we would like to revise a little bit in your mind and let me show you some models that we are going to talk about.

Other instructors take a different approach to talking to their students about the need to change their beliefs. One instructor tells his class that:

> We promote, one of [the] things that we promote in our class is constructivism and student centered problem based learning. But, yet I try to challenge that and tell them that most of them have not been taught that way, but in a very traditional, but here we are. They are one step away from becoming a math teacher. They are very good at mathematics. So why on Earth would we want to do it any other way? So we try to bring out some of those things to see if they can analyze some of their beliefs.

This instructor used other activities as well as just telling them about the differences in approaches to teaching mathematics. Another instructor likes to tell her preservice teachers that "mathematics is very dynamic" because she fears that they forget this in their content courses in

college. She follows this up by informing the preservice teachers that “it is not appropriate to expect students to just memorize a bunch of facts, because then it doesn’t have any kind of connection.” The same instructor stated clearly that “that is the only belief that I am really interested in changing at this point” in reference to the idea that teachers need to do more than just have students “memorize a bunch of facts.” The whole idea of talking to them about changing their beliefs is summed up by one instructor when she said:

> So you are preaching at them to try something different when they have never been exposed to it and you only have this one semester to do it. So yeah we talk a whole lot about what, you know how they have been taught and what they are experiencing and what their principal wants them to do.

The use of talking to the preservice teachers about how they need to change their beliefs was not found in isolation in any of the interviews. It was always found in conjunction with other methods, but it was nevertheless a method that appeared frequently in the interviews.

One method that was found in conjunction with talking was the use of activities. These activities were not always the same, but were similar enough in purpose to put them in the same category. The activities were used by the instructors to challenge the preservice teachers’ beliefs about how mathematics should be taught and how it is learned. One example of an activity used by one instructor was to pose various difficult situations in the teaching of mathematics and ask the preservice teachers to think about how they understand the topic and how they can teach it to students in their classrooms. One example of a situation like this was that they gave their class a problem such as “Why is it that when we raise a number to the zero power we always get 1?” This required that the preservice teachers consider the procedures that they use and why that procedure works and why they use that particular procedure.

Another method that was included in the activities category is the use of similes. One instructor gave his preservice teachers a list of similes to help them identify their beliefs. For example, he gave his class the question "A math student is like a…" He then provides six choices for them to choose what they felt was the best description of how they believed about that particular simile. This proved problematic for him as one preservice teacher chose that "A math student is like a sponge." When he probed this answer further, the preservice teacher said that he chose this because a sponge was the only living growing creature on the list and he felt that math students should be growing and changing all of the time, which is not what the instructor expected that answer to imply. Therefore, this activity required that the instructor probe the preservice teachers further in order to make sense of their responses. Once the preservice teachers understood what beliefs they held, then the instructor was able to proceed with helping them address their beliefs.

There were other types of activities that fell into this category. These activities included a function sort activity and a think aloud activity. The function sort activity helped in addressing the preservice teachers' beliefs by employing metacognition to have the preservice teachers consider what they believe. The think aloud activity incorporated the reading of journal articles and then thinking about the ideas of the articles through modeling, demonstration or discussion.

Two of the teachers used an approach where the preservice teachers were to consider an activity from the viewpoint of a classroom teacher. This was in conjunction with the preservice teachers looking at a lesson from the viewpoint of a student. They were to consider how the lesson should be taught and what is important in the lesson. The preservice teachers were to consider "what ways can they relate that concept to students or help students develop that mathematical understanding."

Two of the instructors would model a lesson and use that modeling experience to teach their preservice teachers. The idea was that the students could glean information about the content and how to teach the content. One instructor said that she used this method in the following manner.

> So I have taken a different approach with them. With them for 2 days I say "sit down here they are watch this" This is how it works. Isn't this cool. Isn't' that neat? Now watch as I fold this, I fold this patty paper and now take the Mirra and it is the same thing. And then I need to know that they retain that so I just made up an assignment.

The other instructor that used this method made a slight change in that he modeled the first activity, but he then asked the preservice teachers to begin to take over that responsibility in order for them to learn how to become the ones that do the modeling. However, these instructors did not indicate that the use of this activity helped them challenge their preservice teachers' beliefs.

There were several methods that were utilized by individual instructors to influence the beliefs of the preservice teachers. These included the use of videos of constructivist teaching, writing a personal philosophy of teaching mathematics, the use of field experiences, and journal readings. The use of journal readings was incorporated into other methods and was popular in the syllabi, but for one instructor this was his primary method of challenging the beliefs of the preservice teachers.

In order to determine which of these methods support the purpose of generating dilemmas for the purpose of challenging preservice teachers' existing belief systems, the number of methods used to challenge the preservice teachers' beliefs was compared to the actual change in their beliefs. For Section A of the MBI, the section that deals with the beliefs of the preservice

teachers in relation to the NCTM standards, the results are shown in Table 7. The results are displayed with the difference between the post-test and the pre-test shown in order where a positive indicates an increase in the alignment of the preservice teachers' beliefs and the NCTM standards. The general trend of the data indicates that a correlation between the two categories might exist. The results for Section B of the MBI are shown in Table 8. The results are displayed with the difference between the post-tests and the pre-tests shown in order where a positive indicates an increase in the alignment of the preservice teachers' beliefs with a constructivist view of the teaching and learning of mathematics. A linear regression analysis will be conducted to determine if a correlation exists between the two variables.

Table 7: *Methods Used to Challenge Preservice Teachers vs. Survey Differences for Section A of the MBI*

Number of Methods Used in Class	Difference Between Surveys
4	1.89
4	1.75
2	0.55
3	0
2	-0.13
1	-0.33
1	-1.21

Table 8: *Methods Used to Challenge Preservice Teachers vs. Survey Differences for Section B of the MBI*

Number of Methods Used in Class	Difference Between Surveys
4	3.89
2	2.88
3	2.14
4	2.00
2	1.45
1	1.25
1	-.29

The possibility of a correlation between these two values in Section A led to analyzing the results to determine if there is a significant correlation between the variables. A linear regression analysis was conducted with the independent variable being the number of methods used in the course and the dependent variable set to the difference in the two surveys. The results of the linear regression analysis indicated that the number of methods used in the course was a significant predictor of the difference between the pre-test and post-test on Section A of the MBI (R^2=*.809,* β=*.900, p=.006).*

Table 9 indicates that an increase of 1 method used to challenge preservice teachers' beliefs in the course will result in an increase of 0.797 points in the mean class post-survey MBI scores as compared to the pre-survey MBI scores. This increase indicates that the preservice teachers hold beliefs that are more aligned with the NCTM standards on the post-survey after participating in a class that uses various methods to challenge their beliefs. The β term indicates

how much a change in one standard deviation in the number of methods used will change the mean difference in the MBI scores for each class in terms of its standard deviation. The SE B, or standard error of the correlation coefficient, gives an idea of the standard error that can be used to calculate a confidence interval for that correlation coefficient.

Table 9: *Summary of Linear Regression for Variable Predicting Differences in Pre and Post Section A MBI Scores*

Variable	B	SE B	β
Number of Methods	0.797	0.173	0.900

A linear regression analysis was performed on the data from Section B of the MBI, which can be seen in Table 8, to determine if there is a significant correlation between the variables. The linear regression analysis was conducted with the independent variable being the number of methods used in the course and the dependent variable set to the difference in the two surveys. The results of the linear regression analysis indicated that there was not a significant correlation between the dependent and independent variables (R^2=.465, β=.682, p=.091*).* Since the results were not significant, the summary of the linear regression variables is not presented here.

Methods that Stimulate Teachers to Use Reform Practices

Question 1.b: Which of the identified methods stimulate preservice teachers to incorporate reform teaching practices into their teaching? The goal of this question was to determine which preservice teachers were actively participating in teaching in order to identify how the methods used in the methods course would affect their teaching. The problem encountered with this question was that none of the preservice teachers were teaching any classes

at the time of their methods courses. Therefore, there was no information available to make a determination as to the nature of their teaching practices. This is discussed more completely in chapter 5.

Degree of Incorporation of CFTK

Question 1.c: To what degree do the methods courses incorporate the multilevel model of teacher knowledge as posited by the Comprehensive Framework for Teacher Knowledge proposed by Taylor and Ronau (2008)?

In order to evaluate this question, the course syllabi, teacher interviews, and course texts were examined. Each of these data sources were evaluated using the rubrics already described. Table 10 provides the results of the rubric analysis for the three data sources. The CFTK rubric provides for a range of scores from 0 to 30 with 0 being no alignment to CFTK and 30 being perfect alignment with all six aspects of CFTK. The interview scores are only provided for the schools that participated in the interviews.

The syllabi of the instructors, who were interviewed, were compared to their interview to identify how many aspects of CFTK were included in both the syllabi and interviews. Only one syllabus had an aspect that was not addressed in the interview. All other interviews contained all aspects covered in the syllabus with at least one additional aspect being addressed. Table 11 lists the six aspects of CFTK and provides a designated value for each aspect that will appear in Table 12. Table 12 displays the distribution of the aspects of CFTK as they appear in the syllabi and interviews for each of the courses at the various institutions.

Table 10: *Rubric Analyses Results for Data Sources*

Institution	Syllabus Score	Interview Score	Textbook Scores
East 1	7	N/A	6, 10
East 2	12	N/A	2, 19, 23
East 3	11	N/A	6, 24
Northeast 1	18	N/A	9, 10, 24
Northeast 2	15	N/A	9, 12, 22, 24
Northeast 3	15	N/A	24
Midwest 1	17	20	22
Midwest 2	22	N/A	25
Midwest 3	11	26	24
Midwest 4	10	24	18
West 1	7	12	1,1
West 2	17	20	25, 25
South 1	10	24	9, 11, 15
South 2	16	N/A	0
Southeast 1	19	16	24
Southeast 2	9	N/A	13, 18

Table 11: *Designation for Aspects of CFTK*

Aspect	Designation
Content	1
Cognition	2
Individual	3
Pedagogy	A
Orientation	B
Environment	C

The most frequent distribution of the aspects can be seen in the Venn Diagram below, Figure 3. From Table 12 and Figure 3 it is clear that the aspects dealing with the individual and with orientations were not frequently detailed in the syllabus, but were present in many of the interviews. Since beliefs fall under the aspect of orientation, this indicates that the instructors

Table 12: *Distribution of CFTK Aspects in Syllabi and Interviews*

School	In Syllabus Only	In Both	In Interview Only
East 1		1, 2, A	3, C
Midwest 3		1, A, C	2, 3, B
Midwest 4		C	1, 2, 3, A, B
West 1		1, A	B
West 2		1, 2, A	3, B, C
South 1		2, 3	1, A, B, C
Southeast 1	3	1, 2, A, C	B

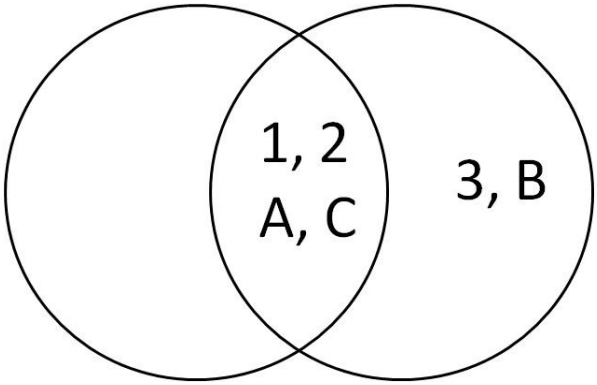

Figure 3: *Venn Diagram of Aspect Distribution*

may not be focusing on the beliefs that the preservice teachers have in regard to the learning and teaching of mathematics. This idea is expressed by one instructor who was asked what he did to address the beliefs of the preservice teachers in his class. He said "I am kind of not sure…I don't know if I challenge." Another instructor, when asked the same question, said "it is not appropriate to expect students to just memorize a bunch of facts…So that is the only belief that I am really interested in changing at this point." This indicates that she is not focused on changing a lot of their beliefs because "I only have them for one class. If I had them for longer, then I would definitely go into that much more."

As can be seen in Table 12, all of the instructors incorporated all six aspects of CFTK except for two. One instructor did not address the aspect dealing with orientations and the other instructor did not address cognition, the individual or the environment. From this information, it appears that many of the courses are incorporating many, if not all, of the aspects of CFTK into their courses. The courses are not incorporating all of the aspects to the same degree, but they are at least addressing some of each aspect.

Changes in Preservice Teachers Beliefs

The second research question for this study asks: In what way are the beliefs about the learning and teaching of mathematics held by preservice teachers changed, if any change occurred? In order to answer this question, there are two additional questions that must first be answered. Since question 2.b must be answered before question 2.a is addressed, then the order of the questions are reversed here.

Degree of CFTK and Student Beliefs

The second area that must be examined in order to investigate question 2 is referred to as question 2B, which states: Does the degree of incorporating a multilevel model of teacher knowledge correlate positively with the subsequent alignment of preservice teacher's beliefs with a reform-oriented view of teaching mathematics? The hypothesis will be stated generally to include all of the data sources that will be used.

Null Hypothesis 2.b: There is no relationship between the differences between the pre-tests and post-test on either Section A or Section B of the MBI and either the syllabi, interviews or textbooks.

In order to investigate this supposition, the class means of the differences between the pre-test and post-test scores for Section A and Section B of the MBI were examined to determine if the differences would correlate positively with the scores that represent the degree of implementation of CFTK in the class based upon the rubric. Since the syllabi were used for all classes, the first analysis examines the degree of implementation as determined by using the rubric with the syllabi. In order to obtain another comparison, the same examination was conducted using the classes where an interview was conducted with the instructor and the

interview was compared to the rubric in order to provide a degree of implementation of CFTK based upon the interview.

In order to determine if any correlation existed between the differences between the pre-test and post-test scores on the MBI for each class and the degree of CFTK implementation, a Pearson product-moment correlational analysis was conducted using the degree of CFTK implementation and the differences in the scores on the pre-tests and post-tests of Section A of the MBI. Upon examination of Section A of the MBI and the degree of implementation of CFTK using the syllabi, the results of the correlation analysis indicated that there was a significant negative correlation between the variables ($r(16)=-.618$, $p=.005$), which can be seen in Table 13. This indicates that the results are a rejection of the null hypothesis. The null hypothesis states: There is no relationship between the differences between the pre-tests and post-test on Section A of the MBI and the course syllabi.

Similarly, when the same analysis was conducted using the degree of implementation of CFTK from the interview rubrics, the negative correlation did not exist and the correlation was not found to be significant ($r(7)=.329$, $p=.236$). Due to this discrepancy, the differences between the pre-tests and post-tests on the MBI were compared to the degree of implementation of CFTK, as determined by an analysis of the syllabi using the rubric, in only those courses that also included interview data. The results of this correlation analysis indicated that there was no significant correlation between the variables ($r(7)=-.259$, $p=.287$). Table 13 contains the regression information on this relationship. Additionally, a correlational analysis was conducted using the differences in the scores of Section A of the MBI and the scores of the textbook analysis as the independent variable. This analysis indicated that there was no significant

correlation between the two variables (r(16), p=.317). The results of a linear regression analysis of this data can be seen in Table 13.

Table 13: *Summary of Linear Regression for Variables Predicting Changes in Preservice Teachers' Beliefs on Section A of MBI*

Variable	B	SE B	β
Degree of CFTK from Syllabi	-0.192	0.065	-0.621
Degree of CFTK from Interview	0.072	0.097	0.315
Degree of CFTK from Syllabi using only instructors who were interviewed	-0.064	0.106	-0.259
Degree of CFTK from Textbook analysis	-0.010	0.022	-0.129

Table 13 indicated that an increase of 1 point on the degree of CFTK, as indicated by using the rubric to score the syllabus for each class, would result in a decrease of 0.192 points in the mean class post-test MBI scores as compared to the pre-test MBI scores. This decrease indicated that the preservice teachers held beliefs that are less aligned with the NCTM standards after completing the methods courses whose syllabi indicate a greater alignment with CFTK. The positive value for the regression coefficient found from the results of the interviews indicated that a one point increase in the degree of CTFK, as found in the interviews, caused a positive 0.072 increase in the post test scores on the MBI, which would indicate that the preservice teachers' beliefs were more aligned with the NCTM standards, if the results were significant. The β term indicates how much a change in one standard deviation in the degree of CFTK implementation, as identified with the various rubrics, would change the mean difference in the MBI scores for each class in terms of its standard deviation. The SE B, or standard error of the

correlation coefficient, gives an idea of the standard error that can be used to calculate a confidence interval for that correlation coefficient.

Pearson product-moment correlational analysis was then conducted using the differences between the Section B MBI pre-test and post-test scores and the results of the syllabi scoring from the CFTK Rubric. The correlation analysis did not show any significant correlation between the course syllabi and the differences in the pre-test and post-test MBI Section B scores ($r(16)=-.275$, $P=.152$). The Pearson product-moment correlational analysis was then used to see if a correlation existed between the differences of the Section B MBI scores and the degree of CFTK used in the course as identified by analyzing the interviews. The correlation analysis indicated that there was not a significant correlation between the differences in the Section B MBI scores and the degree of CFTK found in the interview analyses ($r(7)=.633$, $p=.064$). The courses where the instructors participated in interviews were used for a correlation analysis of the difference in Section B MBI scores and the degree of CFTK as found in the syllabi analyses. This regression analysis found that there was no significant correlation between the variables ($r(7)=-.623$, $p=.068$). An analysis was conducted to determine if a correlation between the difference in the scores on Section B of the MBI and the results of the textbook analysis. This analysis did not indicate a significant correlation exists between the two variables ($r(16)=.005$, $p=.493$). The results of the linear regression analysis are not shown since the analysis did not show any significant correlations.

Change in Preservice Teachers' Beliefs.

The findings for question 2.b have shown significant negative correlation between the differences on Section A of the MBI and the syllabi scores based upon the CFTK rubric. This relationship indicated a negative correlation between the variables. These findings led to an

examination of question 2A: Are the beliefs of preservice teachers changed to demonstrate more alignment with a reform-oriented view of teaching mathematics? This question required a test conducted on the following null hypothesis. The null hypothesis is written generally to stand for all three sections of the MBI.

Null Hypothesis 2.a: The mean scores on the MBI given after the methods course indicate a greater alignment with reform views than the mean scores on the MBI given at the beginning of the methods course.

The results of the pre-surveys and post-surveys were calculated by assigning values to each response. In section A (questions 1 through 16) of the MBI, each question was scored as a 0 or 1 with a 0 corresponding to an answer that does not match the reform views such as those espoused by the NCTM and a 1 corresponding to the answer that holds the opposite view. In order to investigate the effects of the methods courses on all sections of the MBI, all three sections were examined under this hypothesis. In section B (questions 17 through 28) of the MBI, each question was scored as a 1, 2, 3 or 4 based on the Likert-scale used on the survey. A score of 4 corresponded to a view that held to reform ideas and a score of 1 corresponding to the view that is opposite the reform idea. Section C of the MBI dealt mainly with teacher efficacy and was also scored on a 1, 2, 3 or 4 point scale with 1 indicating highest degree of efficacy and 4 indicating the lowest degree. These scores were reversed in order to make the scale similar to the scales in sections A and B.

The scores were recorded into a spreadsheet for preliminary analysis. In order to conduct a final analysis, all data was entered into the software package Statistical Package for the Social Sciences (SPSS). The preliminary analysis included making adjustments for the questions that were asked in reverse order of their approach to reform ideas. The sum of each section of the

survey was calculated for each student who completed both surveys. The mean of these sums was then calculated for each instructor in order to produce 3 separate scores for each course, a mean score for each section of the MBI. Once these scores were calculated, then the mean for each section of each course was entered into SPSS. This process was completed for both the pre-surveys and the post-surveys.

Due to the size of the sample, only 16 courses, a non-parametric test was chosen for this analysis. The test chosen for this analysis was the Wilcoxon signed-ranks test. The descriptive statistics for each of the three sections are shown in Table 14.

Table 14: *Descriptive Statistics for Mean MBI Scores*

	Mean		Standard Deviation	
MBI Section	Pre-Survey	Post-Survey	Pre-Survey	Post-Survey
A	5.55	5.91	1.07	.87
B	34.52	35.97	2.04	1.51
C	4.77	4.81	0.45	0.37

A one-tailed Wilcoxon signed-ranks test was used to compare the pre and post surveys in order to determine if significant change had occurred during the time between the administrations of the MBI. The null hypothesis for each section is that the differences between the pre and post surveys are equal to 0. The alternative hypothesis is that the post surveys indicate more alignment with reform oriented beliefs.

The descriptive statistics of Section A, which measures teachers' beliefs about mathematics in relation to the NCTM Standards, indicate that the mean increased and the

standard deviation was reduced in the mean scores for the courses, but analysis of Section A did not indicate a significant change in beliefs, at the $\alpha=0.05$ level, of the preservice teachers with the Wilcoxon signed-ranks test: $Z=.966$, $P=0.167$, $N=16$. Section A did have 1 class whose mean on the pre-test and post-test was the same. Since this class difference was neither negative nor positive, it does not have an impact when calculating the Wilcoxon signed-ranks test statistic. These findings indicate that there is not sufficient evidence to reject the null hypothesis. This means that there is not enough evidence to indicate that the 16 schools have changed their students' beliefs about mathematics to be more in alignment with reform oriented ideas expressed by the NCTM Standards. This does not indicate anything about the beliefs of preservice teachers in each individual course.

The descriptive statistics of Section B, which measures the teachers' beliefs about the learning and teaching of mathematics, indicate that the mean increased and the standard deviation was reduced in the mean scores for the courses. The analysis of Section B did indicate a significant change, at the $\alpha=0.05$ level, in the preservice teachers' beliefs on this section of the instrument with a Wilcoxon signed-ranks test: $Z=2.43$, $P=0.008$, $N=16$. This result indicates that there is sufficient evidence to reject the null hypothesis for Section B. Therefore, there is evidence to conclude that the 16 courses were able to have a positive impact on the beliefs of the preservice teachers in the area of adopting constructivist approaches to the learning and teaching of mathematics. This does not indicate how each individual course impacted the beliefs of the preservice teachers in each course.

The descriptive statistics of Section C indicate that the mean and the standard deviation increased for the courses. The analysis of Section C did not indicate a significant change in the preservice teachers' efficacy. This is evident in the result of the Wilcoxon signed-ranks test:

Z=0.220, P=0.413, N=16. Section C did have two scores that were the same on the pre and post administrations of the MBI. These scores were not used in calculating the Wilcoxon signed-ranks test statistic because the change was neither positive nor negative. These results indicate that the null hypothesis is not rejected for Section C of the MBI. Therefore there is not sufficient evidence to conclude that the courses had an impact on preservice teacher efficacy. This does not indicate how each individual course impacted the efficacy of the preservice teachers in each course.

Therefore, the only null hypothesis that was rejected in the analyses for question 2.a is: The mean scores on the MBI Section B given after the methods course indicate a greater alignment with reform views than the mean scores on Section B of the MBI given before the methods course. This finding is very interesting, but due to the findings of question 2.a, there is no significant correlation between Section B and the syllabi, interviews or textbooks this finding does not support question 2.

In order to answer question 2, a review of the findings of the two sub-questions is presented here. For hypothesis 2.a, it was found that only Section B of the MBI showed a significant improvement from the pre-test to the post-test. Section B indicated the beliefs that the preservice teachers held about the learning and teaching of mathematics. Hypothesis 2.b resulted in only one significant correlation, as can be seen in Table 15. This correlation analysis indicated that there existed a significant negative correlation between the rubric scores of the course syllabi and the differences between preservice teacher scores on the pre-test and post-test on Section A of the MBI. Section A indicated the beliefs that the preservice teachers held in relation to the NCTM Standards.

Table 15: *Summary of Correlation Analyses*

Independent Variable	Dependent Variable	Results of Analysis
All Syllabi	Section A MBI	Significant Negative Correlation
Interviews	Section A MBI	Not Significant
Syllabi from Interviewed Courses	Section A MBI	Not Significant
Textbooks	Section A MBI	Not Significant
All Syllabi	Section B MBI	Not Significant
Interviews	Section B MBI	Not Significant
Syllabi from Interviewed Courses	Section B MBI	Not Significant
Textbooks	Section B MBI	Not Significant

These findings suggested that the preservice teachers' beliefs about NCTM and the NCTM standards represented a negative relationship with the scores of the course syllabi according the CFTK rubric. The other significant finding was that the preservice teachers' beliefs about the learning and teaching of mathematics were significantly increased after enrollment in a secondary methods course as indicated by the increase in scores on Section B of the MBI, although the regression analysis does not indicate that these changes were significantly correlated with the syllabi, interviews or textbooks.

Chapter 5: Conclusions

Summary of the Study

Instructors of secondary mathematics methods courses from institutions representing various regions of the United States were asked to participate in a study of the changes of preservice teachers' beliefs about the learning and teaching of mathematics resulting from taking a methods course. There were 16 instructors who participated fully in the study. These instructors distributed a pre-test and post-test of the Mathematics Belief Instrument (MBI) used by researchers (Furner, 2000; Hart, 2002; Wilkins & Brand, 2004) to asses students' beliefs about the NCTM standards and the learning and teaching of mathematics. The instructors were also asked to provide a copy of their course syllabi for use in the analysis. After examining the results of the pre-tests and post-tests, 7 of the instructors participated in an interview. The textbooks used by the instructor were also used to obtain information about the course. The syllabi, interviews and textbooks were used to identify the degree to which the instructors incorporated a multi-dimensional model of teacher education know as the Comprehensive Framework for Teacher Knowledge (CFTK) (Ronau & Taylor, 2008).

A qualitative approach was taken in examining the syllabi and the interviews. The qualitative analysis was used to identify characteristics of the courses and methods that were used by the instructors in the courses to incorporate CFTK into the course. The analyses of these artifacts were then used to create a rubric by the researcher, with input from one of the CFTK principle researchers. The rubric was used to evaluate the degree to which the syllabi, interviews and textbooks incorporated the various aspects of CFTK into the course. This rubric was then used to generate a score for each syllabus, interview and textbook.

In order to answer the first research question and its sub-questions, the methods used to challenge preservice teachers' belief about the learning and teaching of mathematics had to be identified. The syllabi and interviews were also analyzed in a qualitative nature in order to identify methods used by the instructors to create dilemmas for the purpose of challenging the preservice teachers' beliefs. The number of methods used for generating dilemmas was then used to run a linear regression with the changes in the pre-test and post-test MBI scores.

The second research question and its sub-questions required an examination of the results of the MBI to determine if the methods course had positively impacted the beliefs of the preservice teachers. In order to answer these questions, a linear regression analysis was conducted on the results of the syllabi, interview or textbook analyses as the independent variable and the differences for either Section A or Section B of the MBI. Another analysis was conducted on the changes in the MBI for both Section A and Section B to determine if the sections has been positively improved, indicating that the preservice teachers' beliefs after the methods course were more oriented toward the reform ideas espoused by NCTM.

Findings

The course syllabi, interviews and textbooks were used to triangulate the data that was collected from each course. The goal of using these three items was to verify that the more reform-oriented the course, then the more likely the course was to use appropriate textbooks and clearly identify the reform approach in the syllabus. From the analysis comparing the three sources of data, this was not the case. There was little consistency between the three sources of data. This leads to a concern about the use of only one source of data, such as interviews, textbooks and syllabi, in analyzing the degree of reform implementation in courses in regard to the degree of CFTK used in the course. The problem may be that the course syllabi lack the

detail necessary for this analysis. There was a great deal of variation in the amount of information provided by the instructors in their syllabi. If course syllabi are to provide insight into the nature of the course being taught, then it will be necessary for the instructors to provide adequate representation of the course in those syllabi to indicate how the course will address the various aspects of CFTK. The interviews provided much more detail about the nature of the courses. The textbooks also provided a challenge for analysis. This was due to the fact that the books used were not always reflective of what the interviews and syllabi indicated as the nature of the course. Some books were not of mathematical or mathematics education nature. The way that those books were used was not clearly defined by the instructor. Other instructors listed books that were very aligned with CFTK, but it is not clear that the books were used to their fullest potential. In some cases, ensuring that preservice teachers possessed quality literature did not guarantee that those preservice teachers changed their beliefs to be more in alignment with the NCTM standards or to reform mathematics in general. One possible reason for this inconsistency could lie in the instructors who were asked to participate in the interviews. Possibly the chosen instructors, whose students did show a large change on the MBI, are instructors who intentionally don't provide a detailed syllabus and the instructors whose students did not show a large change on the MBI tend to have detailed syllabi, but don't necessarily follow the syllabi.

In answering question 1, dealing with what characteristics of the methods courses challenge traditional beliefs and encourage the development of beliefs aligned with reform teaching practice, the results of the regression analysis indicated that the number of methods used to generate dilemmas was a very strong predictor of the change in the preservice teachers beliefs as identified in Section A of the MBI. Section A indicated the degree to which the

preservice teachers' beliefs align with the NCTM standards. This finding indicates that the intentional use of dilemmas for the purpose of challenging the preservice teachers' beliefs holds the potential to move those preservice teachers' beliefs to be more closely aligned with the NCTM standards. Of all of the analysis conducted in this research, the number of methods used for the purpose of generating a dilemma is the only item found to have a positive effect on the beliefs of preservice teachers in regard to how their beliefs align with the NCTM standards. All other significant correlations were found to be negative, or found to reduce the preservice teachers' beliefs being aligned with the NCTM standards.

Question 2.a examined the differences in the pre-test and post-test scores for sections A, B and C of the MBI, which indicated that only section B showed a statistically significant change in beliefs. This raises the question as to why section B was the only section that was significant. One reason for this section being significant may be due to the manner in which the methods courses were taught. One instructor stated that "I don't think that I spent any time on many of the features or forms of reform. I don't think that I paid any time to it." When asked if this instructor challenged the beliefs held by his students about reform ideas, this instructor stated that "I don't know if I challenge." This professor also made the statement that "I actually never used the word 'reform'. I actually [am] not a proponent of, I am not anti-reform, but as a teacher I am not interested in being a proponent of reform either." Another professor, when asked how she challenged the beliefs of the preservice teachers, could only provide various examples of math problems that the preservice teachers had difficulty explaining. One of these examples is "Why is it or how do we know that the square root of 2 is irrational?" While the examples provided some evidence to the learning of mathematics, this teacher could not provide any direct examples of challenging the preservice teachers' beliefs about reform mathematics or the NCTM

standards. Another instructor pointed out that the students in their class would take another class that focused on the Principles and Standards of NCTM (NCTM, 2000), so they did not focus on the PSSM. From looking at the interview data, the instructors who did not show improvement in the scores on section A did not have a focus on the NCTM documents. These instructors may have used NCTM magazine articles, but the focus was not on the reform ideas that were being examined in section A of the MBI.

Discussion and Recommendations

Recommendation to Methods Course Instructors

The course syllabi were used for this study. These provided a plethora of information about the courses. One of the problems with the syllabi was that they were very inconsistent. Some instructors included very detailed descriptions of the course and the activities while other instructors provided only a bare minimal description of the course. These differences were found to cause a false identification of the nature of the class when compared to the interview data with the same instructors. In some cases the syllabi had all of the right terminology and procedures, but the interview revealed that the course did not adhere to CFTK as closely as the syllabi would imply. In other cases the syllabi did not imply that CFTK was used to a very high degree in the course, but the interview showed otherwise. These differences between the syllabi and the interviews led to a very difficult analysis of the data. In order to correct this situation, instructors need to develop their syllabi very carefully in order to represent the nature of the course being provided to the preservice teachers. This could be a challenge as the syllabi are often used for institutional accreditation and other evaluation purposes.

The effect of generating dilemmas for the purpose of changing the beliefs of the preservice teachers was examined in this study. The finding that there is a significant correlation

between the number of dilemmas used by the instructor and the change in the pre-test and post-test administrations of Section A the MBI is very encouraging. This indicates that preservice teachers' beliefs about the NCTM standards are positively impacted by the number of methods used to generate dilemmas in the methods course. It is especially interesting that the use of dilemmas is the only independent variable that showed a positive correlation with the preservice teachers' beliefs about NCTM and the NCTM Standards. This finding suggests that instructors who would like to change their students' beliefs about the learning and teaching of mathematics need to incorporate activities into their methods courses that generate dilemmas that will challenge the existing beliefs of the preservice teachers.

Recommendation to Methods Course Researchers

The MBI worked very well for Section B. The grain size may be too small for Section A. In order to improve this situation, more choices may need to be added to section A to match Section B. If this is done, then Section A may need to be tested again for reliability and validity, but this may be well worth the effort in order to gain more valuable insight for a study of this nature.

The Institutional Review Board process was a major factor in some instructors opting to not participate in this study. This problem would have been alleviated if the instructors at those schools had been included as co-researchers in the study. In order to develop a wider source of data among more institutions, it may be necessary to include more researchers from various institutions in order to obtain IRB approval at some of the various institutions.

Recommendations for Institutions

During the process of interviewing, the instructors from the various institutions reported that many of those in the departments of mathematics were not involved in the student teaching

semester or observation of the students. The reason for this was not given, but the concern was expressed by the instructors. In order for any changes to be extended throughout the student teaching experience, the contact between the methods course instructor and the preservice teacher needs to be extended through this critical time. A long term study that would follow the preservice teachers through the methods course and the student teaching experience would be needed to verify the benefits of this relationship.

Conclusion

The secondary methods course is a very difficult entity to describe. The course appears very differently to students in different institutions. The approach taken by instructors of the methods courses vary widely in their design and intention. This study examined 16 methods courses in order to identify commonalities among these courses. These common findings were then used to determine their effects on the beliefs of the preservice teachers in the classes. The major finding of this research is that the number of activities used by the instructor to create dilemmas for the purpose of challenging the preservice teachers' beliefs does have a positive effect on the beliefs of the preservice teachers changing to become more aligned with reform-oriented beliefs about the learning and teaching of mathematics.

The degree of CFTK included in the course syllabi was found to have a negative effect on the change in beliefs of the preservice teachers on Section A of the MBI. This result needs further study to determine if this was a result of this particular sample or if there is a reason that the preservice teachers' beliefs are less aligned to NCTM and the NCTM standards after the methods course when the course syllabus indicates a higher degree of alignment with CFTK.

Limitations

There were a number of issues that were discovered during the research. The most obvious problem was that the instructors did not have information that could help answer one of the research questions. The second research question dealt with which of the identified methods stimulate preservice teachers to incorporate reform teaching practices into their teaching. The syllabi did not offer information on the teaching practices of the preservice teachers. In the course of the interviews, it was found that very few of the instructors participate in the observation of the student teachers. The methods courses were not done in conjunction with the student teaching at the time that the data was collected. Most students did participate in a field experience while enrolled in the methods course, but that was not sufficient to obtain any information about the changes in their teaching practices. Therefore, there is not sufficient evidence to draw any conclusions about the effects of the methods courses on the practice of the preservice teachers. This was a disappointing find, but it does provide some evidence on the timing of the methods course in these 16 universities. The other issue that this brings to light is the concern that the instructor for the methods course is not involved in the student teaching observation in most cases. This was especially found to be the case in schools where the methods course was taught in the mathematics department and student teaching is observed by the college of education. As one instructor put it "The only time that we are called in for official help is if there is a problem."

The participation of the instructors of the various methods courses was a very important part of this study. The instructors were asked to participate by administering the MBI to their methods courses at the beginning and end of the course. The instructors were also asked to submit a copy of their syllabus for evaluation as part of the study. Most of the instructors were

also expected by their institutions to follow the IRB procedures of their institution, which will be discussed later. Some of the instructors were then asked to participate in an interview after the courses were completed. The instructors were very helpful in this endeavor. However, there were five instructors who submitted the pre-tests and post-tests but failed to submit their course syllabi. After several requests by email and attempted phone calls, these instructors were dropped from the study due to a lack of data. In addition to this situation, there were 5 instructors who were contacted for interviews, but they never responded. The first 2 did not respond, so replacements were contacted. It appeared that one of them would be able to participate, but another was contacted to replace the one who never responded. Eventually, none of these were able to participate in the interviews. This limited the number of interviews that were conducted.

As was stated above, another area of concern was that the number of participating schools was limited due to the effort required to gain permission from local Institutional Review Boards. One very large institution in the North-West withdrew their desire to participate due to the amount of work required on their end in order to gain permission for a researcher from another institution to obtain survey data from their students. Another medium size institution along the East coast was eventually dropped from the study because the IRB at that institution required major changes to the researchers proposed research, which had already obtained IRB approval at the researcher's institution. The very first IRB to be contacted by the researcher was from a large research institution in the Mid-West. This IRB requested modifications to the application for several months until eventually the request was denied. The primary reason for denial was because the researcher was not from that institution. There was one institution in the South-Central part of the country that had agreed to participate and had begun to process the IRB paperwork. During the process of evaluating the research, the IRB chair passed away due to

health problems. The institution was not able to refill that position in time for that institution to participate in the initial data collection phase of the project. There were several institutions that were unwilling to participate due to the excessive work in their institutions in order to obtain permission to distribute the surveys. Many IRB's provide permission to their faculty and students, but are reluctant to provide permission for an outside researcher to work with the students at their institution. This is a problem in trying to conduct a large study that crosses institutional boundaries that needs to be addressed in order to obtain data that can be applied across a wider spectrum of the population.

The tool chosen for the research may have contributed to part of the difficulty in obtaining significant results. The MBI Part A may lack sufficient grain size to adequately determine the degree to which teachers hold beliefs that are consistent with reform oriented beliefs, such as those espoused by the National Council of Teachers of Mathematics. This is due to the questions only having two choices for answers. Part B offers four choices for each question, which provides a wider range of answers for the preservice teachers. The previous users of the MBI did not see this as a problem, but it is a potential area of concern that could help explain the lack of significant results for section A of the MBI.

Another potential problem that arose in the course of the research was that one instructor did not have his students put any identification on the initial surveys. However, the students did identification on the post surveys. In order to use this data, the researcher was able to match the before and after survey data through the demographic data that was collected. The match was made possible due to a small class size and widely different individuals in the class. There is a possibility that the students changed their answers to the demographic data, which would make

this data not useful for this study, but it appeared that the students matched up very well between the two groups so the data was used.

The analysis of the textbooks also provided a challenge. The rubric used to evaluate the degree of CFTK in the textbooks was not as much of an issue as was the total scored for textbooks for each course. For future studies, the textbook analysis could include an interview question for the instructor as to the degree that each book was used in the course and the manner in which the book was used. Several books were used that may or may not have contributed significantly to the course, but that is not accounted for in this analysis.

Recommendations for Further Research

One of the purposes of this study was to collect data from a representative sample of institutions around the United States that would represent the secondary mathematics methods courses over a wide range of institutions. This study does look at a larger number of schools than other studies cited in Chapter 2, but a much larger study could be undertaken. Due to issues beyond the control of the researcher, the number of institutions in this study was limited to sixteen schools. Future studies could benefit from looking at a larger number of institutions. This could be done if the data were collected during the fall semester instead of the spring semester. There were many instructors who replied to the initial request for instructors with a response that they would be glad to help but they were not teaching the methods course during that semester. Another issue that must be overcome to make this possible is to find a way to navigate the various IRB approval processes in a way that does not discourage participation in the study. At some of the institutions, this problem would have been alleviated if the instructor would have been included as part of the research team.

Another area that needs to be studied is the long-term effects of the methods course on the practices of secondary mathematics teachers. It is one thing to cause an effect on their beliefs, but that does not address their long-term practice. This would require a longitudinal study over several years to determine the teaching practices of the students after several years in the school. A study such as this one is only the beginning of the research needed to examine the effects of the methods courses on the teaching practices of teachers once they are in their own classrooms where they are no longer observed by college instructors. This is a challenging quest, but one that is well worth the journey if we are to ensure that all children receive a mathematics education that will meet the needs of our students, teachers, schools and society.

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Appendices

Appendix A

Mathematics Belief Instrument

Unique Identification_____

Hart, L.C. (2002). Preservice teachers' beliefs and practice after participating in an integrated content/methods course. School Science and Mathematics, 102(1), 4-14.
Part A: Please circle the choice that best describes your beliefs about the following statements.

1. Problem-solving should be a separate, distinct part of the mathematics curriculum.
Agree Disagree

2. Students should share their problem-solving thinking and approaches with other students.
Agree Disagree

3. Mathematics can be thought of as a language that must be meaningful if students are to communicate and apply mathematics productively.
Agree Disagree

4. A major goal of mathematics instruction is to help children develop the belief that they have the power to control their own success in mathematics.
Agree Disagree

5. Children should be encouraged to justify their solutions, thinking, and conjectures in a single way.
Agree Disagree

6. The study of mathematics should include opportunities of using mathematics in other curriculum areas.
Agree Disagree

7. The mathematics curriculum consists of several discrete strands such as computation, geometry, and measurement which can best be taught in isolation.
Agree Disagree

8. In 9-12 mathematics, the application of equations and formulas should be emphasized more than the symbolic manipulation of equations and formulas.
Agree Disagree

9. Increased emphasis should be given to the use of clue words (key words) to determine which operation to use in problem-solving.
Agree Disagree

10. In mathematics, skill in computation should precede word problems.

Agree Disagree

11. Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragments as a result of repeated practice and reinforcement.

Agree Disagree

12. Mathematics should be taught as a collection of concepts, skills and algorithms.

Agree Disagree

13. A demonstration of good reasoning should be regarded even more than students' ability to find correct answers.

Agree Disagree

14. Appropriate calculators should be available to all students at all times.

Agree Disagree

15. Learning mathematics must be an active process.

Agree Disagree

16. In grades 9 – 12, reasoning and proof should be addressed primarily in the geometry class.

Agree Disagree

Part B. Please circle the choice that best describes your beliefs about the following statements.

17. Some people are good at mathematics and some are not.

True more true than false more false than true false

18. In mathematics something is either right or it is wrong.

True more true than false more false than true false

19. Good mathematics teachers show students lots of different ways to look at the same question.

True more true than false more false than true false

20. Good math teacher show you the exact way to answer the math question you will be tested on.

True more true than false more false than true false

21. Everything important about mathematics is already known by mathematicians.

True more true than false more false than true false

22. In mathematics you can be creative and discover things by yourself.

True more true than false more false than true false

23. Math problems can be done correctly in only one way.
True more true than false more false than true false

24. To solve most math problems you have to be taught the correct procedure.
True more true than false more false than true false

25. The best way to do well in math is to memorize all of the formulas.
True more true than false more false than true false

26. Males are better at math than females.
True more true than false more false than true false

27. Some ethnic groups are better at math than others.
True more true than false more false than true false

28. To be good at math you must be able to solve problems quickly.
True more true than false more false than true false

Part C Please circle the choice that best describes your beliefs about the following statements.

29. I am very good at learning mathematics.
True more true than false more false than true false

30. I think I will be very good at teaching mathematics.
True more true than false more false than true false

Part D Please circle the choice that best describes you.

31. My age group is:
18 – 23 24 – 28 29 – 40 40 – up

32. My major is:
Mathematics Science related Education Other

33. I plan to teach (circle all that apply):
9 – 12 Math 9 – 12 Science 6 – 8 Math
6 – 8 Science Other

34. I have taken these mathematics courses
College Algebra Statistics Calculus I

Calculus II Calculus III Linear Algebra Differential Equations Abstract Algebra
Geometry History of Math
Analysis Trigonometry Discrete Math Probability
Topology Modern Algebra

Appendix B

Rubric for Syllabi and Interviews

Idea	Indicator	Value
Content		
	Math content is a primary focus in the course and the students are graded specifically on content knowledge.	5
	Math content is addressed as a separate topic in the course, but is not the primary focus and content knowledge does not appear to be part of the grade.	4
	Math content is addressed, but only in conjunction with pedagogical activities.	3
	Math content is addressed, but only in conjunction with pedagogical activities.	2
	Content is addressed only as a byproduct of an activity.	1
	No mention of addressing content is made.	0

Pedagogy		
	Pedagogy is a primary focus in the course and is taught by example along with discussion and assignments that focus on the topic.	5
	Pedagogy is a primary focus in the course, some assignments may include pedagogical issues.	4
	Pedagogy is a focus of the course, but little of the student's final grade is determined by their knowledge of pedagogy.	3
	Pedagogy is discussed as an important aspect of teaching, but little emphasis is placed on pedagogy.	2
	Pedagogy is only addressed as a topic for readings.	1
	No mention of pedagogy is made.	0
Cognition		
	Cognition is addressed by a deliberate focus on metacognition and evaluation, with methods of encouraging and improving metacognitive skills and evaluation techniques being emphasized.	5

	Cognition is addressed, but effort to affect only one aspect of cognition is shown to be a part of the course.	4
	Cognition is addressed with only one aspect (i.e. metacognition or evaluation) being emphasized. There is no attempt made to improve the aspect that is emphasized.	3
	Cognition is discussed, but little emphasis is placed on affecting the students' personal metacognitive skills or evaluation techniques.	2
	Topics dealing with cognition are mentioned or assigned in the readings, but no attempt is made to incorporate them into the course.	1
	No mention of cognition or related topics.	0
Orientation		
	The instructor makes a conscious effort to have students examine their own beliefs about the learning and teaching of mathematics while at the same time attempting to impact the students' beliefs about the learning and teaching of mathematics.	5
	The instructor makes a conscious effort to have students examine their	4

	own beliefs about the learning and teaching of mathematics while at the same time attempting to impact the students' beliefs about the learning and teaching of mathematics.	
	Beliefs are discussed and students are encouraged to examine their beliefs.	3
	Beliefs are discussed, but little or no attempt is made to have students examine their own beliefs.	2
	Beliefs are mentioned, but no attempt to address those beliefs is discussed.	1
	No mention of beliefs in course.	0
Individual		
	The course discusses the need for reaching individuals in the classroom who have diverse backgrounds and needs (i.e. cultural diversity, socio-economic diversity, diversity of learning styles, diversity of levels of cognitive functioning, etc.) and provides various activities and suggestions for dealing with a variety of students.	5

	Attention is given to the importance of developing a relationship with students in order to better understand their individual needs.	
	The course discusses the need for reaching individuals in the classroom who have diverse backgrounds and needs and provides various activities and suggestions for dealing with a variety of students. The need to understand individual needs is mentioned, but is not developed.	4
	The course discusses the need for reaching individuals in the classroom who have diverse backgrounds and needs and provides various activities and suggestions for dealing with a variety of students.	3
	The importance of reaching diverse learners is mentioned, but very little attention is provided as to ways of dealing with these learners.	2
	The needs of diverse learners is mentioned, but is not addressed in a way that will provide the preservice teacher with tools to adequately help students.	1

	The course does not appear to address issues dealing with individual students.	0
Environment		
	The instructor attempts to address the issues of environment by addressing leadership through active involvement in professional organizations and collaboration by providing opportunities for students to collaborate with other students as well as classroom teachers.	5
	The instructor addresses the need for leadership through active involvement in professional organizations and addresses collaboration by encouraging activities between students.	4
	The instructor does address the need for leadership in the field, but does not suggest any way to achieve leadership. The need for collaboration is encouraged through activities and assignments.	3
	The instructor addresses the need for leadership in the field, but does not suggest any way to achieve leadership. The need for collaboration	2

	is stated, but is not included as part of the assignments.	
	Collaboration is mentioned, but there is no clear path to achieving collaboration mentioned in the course. Professional organizations may be mentioned, but there is no indication as to the students' role in regard to the organization.	1
	No mention of collaboration is mentioned in the course.	0

Vita

Ronald Smith grew up in Lancaster, Ohio and the surrounding area. He completed his Bachelor of Arts degree in mathematics and Master of Education degree in secondary school administration at Harding University in Searcy, Arkansas. He taught for half a year in Jacksonville, Arkansas. He then taught for two years with the Department of Defense Dependents Schools in Incirlik, Turkey. He followed that with five years of teaching secondary mathematics at Cabot High School in Cabot, Arkansas. He then spent five years working as a process control engineer in Columbus, Ohio. After that time he went back to alma mater, Bloom-Carroll High School, to continue what he loved – teaching high school mathematics. While teaching there, he entered the ACCLAIM program.

In 2005 he returned to Harding University as a mathematics specialist, working with local school districts. After two years in that position, he accepted a teaching position in the mathematics department at Harding University. He continues to teach there as an Assistant Professor of Mathematics. He especially enjoys working with preservice teachers. Ron has conducted numerous workshops on technology in the mathematics classroom as well as workshops on incorporating various approaches to the teaching of mathematics at all levels in the K-12 curriculum.

Ron has been married to Lesley Rose Smith for 21 years. They have two children, Ronnie and Haley, who are in junior and senior high school. Lesley is a special education teacher in the Searcy Public School district working with grades K – 2.