The Relationship Between Beliefs and Practices of Mathematics Teachers Who Use a *Standard*s-Based Curriculum

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Dedication

This dissertation is dedicated to my family. My husband, Eric, and my kids, Samantha, Emma, and Kameron, have been my support and cheerleaders throughout this process and I am so grateful for all of them.

Abstract

The NCTM *Standards* encourage classroom teachers to teach rigorous mathematical content to all students using problem solving, reasoning, and communication. One particular high school curriculum, Core-Plus, embodies both the process and content standards included in the NCTM *Standards*. As teachers work with any curriculum, their beliefs play a role in the implementation of the curriculum and their daily practices. This study looks at the relationship between beliefs and practices of five high school teachers at Suburban High School who are using Core-Plus. The setting of this study is noteworthy because the entire district containing Suburban High School has used *Standards*-based curricula for over 10 years at all grade levels. There appears to be a compatible relationship between beliefs of the teachers and their practices with Core-Plus. Results indicate that several other factors, such as teacher collaboration, state standards, and students, are highly influential on these teachers' practices and these results provide a framework for looking at implementation of new curricula.

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Chapter 1

In 1989 the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards for School Mathematics (Standards)* to provide guidelines for K-12 school mathematics. This NCTM document began a nationwide push to create curricula that matched these standards and in 1991 the National Science Foundation funded research on curricula that would embody these standards (Senk & Thompson, 2003). One curriculum that was created during this time is the Core-Plus Mathematics Project (Core-Plus) (see Coxford et al., 1997, 1998, 1999, 2001). Core-Plus includes algebra, geometry, statistics, probability, and discrete mathematics within each year of the course (Schoen & Hirsch, 2003). Core-Plus also focuses on student-centered instruction based in realistic problems with the use of technology. This is a shift in both content and pedagogy from the more traditional mathematics classroom of the past. In the traditional classroom, content (e.g., algebra) is typically taught for a whole year within teacher led classrooms where students do problems that are similar to those modeled by the teacher. Because Core-Plus and the other NSF-funded curricula from the 1990's were so new and not used in all schools, most teachers in the classroom had not, as students, experienced using these types of curricula and had come from more traditional mathematics settings. It is natural to question how teachers navigate the differences in content and pedagogy between the Core-Plus textbook and a traditional textbook given that these teachers have built their views of mathematics from a traditional curriculum.

A teacher's beliefs about teaching and learning are developed from early schooling through their current teaching experience (Lortie, 1975; Nespor, 1987; Richardson, 1996). *Standards*-based curricula such as Core-Plus represent a contrast to most teachers' mathematics learning as students. The differences in content and pedagogy could push the teacher to change the curriculum to match his/her beliefs or the teacher might change beliefs to match the curriculum. One particular school, Suburban High School, has used the Core-Plus curriculum since 1998 with great academic success. Suburban High School uses Core-Plus exclusively for all high school students until after they complete the fourth course of the curriculum. Additionally, the entire district uses *Standards*-based curricula for students at all levels. This setting provides a unique opportunity to research the beliefs of teachers and students who have used *Standards*-based curricula for an extended period of time. Some of the teachers at the high school were part of the transition to the new curricula while others joined the teaching team after Core-Plus had been established as the sole curriculum. This study examines the relationship between teachers' beliefs about mathematics teaching, learning and practice in classrooms that are implementing the Core-Plus curriculum.

Beliefs

All mathematics teachers are faced with making decisions about content and pedagogy in the classroom. Lortie (1975) described the "apprenticeship of observation" (p. 61) that occurs for all future teachers. As students, these teachers have been in the classroom since kindergarten and have developed their own beliefs about what it means to be a teacher and student through countless interactions and observations. Expanding this to the mathematics classroom, teachers have had many opportunities to develop their

beliefs about mathematics teaching and learning. Britzman (1991) described the four chronologies during which teachers develop their beliefs about teaching: K-12 education, teacher education, student teaching and independent teaching. These beliefs continue to evolve over time as teachers have more experience and become influenced by a host of other factors. One feature of the classroom that may affect teacher beliefs is curriculum (Collopy, 2003). The amount curriculum changes beliefs can vary depending on aspects such as teacher content knowledge or how the teacher aligns philosophically with the curriculum (Clark, 1997; Remillard and Bryans, 2004). Middleton (1999) suggested that beliefs and practice can both change if use of a curriculum provides evidence of changes in student behavior or achievement. The relationship between beliefs and curriculum is important to examine since implementation of curriculum is an essential part of a teacher's practice. Research shows that teachers' beliefs influence their practice (Raymond, 1997; Roehrig , Kruse & Kern, 2007; Thompson, 1984). Raymond (1997) suggested that there are many other influences on teacher beliefs and practices and some are stronger than others. For example, beliefs and practice have a strong influence on one another while outside influences, like mandated testing, have a weaker influence on beliefs.

Nespor (1987) and Fang (1996) suggested that to study beliefs in the classroom, a teacher's goals as well as theories about subject matter need to be examined. Sometimes teacher beliefs and practice appear to be consistent and the goals the teachers set for the students are reflected in the classroom environment (Thompson, 1984). Other times teachers profess certain goals but those are not reflected in actual practice (Cohen, 1990). Another option still is that outside factors influence practice more than stated beliefs

(Aguirre & Speer, 2000; Raymond, 1997; Thompson, 1984). Phillip (2007) suggested that beliefs are complex and may appear inconsistent with teaching practices. He proposed two ways to explain inconsistencies. The first is to determine if some beliefs play a greater role than others in influencing practice. The second is to examine if the teacher may be able to explain the contradiction.

Beliefs influence practice (Thompson, 1984; Raymond, 1997). In addition, there is a complex interaction among beliefs, curriculum and practice (Clarke, 1997; Remillard and Bryans, 2004; Roehrig, Kruse & Kern, 2007). Some teachers choose to follow their beliefs while others choose to change beliefs and follow a new curriculum. Several studies examined the interaction between teacher beliefs and practice with a relatively new curriculum (Roehrig, Kruse & Kern, 2007; Clarke, 1997; Remillard & Bryans, 2004) but still missing is research that examines the beliefs and practices of teachers who have used a reform curriculum for an extended period of time. Recall that Suburban High has used Core-Plus for over 10 years. Given that beliefs and curriculum have been shown to be connected, this study examined teachers in a district that has sustained reform to determine the relationship between beliefs, practice, and curriculum. The following questions guided this research.

1. What are the current beliefs surrounding the teaching of mathematics of these teachers?
    a. How are past experiences reflected in these beliefs?
    b. What factors outside the classroom influence these teachers' beliefs and practices?
2. How are stated beliefs reflected in current practices of these teachers?

a. Are current practices consistent with stated beliefs?
    i. If so, how is this consistency observed?
    ii. If not, how is this lack of consistency observed?
b. How are observed differences between beliefs and practices explained?
    i. What role does a *Standards*-based curriculum have in the relationship between beliefs and practices?
    ii. What role does testing have in this relationship?

In this chapter, an overview of the relationship between beliefs and practice was examined and a justification for this research was presented. Chapter 2 provides a more in-depth review of the literature in the areas of beliefs, the implementation of curriculum and what *Standards*-based curriculum means. Chapter 3 describes the methodology and procedures used in this study. Chapter 4 provides the data and analysis of this data. Chapter 5 includes a summary, conclusions, and suggestions for future research.

Chapter 2

In 1989, the National Council of Teachers of Mathematics (NCTM) released the *Curriculum and Evaluation Standards for School Mathematics (Standards)*. The *Standards* reflected changes in content and process for teaching K-12 mathematics. Following the release of the *Standards,* the National Science Foundation (NSF), in 1991, funded more than a dozen sets of *Standards*-based materials for K-12 mathematics education (Senk & Thompson, 2003). These curricula were based on the principles and standards outlined in the *Standards* and differ in both content and pedagogy from traditional mathematics textbooks that preceded them. Several of these curricula are currently being used in classrooms and present most teachers with new content and different pedagogy than they have experienced. As teachers navigate their way through these curricula, both personal and professional factors influence their decisions in the classroom. This study examined the relationship between the practice of using one of these *Standards*-based curricula and teacher beliefs. In particular, the current beliefs of the participants were explored with a look at past experiences and other factors that influence these beliefs. The classroom practices of these teachers were observed in order to determine if they were consistent with stated beliefs and inconsistencies were investigated. A specific area of interest was the role of a *Standards*-based curriculum and mandated testing on beliefs and practices. Additionally, the relationship between teacher and student beliefs was analyzed. This comprehensive look at the teachers' beliefs, past experiences, classroom practices, and students' beliefs all within the context of a

Standards-based classroom adds a new perspective to the understanding of the relationship between teacher beliefs and practice.

The setting of this study was a high school (Suburban High School) within a district that uses *Standards*-based curricula from K-12. In addition, this high school is highly effective at producing students that do well on exams such as the ACT and SAT, they have an extremely high graduation rate, most students explore higher education, and they are top performers in mathematics competitions. The high school is a large suburban school with a population over 3000 students and 27 mathematics teachers. Some of these teachers have been part of the change to this *Standards*-based curriculum while others have never taught using another curriculum. This setting provided a unique opportunity to explore the interaction between teacher beliefs and their practice while using a *Standards*-based curriculum.

As this study connects to beliefs, *Standards*, and implementation of a *Standards*-based curriculum, the literature addresses research related to each of these topics. The first section of the review of the literature explores beliefs and their influence on teaching practice. Next, an exploration of *Standards*-based curriculum is presented. Finally, implementation and fidelity of implementation are looked at in the context of the curricular changes that occurred after the publication of the *Standards*.

Defining Beliefs and Knowledge

According to Thompson (1992) beliefs and knowledge hold distinguishable features. Thompson explained that beliefs can be held with varying degrees of conviction, they are not consensual, and they are often held without having procedures for judging their validity.

Knowledge, on the other hand, can be judged as valid by using generally accepted procedures. Nespor (1987) drawing on the work of Abelson (1979) suggested that "belief systems often include affective feelings and evaluations, vivid memories of personal experiences, and assumptions about the existence of entities and alternative worlds, all of which are simply not open to outside evaluation or critical examination in the same sense as knowledge systems are (p. 321)." Pajares (1992) suggested that beliefs are based on evaluation and judgment while knowledge is based on fact. Pajares also explains that beliefs are a person's judgment of the truth. More broadly, a belief system, according to Pajares, is made up of beliefs, attitudes, and values. Phillip (2007) suggested that knowledge may be considered a true belief or a belief with certainty. In summary, beliefs are based on an individual's evaluation and judgment and are not necessarily based on consensus by a group. Beliefs typically contain feelings and are based on personal experiences. Knowledge, on the other hand, can be considered a valid belief and typically uses consensus to verify its truth. Both beliefs and knowledge are used to help make choices; the distinction is whether the truth is considered personal, as in beliefs, or universal, as in knowledge.

Thompson (1992) made a special distinction between beliefs and conceptions. Conceptions were defined as "a more general mental structure, encompassing beliefs, meanings, concepts, propositions, rules, mental images, preferences, and the like" (p. 130). Thompson suggested the use of conception of mathematics instead of beliefs about mathematics because of the many aspects a teacher considers when discussing mathematics and its instruction. For example, conceptions include a teacher's "own role in the teaching, the students' role, appropriate classroom activities, desirable instructional

approaches and emphases, legitimate mathematical procedures, and acceptable outcomes of instruction (p. 135)." This study at Suburban High School looked at teachers' conceptions about mathematics but analyzed these conceptions in terms of beliefs in particular areas and focused on the relationship between these beliefs and classroom practice. The teachers' conceptions of mathematics for this study included definitions of mathematics teaching and learning, the role of the students and the teacher in the classroom, and goals for the classroom. This notion of conception of mathematics is helpful when examining this study as a whole.

Formation of Beliefs

Past experience as a student impacts future teachers and can influence their views of the classroom (Lortie, 1975). Richardson (1996) found that there are three categories of experience that influence a teacher's beliefs and knowledge about teaching: personal experience, experience with schooling and instruction, and experience with formal knowledge. In a study by Nespor (1987) teachers noted that certain "critical episodes or experiences (p. 320)" from earlier in their teaching careers were influential in their current teaching practices. For example, one teacher chose to run a friendly classroom because of vividly remembered experiences that were negative. Another teacher's experience in the Job Corps led him to teach mathematics in ways that showed its usefulness. This study by Nespor showed how particular events can help shape a teacher's beliefs and help create goals on which classroom instruction or environment is based. Britzman (1991) described the times when teachers learn about teaching as four chronologies. The first chronology is experience as a K-12 student, the second is through university courses and teacher education, followed by student teaching and teaching

independently. These four time periods expanded on the ideas of Lortie (1975) that our observation as students influences our teaching. The information on the influence of experience on beliefs suggests that teachers build their beliefs throughout their lifetimes and from many different experiences. This indicates that to gain a clear understanding of a teacher's beliefs, it is critical to examine the teacher's past and present experiences relative to education.

The formation of beliefs can be understood as taking place over time but there is an underlying complexity that exists when trying to determine which beliefs are influential in the decision-making process. It is helpful to understand that beliefs can be held with varying levels of conviction and some views may take precedence over others (Raymond, 1997; Thompson, 1987). Pajares (1992) suggested that the earlier a belief is formed, the more difficult it is to change. Pajares also suggested that beliefs are unlikely to change unless they are challenged and are unable to fit into the current understanding of what is happening in the environment. Adding Pajares' view to the conclusion that past experience influences practice, once the history of a teacher's belief formation is investigated, current practice and context must also be taken into consideration to understand each teacher's environment and how this may influence the teacher's beliefs. This examination of practice and context can lead to understanding how beliefs are used to navigate classroom situations and what beliefs from the past are used or discarded due to present situations. This study investigated teachers' beliefs using interviews to learn about experiences, both as a student and as a teacher. Teachers were asked, in an interview, to describe their experiences as a student, education student, student teacher, and teacher. This part of the study addressed the literature explaining that beliefs are

formed throughout a person's life; the four chronologies (Britzman, 1991) were examined to fully understand the beliefs working in classroom and the experiences that helped form them. Teachers were also given a chance to explain their conceptions of mathematics in the interview. They were asked what mathematics is and what the role of the teacher and student are in the classroom. These questions helped to complete the picture of the teacher's beliefs about mathematics teaching and learning and provided the information necessary when attempting to compare beliefs and practice.

Beliefs and Practice

According to Nespor (1987), beliefs are well suited to make sense of the contexts, environments and problems that teachers encounter because these situations are often not clearly defined. Nespor also stated that if we want to understand why teachers run classrooms the way they do we must examine their goals and how they interpret classroom situations and processes. Fang (1996) explained the influence of teachers' beliefs on the workings of the classroom and stated that these can be observed "in the teacher's expectations of his/her students' performance or in the teacher's theories about a particular subject area's learning and teaching" (p. 50) or in other ways.

Often studies show that teacher beliefs and practice are compatible. Thompson (1984) conducted a case study with three junior high mathematics teachers to examine the relationship between beliefs and practice. Each teacher was observed and interviewed over four weeks. Findings indicated that "teachers' views, beliefs, and preferences about mathematics do influence their instructional practice" (p. 125). For one teacher, her belief in the importance of a positive relationship between teacher and student was reflected in the atmosphere of the classroom. Another teacher held the view

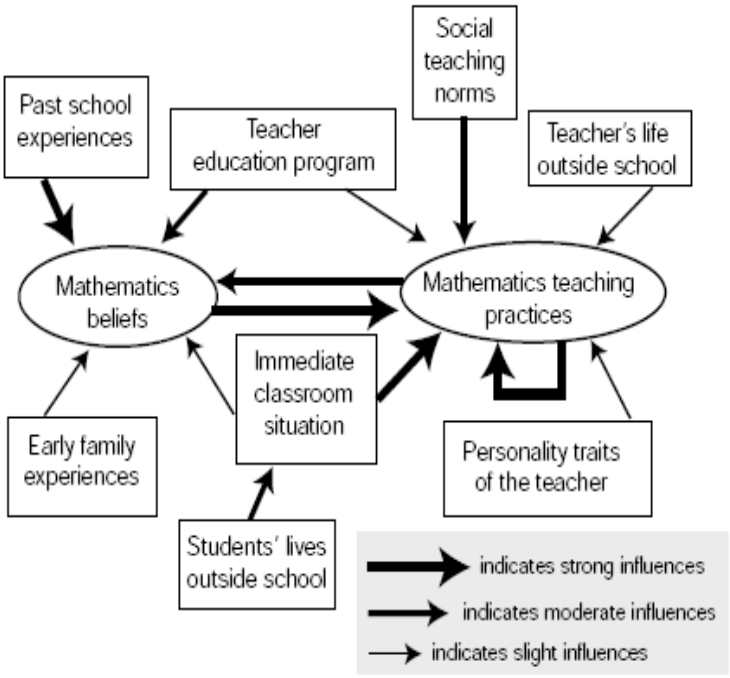
that mathematics is a high-level activity. Her teaching upheld this belief and during lessons she commonly urged students to guess and conjecture. Thompson also found that for some teachers, the beliefs they hold outside of mathematics may take precedence over those beliefs that are specific to mathematics. The teacher Lynn, for example, was more influenced by her belief in the low ability of her students than by mathematics. She ran a very structured class where few questions were asked even though she indicated that students asking questions is an important part of mathematics. Aguirre and Speer (2000) examined the relationship between teacher beliefs and goals and the relationship with actual teacher practice. They found that teacher beliefs and goals greatly influence classroom teaching and some beliefs (e.g., students learn by listening to other students) are pushed aside when there is a change in the classroom situation (e.g., a student is struggling). These examples show the need to understand both beliefs about mathematics and other beliefs regarding students and the classroom.

It is not always the case, though, that teacher beliefs match practice. Cohen (1990), in a case study with one teacher, Mrs. Oublier, found that she believed using manipulatives to teach mathematical concepts was helpful for students. During observation, however, Cohen found that students were only using the manipulatives to mimic her actions without attending to the actual mathematics being studied. It was clear that her methods focused on teaching the right way to do a problem and left little room for other ideas or exploration. This study of her classroom shows that although a teacher may hold particular beliefs, actual practice may not reflect those beliefs. Phillip (2007) suggested that beliefs are complex and may appear inconsistent with teaching practices. He proposed two ways to explain inconsistencies. The first is to determine if some

beliefs play a greater role than others in influencing practice. The second is to examine if the teacher may be able to explain the contradiction.

Raymond (1997) examined the relationship between beginning elementary teachers' beliefs and actual practice. Beliefs were split into four categories; beliefs about mathematics, learning mathematics, teaching mathematics, and practice were all investigated. From this study, Raymond developed a model to represent the relationship among the factors that affect mathematics teaching practice. This model highlights the complexity of the influences on mathematics teaching practice and the importance of beliefs. Raymond also characterized some relationships as more powerful than others. The model indicates that there are specific beliefs in relation to the mathematics as a subject while other beliefs are unrelated to content or even to classroom practice and all may have some direct or indirect effect on classroom practice. This look at teacher beliefs and practices supports the idea that research needs to include the past and present experiences. In addition, teachers may need to be asked about the motivation or goals in specific classroom situations to fully understand the structure of the decision making. This model may not fit all situations that arise in the classroom or all factors that make up a teacher's belief system and other factors or differing strengths may be discovered during new research.

Figure 1



Mathematics beliefs: about the nature of mathematics and mathematics pedagogy

Mathematics teaching practice: Mathematical tasks, discourse, environment, and evaluation

Immediate classroom situation: Students (abilities, attitudes, and behavior), time constraints, the mathematics topic at hand

Social teaching norms: School philosophy, administrators, standardized tests, curriculum, textbook, other teachers, resources

Teacher's life: Day-to-day occurences, other sources of stress

Students' lives: Home environment, parents' beliefs (about children, school, and mathematics)

Teacher education program: Mathematics content courses, methods courses, field experiences, student teaching

Past school experiences: Successes in mathematics as a student, past teachers

Early family experiences: Parents' view of mathematics, parents' educational background, interaction with parents, (particularly regarding mathematics)

Personality traits: confidence, creativity, humor, openness to change

(Raymond, 1997)

Beliefs and Curriculum Implementation

Curriculum is part of "the social teaching norm" (Raymond, 1997) and makes up part of a teacher's beliefs about mathematics and that teacher's teaching practice. This model and other research indicate that to fully understand a teacher's beliefs about mathematics researchers need to look at the interaction a teacher has with the curriculum. Collopy (2003) investigated the relationship between teacher beliefs and the implementation of a new curriculum in the elementary classroom. Teachers learned to use the curriculum through a two-day workshop and were not given additional professional development. The study found that differing teacher beliefs influenced what the teachers learned from the materials and how the teachers used the materials in the classroom. For example, the teacher whose beliefs included speed and accuracy as a goal of mathematics altered the materials to have greater structure to accomplish this goal. The teacher that believed that students need to become confident with mathematics used the materials as they were intended and even gained new goals (i.e. multiple solutions strategies) for her students by the end of the year. Interestingly, the teacher who used the curriculum as intended characterized herself as a poor mathematics student. This study is an example of how curriculum can influence beliefs and practice for some teachers. Remillard and Bryans (2004) studied the role a reform curriculum might have in supporting teacher learning. It was found that teachers' "*orientation toward the curriculum*" (p. 363) played a vital role in the implementation of the curriculum and therefore teacher learning. They found that not only was a philosophical match necessary to use a curriculum as intended, a teacher's opinion of curricular materials highly influenced the use of materials. Two of the teachers highlighted used the curriculum

essentially as a reference while the other followed the curriculum closely. All teachers were veterans and 2 of the 3 had goals and views of mathematics that were similar to the curriculum being implemented. Even with these similarities, only the teacher who trusted the curriculum over her own ideas and beliefs implemented the curriculum as intended. In a study investigating the implementation of an inquiry science curriculum, Roehrig, Kruse, and Kern (2007) found that teaching beliefs and school site issues both played a large role in how the curriculum was implemented. One school site issue, for example, was the lack of collaboration between teachers. Teachers in the study were classified as traditional (did not follow the inquiry science model), mechanistic (used curriculum for topics but not teaching style-group work, for example), and inquiry (followed the curriculum). From this study they found that the teachers who were classified as mechanistic seemed to be influenced the most by other outside factors besides beliefs when implementing the curriculum. In an attempt to understand how the role of the teacher changes when using non-routine problems, Clarke (1997) investigated two teachers who implemented a curriculum unit on measurement. Both the beliefs and practices of these teachers were explored by using observations and interviews. Clarke discovered that the use of an innovative curriculum can have a positive influence on professional growth and can change teacher beliefs. Clarke also found that beliefs and practice do not always align. Additionally, the teacher with the weaker content knowledge seemed to struggle more to make their beliefs and the new role in the classroom sync. When looking at the beliefs and practice of middle school teachers who implemented a new curriculum, Middleton (1999) found that "activities that foster change in teachers' and students' behaviors create instances that teachers must reconcile

with, rather than perpetuate, their current beliefs systems" (p. 356-7). Middleton acknowledged that it is not clear if beliefs or practice changed first for these teachers but that both did change when using the new curriculum.

Research supports the idea that beliefs influence practice (Thompson, 1984; Raymond, 1997). In addition, there is a complex interaction among beliefs, curriculum and practice (Clarke, 1997; Remillard and Bryans, 2004; Roehrig, Kruse & Kern, 2007) with some researchers adding that content knowledge has some influence on this interaction (Clarke, 1997; Raymond, 1997). Some teachers choose to follow their beliefs while others choose to change beliefs and follow a new curriculum. For example, a philosophical match with the curriculum or a trust in the curriculum over one's own ideas may cause a teacher to alter beliefs and practice to match that of the curriculum. Several studies examined the interaction between teacher beliefs and practice with a relatively new curriculum (Roehrig, Kruse & Kern, 2007; Clarke, 1997; Remillard & Bryans, 2004). The literature provides contrasting information regarding whether teachers with weaker content knowledge are more or less influenced by new curricula. It was also found that there are other outside influences on beliefs and those may be strong enough to make a teacher's beliefs less apparent. There is also evidence that goals affect practice and can outweigh other beliefs. The research makes it clear that the interaction among beliefs, practice, and curriculum is complex. Outside influences can complicate the situation and make it difficult to determine what is influencing a teacher's practice. In this study, teachers were asked about outside influences on their teaching and curricular choices in an attempt to understand how these factors shape their practice. Teachers were also observed in the classroom to see if these professed beliefs are reflected in their

practice. This study will help create a complete picture of the choices and factors that have some bearing on teachers' classroom practice by analyzing the teacher's practice relative to their professed beliefs and outside influences.

Standards-based Curriculum

After the publication of the *Standards* in 1989, the National Science Foundation put out a call and later supported the work of about 12 curricula that followed the principles and standards in the NCTM document (Senk & Thompson, 2003). While *Standards*-based is the most accurate term to describe these curricula, the term reform is often used synonymously and represents the idea that these curricula offered a change from the traditional mathematics that most teachers and students had previously encountered in the classroom. *Standards*-based curricula include

> Heavy use of non-numeric representations (e.g., diagrams, manipulatives), and expanded content base (e.g., in elementary curricula, topics that go beyond traditional arithmetic to include statistics and graphing, geometry, and pre-cursors to algebraic reasoning), and extensive use of calculators. Moreover, in order to meet new goals for student learning (i.e., mathematical thinking, reasoning, problem solving, connecting, communicating, seeking evidence, and constructing arguments to make predictions and support conclusions), these new curricula de-emphasized paper-and-pencil skills and focused on students' active construction of and communication about solutions to challenging problems (Stein, Remillard, & Smith, 2007, p. 320).

One curriculum that was developed during this time was the Core-Plus Mathematics Project (Core-Plus) (see Coxford et al., 1997, 1998, 1999, 2001). "The

CPMP [Core-Plus] curriculum was developed not only to reshape what mathematics all students have an opportunity to learn but also to influence the mAnner in which learning occurs and is assessed" (Schoen & Hirsch, 2003, p. 315). As with all the *Standards*-based curricula, Core-Plus offered an alternative to the traditional sequence of algebra, geometry, and advanced algebra and steers teachers away from lectures toward a more teacher-led discussion with large amounts of student input. Schoen and Hirsch (2003) explained that each Core-Plus lesson begins by introducing the whole class to a problem situation. Then, the rest of the lesson involves students working together to complete problems that are focused on the opening situation. The teacher then wraps us the lesson with a group discussion where "common understanding of important mathematical concepts, methods, and approaches" (p. 315) is reached. Each lesson also includes On Your Own and MORE (modeling, organizing, reflecting, and extending) problems for students to work on individually. In contrast, traditional mathematics lessons typically include teacher led lecture followed by student practice with little student-teacher interaction.

The change to the *Standards*-based curricula was difficult for many schools and caused uproar in the mathematics community. Debate ensued over the effectiveness of the reform curricula versus traditional and this disagreement was dubbed the "Math Wars" by Schoenfeld (2004). These debates prompted research regarding student achievement for those using the *Standards*-based curricula. For example, Harwell et al. (2009) and Post et al. (2010) found that there is no relationship between curriculum and grades or difficulty in courses taken for college students who took a reform curriculum in high school versus those who took a traditional curriculum, except for the lowest level

students (ACT < 22). Schoen and Hirsch (2003) found that Core-Plus students did equally well in mathematics on ACT, SAT, and other college entrance exams. Because some of this research is so recent, many schools did not have evidence of the effectiveness of the reform curricula. Subsequently, several schools that faced opposition to reform dropped the new curricula shortly after adoption. This makes Suburban High School especially interesting since it adopted Core-Plus fully (all students take Core-Plus) and has not altered in that decision. The teachers in the study are asked questions in the interview regarding Core-Plus and the choice to continue its use for all students. They are also asked to reflect on changes that they have made to their teaching practice and changes in their beliefs about mathematics and student learning because of Core-Plus. These questions address the notion that curriculum can influence beliefs and practice and specifically examines the affect that a *Standards*-based curriculum has on teacher's beliefs and practices.

Fidelity of Implementation

Every district handles curriculum adoption differently and with each new adoption teachers are presented with opportunities to try new problems, styles, or strategies depending on the level of change from old to new curriculum. Once the curriculum is chosen the teacher is ultimately responsible for the content and pedagogy used within the classroom and there are no guarantees that curriculum is used as intended by the authors or that all topics are covered. Brown, Pitvorec, Ditto, and Kelso (2009) suggested that fidelity of implementation "is a measure of 'faithfulness' between something that is implemented and actions taken by an implementer" (p. 365). They break fidelity of implementation for curriculum up into the categories that they have seen

presented in the literature. These categories are practices, curricular coverage, alignment between written and enacted lessons, and textbook integrity. Each of these categories takes into account different parts of the implementation process and examines specific pieces of the teacher-curriculum interaction. Brown, Pitvorec, Ditto, and Kelso proposed looking at fidelity in two ways: *fidelity to the literal lesson* and *fidelity to the authors' intended lesson*. *Fidelity to the literal lesson* means the fidelity to what is written in the instructional materials. *Fidelity to the authors' intended lesson* is the "degree of alignment between the *authors' intended opportunities to learn* and the opportunities to learn observed in the *enacted lesson*" (p. 373). Teachers were observed and their actions, as well as the students' actions, were coded to determine their fidelity. This study provides a look at emerging ways to look at fidelity of implementation as well as the complexity of examining such an issue. It was found that most teachers followed the literal lesson with 22 out of 33 rated with high fidelity. Interestingly, the level of fidelity to the literal lesson did not match the level of fidelity to the author's intended lesson. This may be a result of teachers not understanding what the authors' statements imply. This difference between fidelity with regard to the authors' intended curriculum and the literal lesson provides a view of fidelity that is more reflective of the choices that teachers make when working with any curriculum.

Although fidelity of implementation may be difficult to research, it is an area of importance when examining the classroom and the interaction between teacher, student learning, and curriculum. As Tarr et al. (2008) noted, a difference between the "intended curriculum and the 'textbook' curriculum" (p. 250) exists. This is because

> The textbook adopted by a school or district is often not perfectly aligned with the intended curriculum (the local or state mathematics curriculum framework); consequently, teachers must make decisions, often on a daily basis, about what to use from the textbook, what to skip, and what to supplement from other resources (p. 250).

Tarr et al. also suggested that "the teachers own beliefs and experiences as well as the student's prior knowledge and motivation influence the ways in which the students interaction with mathematics" (p. 250). Tarr et al. looked at the level of implementation of NSF-funded (*Standards*-based) vs. publisher developed (traditional) curriculum, if curriculum type predicts student achievement, and the relationship between student achievement and the level of Standards Based Learning Environment. They found that beliefs of teachers using NSF-funded curricula differed from publisher-developed curricula in areas of ability grouping, teacher role, encouraging participation of minorities, and collaboration. Teachers using the NSF-funded curricula were more likely to feel able to encourage minorities to participate in mathematics and to have students work collaboratively. Teachers using publisher-developed curricula were more likely to believe that students should be grouped by ability and that the teacher should demonstrate and then students practice for students to learn best.

Remillard and Bryans (2004) introduced the term "orientation toward the curriculum" (p. 364). This was defined as

> A set of perspectives and dispositions about mathematics, teaching, learning and curriculum that together influence how a teacher engages and interacts with a particular set of curriculum materials and consequently the curriculum enacted in

> the classroom and the subsequent opportunities for student and teacher learning (p. 364).

In addition, they added that a teacher's beliefs mediated their use of the curriculum materials.

The research shows different ways of defining and examining fidelity of implementation (Brown, Pitvorec, Ditto, and Kelso, 2009; Remillard and Bryans, 2004; Tarr et al., 2008). Teacher beliefs play a role this research especially when examining the choices teachers make and the interaction they have with the curriculum (Remillard & Bryans, 2004; Tarr et al., 2008). This literature suggested that when looking at the interaction between beliefs and curriculum, fidelity of implementation is a necessary component of that research.

This chapter summarized research on teacher beliefs and the interaction between beliefs, practice and curriculum. Standards-based curricula were defined and the rationale and history behind their creation were examined. Fidelity of implementation and its relationship to beliefs was introduced. The literature clearly supports the idea that beliefs are created throughout a teacher's life and these beliefs subsequently influence classroom practice. As a teacher's career progresses, other factors begin to influence beliefs. Curriculum can influence teachers' beliefs although several factors such as goals, teaching philosophy, and content knowledge can also play a part in this relationship. By examining the beliefs and practices, through interview and observation, of teachers using a *Standards*-based curriculum, an understanding of the relationship between beliefs and practice and the influence of such a curriculum will be clearer.

Chapter 1 provided at an overview of information in the relationship between beliefs and practice. Chapter 2 gave an in-depth look at beliefs, curriculum implementation, and *Standards*-based ideas and provided justification for researching teacher beliefs in the context of a *Standards*-based curriculum. Chapter 3 described the methodology and analysis used in this study. Data is presented in chapter 4; analysis and discussion of the data is provided in chapter 5.

Chapter 3

The purpose of this study was to examine the relationship between the beliefs and practices of teachers using a *Standards*-based mathematics curriculum, Core-Plus, in a district with a long term commitment to this curriculum. The study was divided into three major parts. The first part explored the current beliefs of teachers and the experiences that influence those beliefs. Second, the classroom practices of these teachers were examined to determine if the professed beliefs and observed practices are consistent. There was also an attempt to reconcile any differences between stated beliefs and actual practice.

Specifically, this study addressed the following research questions:

1. What are the current beliefs surrounding the teaching of mathematics of these teachers?
    a. How are past experiences reflected in these beliefs?
    b. What factors outside the classroom influence these teachers' beliefs and practices?
2. How are stated beliefs reflected in current practices of these teachers?
    a. Are current practices consistent with stated beliefs?
        i. If so, how is this consistency observed?
        ii. If not, how is this lack of consistency observed?
    b. How are observed differences between beliefs and practices explained?
        i. What role does a *Standards*-based curriculum have in the relationship between beliefs and practices?
        ii. What role does testing have in this relationship?

Methodology

This study investigated the beliefs and practices of teachers at Suburban High School. This in-depth look at one high school and a group of teachers within that high school was best examined using a case study. Yin (2003) explained that case study research often looks at how and why questions and seeks to "investigate a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 13). In this study, the difficulty in separating beliefs, practice, and the role of the curriculum in this school setting clearly fits this explanation of case study. Case studies focus on a *bounded unit* (Smith, 1978, as cited in Merriam, 2001). This study's *bounded unit* consisted of Suburban High School and the individual cases within that bounded unit are the teachers.

Setting

Suburban High School is a large suburban school in the Upper Midwest. Suburban High School has an enrollment of over 3000 students and 27 mathematics teachers with a high level of student involvement in extracurricular activities (over 60%). In 2009, Suburban had an average ACT score of 25.4 compared to a national average of 21.1, had 88% of their students participating in the ACT exam, and 685 students taking AP exams. In 2010, 46 students were National Merit Scholars or Commended Scholars. According to 2009-10 data, Suburban High School has approximately 18% students of color and about 11% students with free or reduced lunches. About 91% of the students plan on attending college after graduation. Overall, this data indicates that Suburban High School is a high achieving school located in a district reflective of the state in ethnic diversity.

One of the unique characteristics of this school is the sustained use, over a 10 year period, of one NSF-funded curriculum from the beginning of first grade. The sequence was: Investigations in Number Data and Space (elementary), the Connected Mathematics Project (CMP) (middle grades), and Core-Plus at the high school level. These curricula were used for ALL of their students. While other schools and districts chose to only use a reform curriculum for a short period of time and many offered parallel programs of reform and traditional with tracking, Suburban has continued to implement this reform with obvious success and is currently the highest performing district in the state. Since implementing Core-Plus, the high school has increased the number of mathematics teachers significantly (from 17 to 28). This number reflects not only increases due to the number of students taking mathematics but increases due to implementing the block schedule with only four class periods per day. Because both changes occurred simultaneously, it is difficult to attribute the increase in teachers and the number of students in mathematics to only one change or the other.

Suburban High School was chosen as the site of this research because it has sustained reform since 1998 and has consistently seen academic success. This length of use makes this location of special interest because there has been an extended period of time for the curriculum and teachers' beliefs and practices to begin to influence one another. This research aimed to identify the beliefs of the teachers and the role this curriculum and other past experiences have had in the building of these beliefs. Five teachers were selected to participate in this study with the help of the department chairperson. By choosing five teachers there was the opportunity to see variation in beliefs while keeping the size of the sample reasonable for data collection. The sampling

of teachers represents purposive sample as they were chosen because they have large variability in age and experience using this curriculum as well as other curricula.

Curriculum

Core-Plus was developed after the 1991 call for new curriculum from the National Science Foundation. Core-Plus was published under the title of *Contemporary Mathematics in Context: A Unified Approach* (Coxford, Fey, Hirsch, Schoen, Burrill et al., 1997, 1998, 1999: Coxford, Fey, Hirsch, Schoen, Hart et al., 2001). Each year of the Core-Plus curriculum integrates algebra and functions, geometry and trigonometry, statistics and probability, and discrete functions (Schoen & Hirsch, 2003). The curriculum was developed with the guidance of four principles (Schoen & Hirsch, 2003, p. 314):

1. "Mathematics is a vibrant and broadly useful subject that should be explored and understood as an active science of patterns" (Steen, 1990).
2. "Problems provide a context for developing student understanding of mathematics" (Hiebert et al., 1996; Schoenfeld, 1992).
3. "Exploration and experimentation necessarily precede and complement theory"
4. Graphing calculators are used as tools for developing mathematical understanding as well as solving problems.

Each lesson of Core-Plus has a launch, a place to explore, a chance to summarize and problems for extension. The launch, called "Think About This Situation", opens each lesson and gives students the opportunity to begin generating ideas related to the topic at hand. In order to explore the mathematical ideas, students are given questions

and activities that relate to the topic and are developed within realistic contexts. "Checkpoints" are included in each lesson to give the teacher a chance to check understanding by listening student explanations. In order to extend the lesson, individual activities are presented in the "MORE" section of the Core-Plus curriculum. "MORE" stands for Modeling, Organizing, Reflecting and Extending. This section gives teachers an opportunity to choose problems for homework and gives a variety of problem types to vary homework based on individual need. The teacher resource book for the curriculum gives pacing information as well as suggestions for homework.

Course 4 of this curriculum contains 8 units and covers topics of functions (linear, exponential, and quadratic, for example) vectors, trigonometry, logarithms, concepts of calculus, counting methods and induction (Core-Plus Mathematics Project, 2010). The course is considered a pre-calculus course and although the content is what is expected in a pre-calculus text, the introduction of concepts follows the basic principles of the curriculum and fosters mathematical understanding through exploration along with some attention to algebraic manipulation. Students are still expected to work in groups and the teacher is more a facilitator of discussion than one who uses direct instruction. The teachers of this curriculum have the role of one who guides and moderates classroom discussion.

Method

Question 1

1. What are the current beliefs surrounding the teaching of mathematics of these teachers?
    a. How are past experiences reflected in these beliefs?

b. What factors outside the classroom influence these teachers' beliefs and practices?

In order to explore the first question, teachers completed a survey and interview to delve into current beliefs as well as past experiences and to begin to understand how these experiences have influenced the views that these teachers currently hold.

Survey

The survey (Appendix A) was adapted from a Mathematics Inventory for Teachers assembled by Bracht (1972) and used by Post, Ward, and Wilson (1977) that looked at views of teachers, principals, and university faculty regarding mathematics teaching and learning. In this study, the survey was used to gain an understanding of the general beliefs of the teachers. This survey was not included to provide statistical data, but to provide an overview of each teacher's beliefs. The survey was chosen because the questions contain elements of both mathematics beliefs and practices and provide a good first glimpse into those areas for each of the teachers. It was originally used for university faculty, teachers and principals and the questions are broad enough to include ideas about mathematics teaching and learning that would make sense to use in this setting with these high school faculty.

The survey was pilot tested with 4 teachers from a large urban high school who are my former colleagues. Each of these teachers taught Core-Plus and represents a variety of different teaching philosophies and styles. These teachers were chosen to see if there were differences in their responses so that information could be gained from the survey and to determine if any questions are difficult to understand and have to be rewritten. Data from these teachers were collected via email and put into a table to

compare the responses. Because I had prior knowledge of these teachers' classroom practices and beliefs, I was able to use this data to determine if the questions provided the variety of information that was intended from the survey. For example, could I tell the difference between the teachers that preferred using Core-plus to those who preferred traditional curricula?

After the pilot, some questions were deleted because they did not provide enough information or, upon further inspection, the information collected was not relevant to the study. For example, in the original survey, question 1 asked the participants to give their level of agreement to the question: *The field of mathematics consists primarily of procedures and formulas*. All of the participants answered either disagree or strongly disagree. I decided that this did not provide enough useful information and it was, therefore, eliminated. Some questions were reworded to more clearly convey the intent. For example, on the original survey one statement was: *In mathematics there is opportunity for developing and experimenting with different methods of solving problems*. This statement was changed to be: *In my mathematics classroom there is opportunity for developing and experimenting with different methods of problem solving.* This change reflects the focus on each teacher's classroom and personal beliefs.

After all the changes, the survey was crafted to include only questions of interest to the study that would provide information related to either past experiences teaching and learning mathematics or the current beliefs and practices of the mathematics teachers. The survey was inspected to determine which questions directly related to the differences in a reform and a traditional way of thinking. Question 3, for example, on the survey asks teachers if students in their class are encouraged to look for different ways of solving

problems. A teacher with beliefs that are more aligned with a reform curriculum would most likely answer with an Agree or Strongly Agree. Since one question cannot determine a teacher's alignment, thirteen of the twenty-four questions deal with the concepts that may be different for those who have beliefs more aligned with reform curricula than traditional curricula. Another question related to problem solving is "In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems". Although this question is similar to the other question mentioned above, it differs in that it focuses on the opportunity to explore versus just the teacher's encouragement to do so. Overall, the survey gives a first glimpse and helps to complete the understanding of each teacher's beliefs regarding mathematics content, thinking and learning.

Interview

After teachers completed the survey, they were interviewed to gain a more comprehensive look at their past experiences, current experiences, and current beliefs. The interview (Appendix B) is intended to delve deeply into several facets that make up a teacher's current beliefs. Among those areas are past experiences as a student and as a teacher, outside influences on teaching, and the interaction they have with the curriculum. Also included are questions that explore their beliefs about the role of students and teachers in the classroom and what mathematics is. The interview was piloted with one teacher from the group that completed the survey from the large urban high school. This teacher was chosen because her views were well known to the interviewer and that helped to identify if the questions were able to solicit the expected responses. The participant was also willing to identify questions that were difficult to answer. As a result

of the pilot interview changes were made to the interview and are described below in more detail within the question sections that were altered.

Past experiences were included because research indicates that teachers' past experiences influence both their current beliefs and practices (Thompson, 1984; Raymond, 1997). Raymond (1997) also proposes that there are many other influences on a teacher's beliefs and practices. Question 1, for example, asks participants to *Please describe your experiences as a student in mathematics*. *If possible, describe experiences from all levels of education such as a student in elementary, secondary and college level mathematics*. This question begins to examine the teacher's experiences in education as a K-12 student. In addition, participants are asked about their experiences as a student teacher and as a classroom teacher on their own. Together, these sections of questions try to paint a picture of the teacher's past and create an image of what the mathematical experiences were prior to teaching Core-Plus.

Next, questions were included in the interview to determine influences on the teachers' beliefs and classroom practice beyond past experiences in the classroom. These questions focused on the decisions about classroom instruction and the influences on those decisions. Teachers were asked, for example, *How do you decide what you will teach?* and *How do you decide how you will teach?* Another question asked how statewide or other testing influences what is done in the classroom. Together these questions comprised another area of the outside influences on beliefs and classroom practice.

The connection between curriculum and beliefs was of particular interest in this study. As shown in Collopy (2003) and Remillard & Bryans (2004), the interaction

between curriculum, classroom practice, and beliefs can be complicated. In order to dissect this relationship, questions were included to learn about each teacher's beliefs about Core-Plus and how this curriculum has influenced each teacher's practice.

Thompson (1984) suggested that conceptions of mathematics are a teacher's beliefs about mathematics teaching, learning, and practice. With this in mind, questions were included to delve into each teacher's beliefs in this area. These questions focused on a teacher's beliefs about what mathematics is and what it means to learn mathematics. First, participants were asked, *How would you describe what mathematics is?* In addition, they were asked *What does is it mean to learn mathematics* and *How do you know that your students have learned*. As a result of the pilot interview, the questions dealing with conceptions of mathematics were altered to include a continuum. For example, participants were originally asked *How would you describe what mathematics is?* In the final study they were offered a continuum to mark where they think their beliefs lie after they have answered the questions. A continuum was added for four out of the five questions in the conceptions of mathematics section (questions 14-18). Here is the continuum for describing what mathematics is:

Collection of facts, rules, formulas, and procedures		Collection of facts, rules, formulas and procedures and but includes an understanding the concepts and principles behind the rules.		Interconnected concepts and ideas found in sometimes seemingly dissimilar situations.

Participants simply placed an x where their beliefs lie, either on or between any of the descriptions provided. Identifying a teacher's beliefs in these areas gives specific points to look for when comparing stated teacher beliefs and actual practice.

Finally, questions concerning the teacher's beliefs about students and teaching were asked to complete the picture. Originally the interview asked *What do you think is the best way for students to learn mathematics?* After the pilot, this question was changed to include, *From the student perspective, what do you think is the best way for students to learn mathematics*. This was because the pilot participant expressed concern that this question was too similar to *What do you think is the most effective way to teach mathematics?* This question was then changed to, *From a teacher perspective, what do you think is the most effective way to teach mathematics*? The goal was to get the participants to focus on students in the first question while addressing teachers in the second. In addition to these two questions, participants were asked *What influence do you believe you have on students' learning? Confidence? Attitude? Beliefs about mathematics?* This question was designed to look at the relationship between the teacher and the student and the influence the teachers believe they have on their students.

Together the questions in this interview create a picture of the teachers' beliefs. The interview was designed to first look at the teacher's experience as a student at all levels including teacher preparation. Participants were then asked about their experiences as a teacher and other outside influences such as testing that may affect the choices they make regarding content and pedagogy. Teachers were questioned regarding any changes to their pedagogy and beliefs because of the Core-Plus curriculum. Finally, questions regarding their conceptions of mathematics (e.g., what mathematics is, what is the role of the teacher in the classroom) were posed. This interview covered teacher beliefs from past experiences to current practice and the interaction with the curriculum. It also

provided a comprehensive look at where the teacher's beliefs come from and the influence experience and other outside factors have on those beliefs.

Question 2

2. How are stated beliefs reflected in current practices of these teachers?
    a. Are current practices consistent with stated beliefs?
        i. If so, how is this consistency observed?
        ii. If not, how is this lack of consistency observed?
    b. How are observed differences between beliefs and practices explained?
        i. What role does a *Standards*-based curriculum have in the relationship between beliefs and practices?
        ii. What role does testing have in this relationship?

To answer question 2, each of the five teachers in the study was observed three times. These observations were recorded with the Comparing Options in Secondary Mathematics: Investigating Curriculum (COSMIC) observation protocol (Appendix C) designed for Core-Plus (Tarr, McNaught, & Sutter, 2006)). The intent of this protocol was to use both live and video-taped lessons to analyze the teaching of Core-Plus. This protocol was chosen because of the connection to Core-Plus and the ease of use it presents while in the classroom. COSMIC includes all areas of instruction introduced and developed within each lesson or unit of Core-Plus (e.g., checkpoints). There is a simple checklist for each part of the lesson and then room for additional notes at the end of the observation. Some other additional features make this protocol ideal for this study. Fidelity of implementation and teaching fidelity are both included in this protocol as well

as factors such as student thinking and reasoning. Overall, this protocol fits well with this research and makes a great companion to the observations.

Schoen and Hirsch (2003) described the intent of the Core-Plus curriculum authors in terms of classroom instruction. Schoen and Hirsch explained that the instruction for each lesson should include a problem situation that is introduced and investigated by the entire class. Students should then work together in pairs or small groups to investigate more focused problems that relate to the launch. Checkpoints are included to bring the class together to agree on the mathematical concepts and ideas. These checkpoints are designed to be teacher moderated discussions. For individual work, the lessons contain two different places for individual work: the On Your Own and the MORE problems. Finally, both individual and group assessments are included in the materials for each lesson with a final capstone at the end of a unit. The COSMIC materials provide a clear and concise way to record the teacher and student's actions with regard to each of these areas.

Fidelity of implementation, as defined by Brown, Pitvorec, Ditto, & Kelso (2009) is "a measure of "faithfulness" between something that is implemented and actions taken by an implementer" (p. 365). The COSMIC materials look at fidelity of implementation in terms of what Brown, Pitvorec, Ditto, & Kelso call the "authors' intended lesson" (p. 374). This examines how closely the teachers use the materials in relation to what the author's intend. A second type of fidelity that is examined by Brown, Pitvorec, Ditto, & Kelso is that of the fidelity to the literal lesson. In their study, they looked at how closely teachers used the materials as written. This fidelity is not explicitly examined in the COSMIC materials but is identified in part with the opportunities to record which of the

materials were and were not used. While in the classroom, field notes were also taken to note anything that reflects or contradicts stated beliefs that were recorded earlier in the surveys and interviews. Each observation was videotaped so selected elements can be watched at a later time.

Upon conclusion of the observations, teachers were interviewed again in an attempt to explain any differences between stated beliefs and actual practice (Appendix F). Phillip (2007) suggested that teachers can often explain why these differences occur. The discrepancies were from the responses to the initial survey and interview and the actions in the classroom while teaching with stated beliefs. First, teachers were asked if the three days they were observed are typical and to explain why they are or are not typical. This question was included to give the teacher a chance to explain any unusual occurrences in those three days and to give the researcher a sense of what may have been missed in those observations that usually takes place in the classroom. The final interview also asked teachers about the differences between the author's intended curriculum and the written curriculum (Brown, Pitvorec, Ditto, & Kelso, 2009) and what was actually observed and to explain reasons for any difference. The participants were asked to explain why and when they choose to deviate from the content that was written in the textbook. This line of questioning was intended to gain a clearer picture of the reasoning behind these teachers' choices when determining what and how to teach in the classroom.

Analyzing the Data

Survey. The survey consists of twenty four questions and results were gathered from all 5 participants prior to the initial interview. The survey data were compiled into a

table with the questions so the answers from the 5 participants could be readily compared (see Appendix D). The questions that reference *Standards*-based practice were highlighted for easy comparison of these teaching methods or principles. Survey data were examined to look at the teachers' beliefs about mathematics teaching and learning relative to a *Standards*-based perspective and classroom practice. First, each teacher's data was examined relative to the questions that were identified as eliciting answers that refer to a *Standards*-based perspective to determine if they are aligned more with a *Standards*-based teacher, a traditional teacher, or somewhere in between. Each teacher was then categorized as having Standards-based responses or traditional responses. By assigning a number to each response relative to the answer that was connected with a more *Standards*-based answer, the total for each teacher can be looked at as how strongly they align with the *Standards*-based responses. A total of forty four points is possible if each of the eleven responses is either Strongly Agree or Strongly Disagree, whichever corresponds to a *Standards*-based answer. From there on every other response was assigned 4, 3, 2 or 1 point(s) relative to the strength and the total calculated to give an indication of the level of agreement the participant has with some select *Standards*-based ideas. This calculation also provided an opportunity to compare the teachers to one another in this area.

The survey also provided information regarding beliefs about classroom practice. Looking specifically at the questions regarding problem solving (3, 8, 10, 15, and 23), the students' role in the classroom and communication (6, 13, and 24) and homework (8 and 16) a summary of these views, including those questions that are *Standards*-based, was made to begin to understand each teacher's beliefs about classroom practice (Table 1).

Table 1

Questions Grouped by Category from Survey

Category	Question
Standards	3. Students in my class are encouraged to look for different ways of solving problems.
	5. One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures
	6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas.
	8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.
	9. I use a variety of assessments to determine a students' learning progress.
	10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.
	13. A silent classroom is better for students than one with talking.
	15. I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas.
	20. The study of mathematics consists primarily of learning formulas and computational procedures.
	23. Students in my class are expected to develop the methods for problem solving.
	24. Students should first ask the teacher for help when having difficulty in the classroom.
Problem Solving	3. Students in my class are encouraged to look for different ways of solving problems.
	8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.
	10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.
	15. I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas.
	23. Students in my class are expected to develop the methods for problem solving.

Student role and communication	6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas.
	13. A silent classroom is better for students than one with talking.
	24. Students should first ask the teacher for help when having difficulty in the classroom.
Homework	8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.
	16. Most of the mathematics I assign outside of class is intended to give students practice in using a particular rule or formula.

The survey also contains questions about the teaching profession. These questions helped determine the teacher's beliefs about students and the teaching profession. An overview of each teacher's beliefs in these areas was developed to begin to understand his/her view of the profession, past experiences in mathematics, and views about students as they are all related to beliefs about mathematics teaching and learning and may influence classroom practice. Overall the survey provided a cursory look at the beliefs of each teacher regarding *Standards*-based instruction and classroom practice and gave a basis of comparison when examining the interviews and observations.

Initial Interview. Each interview was transcribed and responses were recorded in a table with the question, teacher number, and response. The initial interview was examined to look for themes within each participant's answers and to highlight his/her beliefs. Emerging themes were gathered and compared to both the survey responses as well as the observations. When examining each teacher's beliefs responses that were given multiple times and those that were given to the questions pertaining to the biggest influences were of particular interest. The initial interview questions were separated into the parts that address the specific research question (Table 2).

Table 2

Initial Interview Questions and How They were Used to Answer the Research Questions

Question	Initial Interview Questions
Question 1	1. Please describe your experiences as a student in mathematics. If possible, describe experiences from all levels of education such as a student in elementary, secondary and college level mathematics.
	2. Please describe your experience in mathematics education courses.
	3. Please describe what you remember about student teaching.
	4. Please tell me about your teaching career and the experiences you have had so far.
	5. How do you decide what you will teach?
	6. What are the biggest influences when you are deciding what you will teach?
	7. How do you decide how you will teach?
	8. What are the biggest influences when you are deciding how you will teach?
	9. What other factors influence your decisions in the classroom?
	14. How would you describe what mathematics is?
	15. What does it mean to learn mathematics?
	16. How would you describe what you are teaching when you teach mathematics?
	17. What is the role of the teacher and the role of the student in the mathematics classroom?
	18. How do you know that your students have learned?
	19. From a student perspective, what do you think is the best way for students to learn mathematics?
	20. What influences do you belief you have on students' learning? Confidence? Attitude? Beliefs about mathematics?
	21. From a teacher perspective, what do you think is the most effective way to teach math?

Question 2 part b	10. How has statewide or other testing influenced what you do in the classroom? 11. What do you think about the Core-Plus curriculum? 12. Reflect on and share changes you have made to your teaching because of this curriculum. Student communication? Group work? Content integration? Different content? Assessment? 13. How have your beliefs changed regarding what students are able to do as a result of using this curriculum?

After transcription, the responses that addressed the question were read, highlighted and examined to find themes and other information that helped answer the research question. Questions fourteen to seventeen on the initial interview had a second component. After the participants responded to those questions, they were given a continuum with responses they could choose from to compare to the interviewer's opinion of what each response indicates. For example, question fourteen asks participants *How would you describe what mathematics is*? After the question was answered, the following continuum, without the numbers at the top, was shown to the participants:

0	1	2	3	4
Collection of facts, rules, formulas, and procedures		Collection of facts, rules, formulas and procedures but includes an understanding of the concepts and principles behind the rules.		Interconnected concepts and ideas found in sometimes seemingly dissimilar situations.

With this definition and the ones they gave an understanding about their beliefs about mathematics teaching and learning was formed. These responses were then put into a summary table with general survey results (Appendix E). Included in the summary table from the interview were the responses from the continuum, highlights of each participant's experiences and other influences on teaching with "biggest influences"

bolded. This table was then used for reference when assessing and understanding each teacher's beliefs, experiences, and influences.

Observations. Each teacher was observed for three 85 minute class periods. During these observations, field notes were taken to record the overall impressions of the researcher. These notes were used to create a table highlighting actions and other observations. In addition, the COSMIC Observation Protocol (Tarr, McNaught, & Sutter, 2006) was filled out to look more closely at the teaching environment and use of the Core-Plus curriculum. Each session was video-taped in case there were questions about the written record of the observation. The observation summary table that was created and COSMIC are then used to compare the stated beliefs that were summarized in question 1 of this research to the actual practice that was observed. This COSMIC protocol was also used to help answer question 2b and to examine the role of the curriculum in the relationship between beliefs and practices. The protocol helped by giving a record of the actual parts of the book that were used and documenting any additional materials used during the lesson. Together the field notes and COSMIC observation protocol helped create a record of what happens in the classroom and then were used to recreate this observation in the context of each teacher's beliefs.

Final Teacher Interview. The final teacher interview consists of five questions (Appendix F). Each interview was transcribed, put in a table, and examined to help answer question 2 of this research. The results of the final interview were used to look for reasons that the observations may not have followed the stated beliefs. In addition, the final interview was used to more closely analyze the influence of the Core-Plus

curriculum and the use of the curriculum. These answers were related back to both the responses from the initial interview and the observed practices.

Summary

Five participants are surveyed, interviewed, observed, and interviewed again to try to understand their beliefs and the relationship these beliefs have to their practice with the Core-Plus curriculum. Chapter 1 provided an overview of information relative to this research. Chapter 2 provided justification for researching teacher beliefs in the context of a *Standards*-based curriculum. Chapter 3 described the methodology and analysis used in this study. Data is presented in chapter 4; and analysis and discussion of the data is provided in chapter 5.

Chapter 4

Curriculum and past experiences influence teacher beliefs (Clarke, 1997; Remillard & Bryans, 2004; Roehrig, Kruse & Kern, 2007). Raymond (1997) suggested that there is a back and forth interaction between beliefs and practice. This research study expanded on previous research by closely examining the relationship between beliefs and practices of teachers using a reform curriculum. The interaction of beliefs, practice, and curriculum was framed in the context of the NCTM *Standards* and the relationship these and other state standards have on existing beliefs and current practice. To better understand these relationships, the following questions were addressed in this research:

1. What are the current beliefs surrounding the teaching of mathematics of these teachers?
    a. How are past experiences reflected in these beliefs?
    b. What factors outside the classroom influence these teachers' beliefs and practices?
2. How are stated beliefs reflected in current practices of these teachers?
    a. Are current practices consistent with stated beliefs?
        i. If so, how is this consistency observed?
        ii. If not, how is this lack of consistency observed?
    b. How are observed differences between beliefs and practices explained?
        i. What role does a *Standards*-based curriculum have in the relationship between beliefs and practices?

ii. What role does testing have in this relationship?

This chapter takes an in depth look at five participants and the relationship between their beliefs and practices with the Core-Plus curriculum by:

- Providing an overview of each participant
- Responding to each research question individually and relating it to applicable research

For question one, each participant's responses to the survey and select interview questions was closely examined to determine current beliefs, past experiences and other factors that influence beliefs. The survey provided information regarding the alignment of the teacher's beliefs with the *Standards* and interview questions that deal with past experiences and other factors that each teacher finds influential. All of these responses to the survey and interview are summarized to create a picture of each teacher's beliefs about mathematics teaching and learning.

To answer question two, classroom observations were analyzed for each teacher and these observed practices were compared to stated beliefs (the results from question one). In addition, question two specifically looks at the role of the curriculum and mandated testing with regard to classroom practice. This information was taken from responses to questions from the initial interview that deal with testing and curriculum. Finally, question two is addressed by looking at the teacher's explanation of differences between stated beliefs and actual classroom practice that was gained from the final interview with each participant. Together this information allows a comparison of stated beliefs with actual practice considering the role of curriculum and testing in this relationship.

Participants

Five teachers were chosen to participate in this study. All five teachers have been at Suburban High School for at least four years. The participants represent a variety of teaching perspectives and were chosen with the help of the department chair. The teachers had a wide range of teaching experience (from four to 40) and differing educational backgrounds, ages, and experiences outside this school. Suburban High School switched to the Core-Plus curriculum in 1998. Two of the teachers were present during the switch while others joined the staff after the full implementation. Each teacher in the study completed the survey, interview, observations, and final interview.

Pat. Pat is a long-time teacher and active participant in the mathematics community. His career spans forty years and includes many experiences outside the classroom including coaching math team and writing questions for mathematics exams. In addition, Pat is the department chair, handles scheduling decisions and has helped build the solid mathematics reputation of Suburban High School. Pat has taught almost all the courses offered in a traditional mathematics curriculum as well as all levels of Core-Plus. Currently he is teaching Course 4 of the Core-Plus curriculum to the accelerated students.

Jamie. Jamie has taught for four years and has only worked at Suburban High School. Core-Plus is the only mathematics curriculum she has used as a teacher. Jamie has taught all levels of Core-Plus except Course 3 and is currently teaching Course 1 and Course 2.

Dana. Dana has taught for 19 years at multiple schools. Dana's experience includes teaching outside this country and several traditional teaching experiences. She has taught traditional courses from algebra to calculus and all levels of Core-Plus. Currently she is teaching Course 4.

Anne. Anne has 11 years of teaching experience with professional experience outside of teaching prior to working at Suburban High School. This is the only school at which she has taught. Anne was present as a student teacher during the change to Core-Plus and continued here full-time, therefore her teaching experience only includes Core-Plus except for part of student teaching. She has taught all levels of Core-Plus and is currently teaching Course 4.

Kelly. Kelly has four years of teaching experience at Suburban High School and has no experience prior to this position. Kelly has only taught Course 1 and Course 2 of the Core-Plus curriculum, which she also currently teaches.

Data

Question 1

1. What are the current beliefs surrounding the teaching of mathematics of these teachers?
    a. How are past experiences reflected in these beliefs?
    b. What factors outside the classroom influence these teachers' beliefs and practices?

To explore question one, data from the survey and initial interview were compiled to create a summary of each teacher's beliefs about the teaching of mathematics. This analysis included looking at how past experience and other factors influence beliefs. First, the survey was examined to determine the current beliefs of each teacher relative to

the *Standards*. Second, the survey was studied again to begin to understand each teacher's beliefs about problem solving, the role of the teacher and student in the classroom, and homework based on specific questions in the survey. Finally, each teacher's interview was closely analyzed to understand the past experiences, current beliefs, and other influences on classroom instruction. Each of these is described in detail and a brief summary is created from these details.

Alignment with the Standards, Problem Solving, Students, and Communication

Eleven of the questions on the survey related to beliefs and practices that are reflective of the *Standards* (Table 1). These questions contained the areas of using and exploring multiple solutions, problem solving, reasoning, student communication, and a variety of assessment, all of which are supported by the *Standards*. Each teacher's responses to these questions were examined and a level of agreement with the *Standards* was determined. Teachers' responses to the survey in the specific areas of problem solving, the role of the students in the classroom and communication were also examined from the survey.

Table 1

Questions Grouped by Category from Survey

Category	Question
Standards-supported ideas	3. Students in my class are encouraged to look for different ways of solving problems.
	5. One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures
	6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas.
	8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.
	9. I use a variety of assessments to determine a students' learning progress.
	10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.
	13. A silent classroom is better for students than one with talking.
	15. I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas.
	20. The study of mathematics consists primarily of learning formulas and computational procedures.
	23. Students in my class are expected to develop the methods for problem solving.
	24. Students should first ask the teacher for help when having difficulty in the classroom.
Problem Solving	3. Students in my class are encouraged to look for different ways of solving problems.
	8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.
	10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.
	15. I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas.
	23. Students in my class are expected to develop the methods for

	problem solving.
Student role and communication	6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas. 13. A silent classroom is better for students than one with talking. 24. Students should first ask the teacher for help when having difficulty in the classroom.
Homework	8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems. 16. Most of the mathematics I assign outside of class is intended to give students practice in using a particular rule or formula.

Pat. Pat's responses were clearly aligned with *Standards*-based ideas. For example, the response to *Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures and formulas* was Strongly Disagree. The question *In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems* elicited a response of *Strongly Agree*. The one surprising response, relative to the others, was that he chose *Strongly Agree* as the response to *One of the most important reasons for studying mathematics is that it helps one think according to strict rules and procedures.* This is in contrast to the response reported earlier and to several others that clearly indicate that problem solving and reasoning are highly valued. Overall, Pat's responses indicate a very high level of agreement with *Standards*-based ideas. Out of the 44 points possible for the *Standards*-based questions (four for strong agreement or disagreement with each of the 11 questions), Pat scored 40, the highest of the five participants.

According to the survey, students in Pat's class are focused on problem solving in a variety of ways, he does not believe that class time should be filled with the teacher explaining the mathematics, and students need to be active participants in class by

problem solving and talking. Pat's Agree response on the survey indicates that homework in his class does focus on practicing rules and procedures learned in class.

Jamie. Jamie's responses indicate a high level of agreement with the *Standards*-based questions. Jamie scored 39 on these questions out of the possible forty four. Jamie chose a Strongly Agree or Strongly Disagree response seven out of eleven times. One such time is the question *One of the most important reasons to study mathematics is that is helps one to think according to strict rules and procedures* when the answer of Strongly Disagree was chosen. On several other questions, responses were Agree or Disagree such as *Students in my class are encouraged to look for different ways of solving problems* and *Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas* indicating agreement with the *Standards*-based ideas but not with as much strength. Jamie appears to have beliefs that are very highly aligned with the *Standards*. In terms of classroom practice, Jamie responds Agree to the question *In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems* and *Students in my class are expected to develop the methods for problem solving*. Also, she Disagrees that *Most of the mathematics I assign outside of class is intended to give students practice using a particular rule or formula* and that *Nearly all class time should be spent by the teacher explaining mathematical ideas, procedures and formulas*. These answers indicate that she emphasizes problem solving over rules in class and on homework. In addition, she believes that class time is not dominated by teacher lecture.

Dana. Dana's score on the survey was 38. One difference from the other participants is that she chose the Agree response to *A silent classroom is better for*

student than one with talking. All the other participants chose Disagree or Strongly Disagree to this question. She also responded that she Agrees that *One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures*. Even with these responses, because Dana chose Strongly Agree or Strongly Disagree to six out of the eleven *Standards*-based questions her overall score is high and it appears that her beliefs are highly aligned with the *Standards*. The questions on problem solving indicate that Dana emphasizes problem solving over rules and procedures. For example, the responses to *Students in my class are encouraged to look for different ways of solving problems*, *In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems,* and *Students in my class are expected to develop the methods for problem solving* were Strongly Agree. Dana Agrees that *Most of the mathematics I assign outside of class is intended to give students practice in using a particular rule or formula* and Disagrees that *Nearly all time should be spent by the teacher in explaining mathematical ideas, procedures and formulas*. These responses indicate that classroom practice involves problem solving without emphasizing teacher lecture but she does hold some traditional views like having a quiet classroom and the importance of rules and procedures.

Anne. Anne's score was 35 on the survey and she only responded with Strongly Agree or Strongly Disagree twice. Although her responses were less opinionated, overall they align with the *Standards*-based ideas presented in the survey. Anne has the lowest overall score which may indicate that she, although still in line with the *Standards*-based ideas, is in agreement with them the least. The only questions with a Strongly Disagree

response within the *Standards*-based questions were *A silent classroom is better for students than one with talking* and *One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures*. The rest also aligned with *Standards*-based ideas but are only Agree or Disagree. Anne Disagrees that *The study of mathematics consists primarily of learning formulas and computational procedures* and that *Most of the mathematics I assign outside of class is intended to give students practice in using a particular formula*. She Agrees that *I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas* and *Students in my class are encouraged to look for different ways of solving problems*. These answers indicate that problem solving is a focus of both the classroom and homework.

Kelly. Kelly only responded to three questions with Strongly Agree or Strongly Disagree and had a total score of 36 out of 44 on the *Standards*-based questions. All of her responses reflect what would be expected of someone whose beliefs align with the ideas in the Standards. For example, she Agrees that *I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas* while Disagreeing with *Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas*. Kelly Strongly Agrees that *Students in my class are expected to develop the methods for problem solving* and Disagrees that *When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems*. Regarding homework, she Agrees that *Most of the mathematics I assign outside of class is intended to give students*

practice in using a particular rule or formula. Kelly's survey responses indicate that she believes in problem solving in both class work and homework.

Comparing Survey Results

Table 3 shows the results of the survey for each of the participants and allows for easier comparison. Highlighted questions indicate that they reflect ideas based on the Standards.

Table 3

	Pat	Jamie	Dana	Anne	Kelly
1. A good learning environment is maintained when instruction is focused on the interests and motivation of the students.	A	SA	A	A	SA
2. There are many aspects of teaching mathematics which I do not enjoy.	D	D	D	D	D
3. Students in my class are encouraged to look for different ways of solving problems.	SA	A	SA	A	A
4. I frequently spend time helping students who have difficulty understanding mathematics.	SA	A	SA	SA	SA
5. One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures	SA	SD	A	SD	A
6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas.	SD	D	D	D	D
7. I was a good mathematics student.	SA	A	SA	SA	A
8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.	D	D	D	D	D
9. I use a variety of assessments to determine a students' learning progress.	SA	A	SA	A	SA
10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.	SA	A	SA	A	A
11. Student interest is greater if instruction is organized so that the logical structure of mathematics is apparent throughout the course.	SA	A	SA	A	A
12. Being a mathematics teacher is what I expected the career to be.	SD	D	A	A	D
13. A silent classroom is better for students than one with talking.	SD	SD	A	SD	D
14. Teaching mathematics takes a lot of work.	SA	SA	SA	SA	SA
15. I place more emphasis on the reasoning involved in solving problems than on the	SA	A	SA	A	SA

	learning of rules and formulas.					
16.	Most of the mathematics I assign outside of class is intended to give students practice in using a particular rule or formula.	A	D	A	D	A
17.	There are several topics in my mathematics courses that I do not enjoy teaching.	SD	D	D	D	D
18.	The teacher has only a small influence on students' attitudes about mathematics.	SD	D	D	D	D
19.	Students who are not making an effort to learn mathematics should not be required to take mathematics courses.	SD	SD	SD	D	D
20.	The study of mathematics consists primarily of learning formulas and computational procedures.	SD	SD	SD	D	D
21.	The outcomes of a mathematics course are maximized when the rate and depth of learning are about the same for all students.	SD	D	D	D	D
22.	I often collaborate with other teachers regarding my mathematics teaching.	SA	SA	SA	SA	SA
23.	Students in my class are expected to develop the methods for problem solving.	SA	A	SA	A	SA
24.	Students should first ask the teacher for help when having difficulty in the classroom.	D	D	D	D	D

The survey results indicate that all five participants share many of the same beliefs about the mathematics classroom and the point totals only range from 35 to 40 points. Most of the questions are answered similarly by all five participants with only a difference of Strongly Agree and Agree, for example. Questions five, 13, and 16 are the exceptions to this similarity. Question five was included to help determine, along with question 20, if these teachers saw mathematics as highly procedural. Pat chose strongly agree, Dana and Kelly chose Agree, and Jamie and Anne chose Strongly Disagree on question five. Surprisingly these results are drastically different for Pat, Dana, and Kelly than their responses to question 20 about mathematics being based on formulas and computation. These questions were obviously interpreted differently by the participants and reflect different aspects of their beliefs. For question 13, Dana chose Agree to a silent classroom being better. This may indicate a different view of the word talking,

such as disruptive chatter, or it may indicate that she truly believes that a silent classroom is better. Question 16 indicates that Pat, Dana, and Kelly assign more homework on rules and procedures than Jamie and Anne.

Pat is described as very highly aligned with the *Standards*, with the exception of question five, based on both his score and the strength of his responses on these questions. Jamie and Dana are also very highly aligned, their point totals are close to Pat's and their responses are reflective of the *Standards*. Anne and Kelly are classified as highly aligned because their overall score is lower than the others and they responded with fewer Strongly Agrees and Strongly Disagrees. Overall, all of the participants seem to hold views that align with the *Standards*.

A summary of the information found in the survey is included in Table 4.

Table 4

Summary of information from Survey

	Years Exp.	Alignment with *Standards*-based beliefs	Classroom Practice
Pat	40	Highly *Standards*-based (40 points)	•High focus on problem solving and reasoning •Low focus on teacher explanation •Homework involves practice on rules or formulas
Jamie	4	Highly *Standards*-based (39 points)	•Focus on problem solving and reasoning, •Low focus on teacher explanation •Homework does not mainly focus on rules and procedures
Dana	19	Highly *Standards*-based (38 points)	•High focus on problem solving and reasoning •Low focus on teacher explanation •Homework involves practice on rules or formulas.
Anne	13	Highly *Standards*-based (35 points)	•Focus on problem solving and reasoning •Low focus on teacher explanation •Homework does not mainly focus on rules and procedures.
Kelly	4	Highly *Standards*-based (36 points)	•Focus on problem solving and reasoning •Low focus on teacher explanation •Homework involves practice on rules and procedures.

Stated Beliefs

In addition to the survey, teachers were interviewed to gain a better understanding of their beliefs and the influences past experience and outside factors have on these beliefs. There were seven questions on the interview that relate to the topic of current beliefs. These questions asked teachers to describe what mathematics is, what it means to

learn mathematics, what is being taught when teaching mathematics, the role of teacher and student in the classroom, and how it is known that students have learned. In addition, participants were asked what they think is the best way for students to learn mathematics and the most effective way to teach mathematics. Since past experiences have a connection to beliefs (Raymond, 1997) it is important to examine these experiences. To understand how past experiences are reflected in beliefs, participants were asked about their experiences as students from kindergarten through their college degree, during their mathematics methods courses, as well as their experiences during student teaching and full-time classroom teaching. It is also important to consider other influences on beliefs. Therefore, participants were asked about what other things influence their decisions in the classroom. They were asked how they decide how and what they will teach as well as specifically investigating the influence of statewide testing on classroom practices (Table 5).

Table 5

Interview Questions by Category

Category	Question
Beliefs about mathematics teaching and learning	14. How would you describe what mathematics is?
	15. What does it mean to learn mathematics?
	16. How would you describe what you are teaching when you teach mathematics?
	17. What is the role of the teacher and the role of the student in the mathematics classroom?
	18. How do you know that your students have learned?
	19. From a student perspective, what do you think is the best way for students to learn mathematics?
	21. From a teacher perspective, what do you think is the most effective way to teach math?
Experiences	1. Please describe your experiences as a student in mathematics. If possible, describe experiences from all levels of education such as a student in elementary, secondary and college level mathematics.
	2. Please describe your experience in mathematics education courses.
	3. Please describe what you remember about student teaching.
	4. Please tell me about your teaching career and the experiences you have had so far.
Outside influences	5. How do you decide what you will teach?
	6. What are the biggest influences when you are deciding what you will teach?
	7. How do you decide how you will teach?
	8. What are the biggest influences when you are deciding how you will teach?
	9. What other factors influence your decisions in the classroom?
	10. How has statewide or other testing influenced what you do in the classroom?

To explore the conceptions of mathematics, teachers were first asked the questions without being given any guidance. Once all the questions in this category were asked, teachers were given some possible responses and asked where they believe they fit within those responses. They could place their x anywhere along the continuum. The first box is considered zero the next is one and so on. The 4 questions with the corresponding continuum are shown here. Teachers were not shown the zero through 4 and they are only included as a reference for description.

14. How would you describe what mathematics is?

0	1	2	3	4
Collection of facts, rules, formulas, and procedures		Collection of facts, rules, formulas and procedures but includes an understanding of the concepts and principles behind the rules.		Interconnected concepts and ideas found in sometimes seemingly dissimilar situations.

15. What does it mean to learn mathematics?

0	1	2	3	4
Memorization and the ability to apply procedures		Learn the facts and procedures as well as some concepts behind the procedure		Investigate and construct mathematical ideas. Understanding grows out of engagement with the material.

16. How would you describe what you are teaching when you teach mathematics?

0	1	2	3	4
Progression though a sequence of topics and skills specified in a textbook. Each skill is viewed as a prerequisite for the next and are equally important		Manipulatives are used to help achieve attitudinal goals such as “math is fun”. Teaching about problem solving is prevalent versus teaching with problem solving.		How different concepts, procedures, and representation are interconnected in sets of problems and situations. Pictorial and physical representations are used to engage students in tasks.

17. What is the role of the teacher and the role of the student in the mathematics classroom?

0	1	2	3	4
Teacher as demonstrator of well-established procedures. Student imitates the procedures until they become habit. Authority lies with the teacher or the book.		Teacher is the same as level 0. Student roles include some understanding of the justification of standard procedures. Authority still lies with the teacher or book.		Teacher provides contexts in which students can explore ideas and generate procedures. Teacher gives opportunities for students to express their ideas and for the teacher to listen to and assess their reasoning. Questioning is intended to stimulate, guide, or focus student thinking rather than for the sole purpose of eliciting answers. Students must engage in mathematical inquiry.

Pat's beliefs. Pat described mathematics as including the "study of pattern", problem solving, being able to communicate ideas about patterns, and the ability for children to write their thoughts. He considers arithmetic at a low level. He makes a connection between mathematics and English and explains that spelling in English is comparable to arithmetic in mathematics. His explanation is, "Think about if I was an English teacher and if I spent the entire time teaching kids how to spell, would you think I am a very good teacher? I said, for me Arithmetic is like spelling. It's great if you know how to do it but if you don't there are tools you can use to be a better speller or to be able to spell right. As far as algebra goes it is like the grammar of mathematics it tells you how you put together these pieces. If I was an English teacher and I spent the entire time teaching grammar I wouldn't be a very good English teacher. The goal of an English teacher is to get kids to be able to write and communicate their thoughts. That is

exactly my same goal in mathematics." When given the choices on the continuum, Pat chose to the very left of *Interconnected concepts and ideas found in sometimes seemingly dissimilar situations* (region 4). This choice is in agreement with the answers he provided on his own as he explained how there is more to mathematics than just arithmetic or algebra, it is a way to communicate mathematically and "put together these pieces." Pat believes that learning mathematics is "teaching kids how to think analytically". He also explained in an earlier response that because of Core-Plus he, "can have kids working in groups, reading the questions, and answering questions together" instead of discussions led by him. He chose the response *Investigate and construct mathematical ideas. Understanding grows out of engagement with the material* for this question. This clearly fits with his responses for this and other questions in this section. To Pat, teaching mathematics means "teaching problem recognition", "understanding/comprehension of symbols" and "logical thinking." Again, Pat's response was in region 4 on the continuum, as was his response to the roles of the teacher and student in the classroom. This was confirmed by his answer to those questions. He stated that, the role of the teacher is to ask the right questions and present problems so "kids can make their own inferences". Besides the common ways of determining if students understand the mathematics that is introduced in class such as homework, quizzes and tests, Pat explained how he focuses on the students daily to determine if they are learning. He chooses to "look at their faces and expressions and their connections" to see if they understand the material. He feels he gets to know the students well enough that he can tell by their expressions if they understand what he is saying. He says that he likes to "ask lots of questions" and after each quiz and test they "go back and talk about

it". Pat believes that to learn mathematics it is important to assign problem sets that are engaging. Pat summarized what he believes is the most effective way to teach as, "There are times you lecture, there are times when you have the Socratic discussion, there are times when you have students investigate, and underlying all those things you are pointing out attention to connections, attention to detail, attention to accuracy. Those underlying things become important too."

Although several of Pat's beliefs may be difficult to distinguish from a more traditional mathematics response, his responses in other areas help understand his beliefs about mathematics. He talks about it being important "that they [students] didn't watch me do problems. If they watch me do problems they might be engaged with the logic and never focus in on what is next and that is the critical part we need to focus in on and that has been my complaint about anybody who is just up there lecturing. Stop and talk about it. What should I do next."

Jamie's beliefs. Jamie had a difficult time articulating her ideas about what mathematics is. She stated that, "Math is the thinking and studying, not just numbers, but with this whole sense of a system almost as why what makes our world what it is." She placed herself in region 3 but closer to region 2 for this explanation. So her beliefs were closer to a *Collection of facts, rules, formulas and procedures but includes an understanding of the concepts and principles behind the rules* but are between that and *Interconnected concepts and ideas found in sometimes seemingly dissimilar situations*. From Jamie's short response, it is difficult to make a comparison between her selection and her stated response. Jamie stated that learning mathematics is "Deepening your thinking skills so that you're able to problem solve." Her choice on the continuum

matched this idea in that she also suggested that mathematics should prepare students to know how to approach problems. Her choice was *Investigate and construct mathematical ideas. Understanding grows out of engagement with the material*. When describing what it means to teach mathematics, Jamie talked about teaching some skills but these skills are used to "think about the deeper problems" and overall she described it as, "The understanding as to why things work the way they work." She talks about teaching about the x-intercepts of a parabola but adds that they are also teaching "where you might see a parabola in real life. We are connecting it with that but we are still teaching why are these the x-intercepts." Jamie's choice of the response in region 4 makes sense because this contains *How different concepts, procedures, and representation are interconnected in sets of problems and situation. Pictorial and physical representations are used to engage students in tasks* which is very close to her own explanation of what she does in class. Jamie explained that the role of the teacher is to be the "facilitator so that they recognize when kids are struggling to come up with ok I am explaining it one way and the kids are not getting it and then they explain it a different way." She added that teachers should "guide them to get the correct answer" and to ask questions if kids are working and I see something that is incorrect to try to get them to explain to me why they got that answer." She stated that students should "ask questions of other students and with me when he or she is not getting it or when he or she needs extra assistance or when he or she has a little tangent about it." Jamie's choice on this continuum lies in region 3 which is between *Teacher as demonstrator of well-established procedures. Student roles include some understanding of the justification of standard procedures. Authority still lies with the teacher or book.* and *Teacher provides*

contexts in which students can explore ideas and generate procedures. Teacher gives opportunities for students to express their ideas and for the teacher to listen to and assess their reasoning. Questioning is intended to stimulate, guide, or focus student thinking rather than for the sole purpose of eliciting answers. Students must engage in mathematical inquiry. This seems reasonable relative to her responses because she still is acting like the authority figure with respect to answering questions but she also responded to the previous question that she gives students an opportunity to explore concepts within context. Jamie's response to knowing how students have learned focuses on tasks that students complete to show their competency such as exit slips, homework, homework quizzes, quizzes and tests. Jamie suggested that the best way for students to learn depends on the student. She also explained that they key thing is to get the student to "be motivated and be confident." Jamie's response to the most effective way to teach mathematics was very clear. She stated that it is one where students, "are trying to solve problems but they are still very much guided by a teacher who is making sure they also have the skills they will need in order to solve a variety of problems and apply them." Her explanation reflects her earlier response that mathematics contains both skills and problem solving.

Dana's beliefs. Dana described mathematics as "just a pattern. It is just a pattern between, they are all related." She adds that "The graph, the equation, the table all matching so you see the pattern everywhere." She continues that "you learn how to solve problems, you need to break it down into steps in your life, you need to break it down into steps. See the pattern and attack the problem." Her choice on the continuum was *Collection of facts, rules, formulas and procedures but includes an understanding of the*

concepts and principals behind the rules (region 2). Although her response focused more on patterns and problem solving, this choice does seem the most appropriate because she not only talks about learning the procedures, which would be region zero, but adds that the students need to learn to break it down and see the patterns in the problems. She also does not mention interconnected ideas which is included in region 4. Learning mathematics to Dana "means understanding, understand what is going on. Not just memorizing some formulas." Dana's mark was between *Learn the facts and procedures as well as some concepts behind the procedure* and *Investigate and construct mathematical ideas. Understanding grows out of engagement with the material* (region 3). From her short response it is difficult to determine the accuracy of this response. Dana explained that teaching mathematics "means you see examples in real world related to those topics." In the range for this question, Dana's choice was in region 4. Again her short response makes it difficult for comparison. The role of the teacher is described as someone who "persuade[s] them, I am looking for a word, yeah, inspire to move on especially for our kids, regular four kids they just, you know, some of them hate math they are just taking course four because it is required." Her choice was again in region 4. Dana explained that for students to best learn mathematics they need to, "Stay focused in class, practice at home, ask questions." Dana's explanation regarding the best way to teach mathematics was, "It is not, there is not an easy answer for this one. So you have to be really flexible and you have to use different methods to teach math. So sometimes you have to lecture. Not everything bad about that method, you have to lecture, kids need to see some examples. You can't just show them from nothing. So that's my writing, my procedure, show them how to do that so I have to show them. I have to show

them. So that is the lecture time, that is the traditional. And the other part is just show them some examples. So that is the problem based part. The other way is using technology." She talks about varying methods depending on the topic.

Anne's beliefs. Anne described mathematics as the "process of thinking mathematically and whether that is learning how to solve real life situations in everyday life or whether it is going to lead to a career that more directly uses math. I think it is just the intellectual development is huge with it." Anne's choice on the continuum was between the *Collection of facts* and *Interconnected concepts* but closer to the *Interconnected concepts* explanation (to the right in region 3). Her brief response makes it difficult to compare these responses. Learning mathematics to Anne is "both the practical and the ideological or what learning all of the skills and procedures and solving problems, problem solving literal problem solving is important but also that just helps your thinking becomes so much more developed and sophisticated and that spreads out to other areas in life other than just math class or solving a math problem in everyday life. So I think it is both the practical and learning how to stretch your mind to think." Her choice of the given ones was to *Investigate and construct mathematical ideas. Understanding grows out of engagement with the material* (region 4). This fits closely with her description of mathematics as a way of thinking instead of just something to use to solve problems in class. Anne described teaching mathematics as something to help students "get ready for college mathematics" and to help them "think on another level." Her mark indicates that her beliefs lie somewhere between *Teaching about problem solving* and *How different concepts, procedures, and representation are interconnected*. Her response again focuses on the thinking involved and does not exactly match any of

the choices on the continuum. The role of the teacher is to "lead them in what they need to learn and to help them learn the material whether it is through direct teaching or through them working through it in their groups or later in their homework. So helping them learn the material but that happens in a variety of ways. Be supportive of them." The role of the student is to "learn the math and learn how to be a good student to get ready for college and to get ready for life and to be a productive working person." Her choice on the continuum was in region 3 and this fits her description because she explained her use of teacher led instruction (like region 2) to get information across as well as having student explore at time (like region 4). Knowing how students have learned is achieved through tests, quizzes, homework, questioning in class and talking to them. Anne described the best way to learn mathematics as having students "work through the material and learn it as much as they are able with somebody who knows the material to guide them and help clarify things." The most effective way to teach was "a combination of them working through things and practicing them and trying to discover what they can but also guiding them and showing them how to learn it when they can't get it on their own."

Kelly's beliefs. Kelly described mathematics as a "problem solving process. And so it is a way to look at the world and kind of solve different problems within it." Her choice was between *Collection of facts, rules, formulas and procedures* and *Interconnected concepts* on the continuum (region 3). Her short response makes it difficult to determine if these two response fit together. For the question about what it means to learn mathematics, she put her mark between *Learn the facts and procedures* and *Investigate and construct mathematical ideas* and *Investigate and construct*

mathematical ideas. Understanding grows out of engagement with the material. (region 3). Her response to the interview question was, "It means to learn how to look at a problem and figure out how to attack it and for a lot of our students they look at a problem and if it is a little bit different than the one before they are able to use their problem solving skills and strategies to still attack the problem." She compares this to her education saying, "And I know for myself as a student I just learned processes and if this problem did not fit x, y, and z that I had seen then I didn't know what to do with it. Where I think our students are more able to kind of go well this just shifted by five or whatever it happened to be and they are able to use what they have seen but also transfer it to a new problem." It is no surprise, given this interview response, that Kelly chose region 3 between fact and procedures and constructing mathematical ideas. Her response indicates that the use of the procedures in other situations and using these mathematical ideas is important. Kelly stuck with the central theme of problem solving by stating that when teaching mathematics, "I am teaching them how to solve problems." Not surprisingly her response was *How different concepts, procedures, and representation are interconnected in sets of problems and situation* along the continuum because she clearly believes that doing mathematics means an application in different situations. However, Kelly often referred to the fact that she did not want students to be bored in other parts of the interview and it would not have been surprising for her to choose region 2 where it talks about attitudinal goals. Kelly stated, "The role of the teacher is to facilitate learning and that doesn't necessarily mean that I have to be up front talking all time. I think my students learn a lot from each other from talking to each other." She continues, "But it is more facilitating their learning. So giving them time to talk with

each other. Giving them time to think about what the problem is asking and not just necessarily saying this is the only way to solve the problem. Because a lot of the students come up with unique ways that I never even would have envisioned but they work." The students should "kind of go through the problems and the processes and develop an understanding for that type of problem." She put her mark in region 3 for this question. This is reasonable considering her responses continue to include the students problem solving and the teacher facilitating this exploration. With the part of her response regarding the students sharing their ideas, region 4 may have been expected for her choice. Knowing her students have learned is accomplished by walking around the room, exit slips, warm up problems, homework, quizzes and tests. She described the best way for students to learn as including examples she provides that are not always included in the book. She also believes it is important for students to talk about the math they are working on and said, "But students like to talk about the math and so I hate when my classroom is silent because then they are not learning anything." She states, "discovery based learning is the most effective as long as the students have a point of reference. There's times where I think that's where I find myself supplementing the direct teaching in the book is because the students have no point of reference. For example, they have never seen a log before so they have no idea what it even means and for them to just all of a sudden to just start using the log button on their calculator doesn't make much sense to them. So if they have a point of reference and understand why it's useful and why we might be using it then to discover on their own is really beneficial." This reflects her ideas about mathematics learning that she explained earlier, a combination of procedures with some context.

Experience

To get a picture of these teachers' experiences, they were asked about their schooling through college, specifically asking about mathematics education courses. They were then asked about student teaching and their teaching career so far. These responses were used to help answer the question *How are past experiences reflected in these beliefs*? After looking at all the experiences with education as well as their stated beliefs a clearer picture of the overall beliefs of each participant can be formed.

A summary of the information from the continuum questions is found in Table 6.

Table 6
Summary of regions for continuum questions on interview.

	Region 0	Region 1	Region 2	Region 3	Region 4
What is mathematics?			Dana	Jamie Kelly Anne	Pat
What does it mean to learn mathematics?				Kelly Dana	Pat Jamie Anne
What is teaching mathematics?				Anne	Pat Jamie Dana Kelly
What is the role of the student and the teacher?				Jamie Anne Kelly	Pat Dana

Pat's experiences. Pat had a wide variety of experiences from his long career in education. He recalled doing the New Math in 7th grade and then the SMSG (School Mathematics Study Group) program in high school. He began as a math major in college where he recalls working in groups and does not remember any methods courses as part of this undergraduate degree. His student teaching was done with modular scheduling and he explains that he had to do "motivational lectures" to groups of 120 students. This experience showed him the importance of getting "into it and motivated". He has a

master's degree in math education and has taught methods courses and worked with student teachers. During his coursework for his master's degree, he was heavily into problem solving and feels he may have taught the professor a few things. His time teaching methods courses focused on content and pedagogy versus behavioral objectives. He worked as a chemical engineer for a brief period of time but came back to teaching because he missed the classroom. He has worked on projects throughout the country on graphing calculators and both national and international mathematics exams, ARML, for example. These exams are typically very challenging and require both strong mathematics skills and problem solving ability. His teaching career has always focused on finding the best and most innovative ways to teach students, even if that meant creating his own materials. He was on the forefront of bringing graphing calculator technology and curriculum into the classroom. He has spent many years coaching math team and working and writing for mathematics competitions.

Jamie' experiences. Jamie described herself as someone who was "naturally good at math." She explained that her experience was "traditional" in high school except for a few extension projects. She recalls having teachers that were "always there to give me extra help" and this had made it important to her to be "available before and after school for the students". Her math methods course focused on giving "different insights into how to teach." She explained that her instructor focused on both "traditional and integrated approaches" and that she was "very much pro-traditional in college." She believes that she was challenged by her professor's statement that "A lot of your classmates weren't successful in math so you need to make sure you are doing other things in there, having other strategies to make it meaningful for kids." Student teaching

was comprised of two different types of experiences for Jamie. She spent part of it in an elementary teaching an NSF curriculum called *Investigations* and the other part was teaching a traditional Algebra II class. She recalled that the Algebra II students found it difficult to work in pairs because they had not had any experience doing so. For her the Core-Plus curriculum posed a bit of a challenge in the beginning because of her lack of experience with anything like it but she likes that students are "doing other things."

Dana's experiences. Dana explained that math was an easy subject for her. She grew up in a different country with a very traditional mathematics experience. She liked teachers who explained the material in depth. Her undergraduate degree was in applied math and she has experience teaching in the country she grew up in. She came to the United States and took courses to become certified to teach here. She reflected on her experiences in methods courses as improving her content but not necessarily her pedagogy, since she already had several years teaching experience. Student teaching provided her with experience managing the classroom and understanding the teaching environment. Her first experience teaching in the United States was "traditional".

Anne's experiences. Anne had many memories of mathematics in elementary such as using a felt board for place value and doing a lot of fractions. Teaching was a second career for Anne and she related that she always wanted to be a teacher. She described her high school math experience as "very traditional, like sit in your desk and rows and watch the teacher." She did have a course that they worked in groups on proofs in college but most of the classes were "traditional." Her math methods course was a disappointment to her and she explains that her instructor never mentioned integrated math. She did her student teaching at Suburban High School during the transition from a

traditional to the *Standards*-based curriculum they are using now and she admits that she did not really like the new curriculum and preferred the lecture style she used with an Algebra II course. She has only taught at Suburban High School for her professional teaching career and has taught a variety of levels of the curriculum.

Kelly's experiences. Kelly described her elementary math as a "game" with a "lot of puzzles and manipulatives." She recalled that math in 7th and 8th grade were very traditional "with notes and you just did a lot of rote problems." She stated that math became boring to her and this idea carries through to her choices today. In math methods she compared traditional and integrated in a paper and that experience was something that did "kind of push me more toward the integrated." Student teaching was done using a traditional program but she "developed a lot of hands-on" and "group-work based" activities. She stated that "if you try to just traditionally teach them they are going to be very bored." She explained that Suburban High School is her first job and she recalls following the book carefully her first time through.

Outside influences

In addition to the experiences each participant has had in the classroom as a student, student teacher, and teacher Raymond (1997) suggested that other factors influence teachers' beliefs. Participants in this study were asked to reflect on the other factors that influence their decisions in the classroom. For example, they were asked how they will decide what and how they will teach and what the biggest influences are on these decisions. These responses, together with the information already given, help to define the aspects that are most influential in the decision-making process and, therefore, part of the belief system.

Pat. Pat talked about his use of innovative textbooks to shape the classroom and determine what he will teach. He recalls that he used a book by Cohen for pre-calculus and "his problem sets weren't just the same problem sets 15 times, they were all sort of integrated and this is cool and I really like this idea but it was really hard for some kids because most kids were used to mathematics by repetition." He included Core-Plus in this class of innovative texts and said that he uses it the way it is without adding very much "In the Core-Plus I essentially teach what is there." Pat explained that his biggest influence in deciding how to teach is the "…topic of the day and how I can connect it with the kids the best. Some days that is going to be lecture, some days Socratic discussion, some days problems to explore." When asked what other factors influence his decisions in the classroom, Pat explained that the students direct a lot of what he does. He says, "I want kids to become much better problem solvers." He adds about his teaching to the kids that, "I am leading a discussion where the students are engaged so I don't want to use the bad lecture word but there are some times it is very much teacher directed. Other times, like today, after going over last night's questions I said today is more of the same so I just took problems right out of the investigation and gave it to them and after they worked for a while I put some answers on the board and I walked around to see where there were problems. It was an opportunity…it was important that they didn't watch me do the problems." He explains differences in his students that direct his lessons. "right now I can tell you that my 4th block class is very different than my 2st and 3rd. so I end up teaching them differently. For some of those students I might spend more time writing down steps and details." Beyond the idea of an integrated curriculum

that Pat likes, the state mathematics standards also played a role in deciding what curriculum would be used at Suburban High School.

Jamie. Jamie explained that the biggest influences when deciding what she will teach are "The input of the other teachers and the curriculum…the book." She describes the process of aligning the curriculum with the standards, "We had to, for Math 2, when they first made the schedule, they had to go through and mark everything with the standards. Like what standards does this go to." She says about the other staff, "As teams we are trying to have the same thing. Two other teachers and I last year were assigned to come up with a Math 4 schedule so we worked together. We just kind of adapted things we had previously done and we conferred with the Math 3 teachers because all the books had changed and we conferred with the chair of the department to see which of these chapters can we not do. Which do we need to make sure they really have." When deciding how she will teach, Jamie indicated that her students are the biggest focus. "I have to look at my kids first of all. It starts off with these are the investigation problems we are going to do. So I have to look through them or do them myself and make sure I understand what the goal is, what do I want them to walk away with for the day and then based on the questions and the level of difficulty are we going to do it where we do part of the investigation together or maybe we start and do question one and then they go off and do it in their groups and then go back." She adds, "I have to be really ready to adjust that maybe I thought this should be one I thought they should be fine working in groups but actually it looks like we need to do this as a whole class." She explains, "I try to consider it from the student's point of view" She describes her classroom as different from the traditional experience because, "I am up at the board

going back and forth a lot with the kids." The other members of the department, a collaboration involving discussion and sharing of ideas, are also a big influence on her teaching. She explained that the state standards influence the whole department by guiding what topics will be taught and they follow them closely.

Dana. When deciding what she will teach, Dana explained that the biggest influence is the cooperation between her and another teacher. "For each unit we sit and decide what homework we will assign and then what parts of the unit we need to more emphasize and teach." This includes deciding which topics will be covered and at what pace. On a daily basis, the biggest influence was student knowledge and then what was done the day before. She explains, "I decide based on my students' knowledge and then based on what we did yesterday. Did they understand the material? Should I slow down or move on? Even every day I do things differently in my three classes." Differences between students within classes and well as in different classes influences the day to day teaching. She explained that deciding how she will teach is again based on her knowledge of her students, the lesson, and the curriculum. She states, "I have to lecture some days because kids need to see the steps and instruction. Sometimes I do group work. It depends on the lesson. I know my students, I know that they are struggling in this part of algebra, I know it is hard for them. It is a waste of time for them to work in their group." She adds, "so I prefer to teach them before they start their class work to give them a quick lecture, may 15 or 20 minutes, this is our goal today, this is what we are going to do today and this si the example. By combining her knowledge of her students and her understanding of the material, she decides how the material should be presented. For example, she may use group work, lecture, and/or independent work.

When deciding what she will teach, Dana stated that "Departmental policy" and "Having consistency with my coworkers" are the biggest influences. She also explained that state standards are checked with what they are doing in class as well as what they need to improve or emphasize more.

Anne. Anne described that the overall outline of what she will teach is determined by what was done before and also by the department chair. She explained that she and another teacher work closely together to write quizzes and tests together and to determine what will be taught on a more daily basis. "We work really close together as a team." She added, "We write the test together and make a rubric for how to grade it so we are really lined up and we give tests and quizzes on the same day we work really close together." This teamwork is the biggest influence on what she will teach. When deciding how to teach, Anne described how she "works through all the material" and then she will "go on past experience." She believes that the harder the material, the more difficult it is for the students to learn through discovery and when, through experience, she knows that the students are struggling she teaches directly. "I try to stick to the philosophy of the program of having kids work through it and do the discovery thing but the higher up you get the harder it is for them to do that." She stated that "experience" is the biggest influence when deciding how she will teach. She added that "each class, their personality and their ability level" also influence these decisions as well as working with the team. She explained that all of the state standards are covered because their curriculum is intentionally aligned with the standards. She said, "We've painfully gone through and made sure everything is covered."

Kelly. When deciding what she will teach, Kelly listed several factors that influence this decision. She said the curriculum pacing guide, the students and how they do in the subsequent course, and the team of teachers all influences her decisions. She stated, "Our students, when they go on to Math 3, we were seeing that they were struggling a lot with factoring and struggling a lot with the trig identities so we have moved those to second semester so that it is fresh for them when they go on to Math 3 and also we can spend a little more time and push the easy units up to first term and spend a little less time if it comes naturally to the students." Collaboration with other teachers in the department is the biggest influence when teaching a curriculum for the first time. " The first time through the course I am kind of basing it on what the other teachers have noticed and where their students have struggled in the past." She adds, "Every day the math teachers have a common lunch period" and this is used as a time to share information and help one another. She also makes notes of where kids struggled or needed less time to succeed so she can make changes for the next year. After working through the problems, Kelly decides how the content will be taught. She explains, "Once I have worked through them I am able to kind of go back and say did I like the way the book kind of laid it out, is there anything I would need to add or change. And I found myself able to supplement on the front end if they just need a little bit before they jump into the book or as we are working on it I might stop the whole class and say, hey, you guys focus on this part and kind of directly teach a problem so they are able to get what they need out of it." She adds both group work and lecture to the given lessons when she feels it is appropriate. Her biggest influence in deciding how she will teach is the students. She says, "I try to keep in mind my students and their attention level and their

interest level." She recalls being bored as a student as is very careful to make sure her students are not bored but are challenged. In response to the influence that statewide testing has on what she does in the classroom she explained that, "Everything we do we go back to the standards."

Analysis of beliefs

Pat. Pat's responses in both the interview and survey indicate that he holds strong beliefs about mathematics teaching and learning. From the survey and interview, it appears that there are three areas of beliefs that may his influence classroom practice: problem solving, content, and students. All three of these topics are repeatedly mentioned throughout the interview and seem to guide him daily in his work.

Part of Pat's definition of what mathematics is includes problem solving. He repeatedly professed that problem solving is a key to mathematics and a core focus for him. Problem solving is important to what he does in the classroom, what he studied during his master's degree, and how he believes children learn mathematics the best. This belief in the power and importance of problem solving appears to be central to Pat's beliefs about mathematics teaching and learning. Pat's definition of problem solving includes "teaching kids how to think analytically" and to "write their thoughts." Recall that he used materials that were integrated and not repetition earlier in his career. This belief reflects the variety of experiences Pat has had. These experiences include studying problem solving in a master's degree program, working on innovative curriculum for the graphing calculator, and writing competitive mathematics exams that focus on challenging problems for top mathematics students. His interview also indicates that his career includes obstacles, such as overcoming other staff to implement curricula that is

integrated and makes use of technology, to making this kind of learning environment a reality but he has persisted in working with new and innovative curriculum because of his beliefs.

Pat also strongly believes in focusing on students' needs, questions, and interest while in the classroom. There seems to be a blend of focus for Pat on content, problem solving, and students when in the classroom. According to the survey, Pat clearly believes in a *Standards*-based approach to teaching and learning and combines this with a desire to teach his students to "think mathematically" and to "attack" problems. Together this seems to summarize his definition of problem solving. He states that one of the biggest factors that influence his decisions in the classroom is the students. He indicates that he asks a lot of questions and he likes to "look at their faces" to determine if they understand the material. It is difficult to determine from Pat's experiences where this intense focus on students and the belief that they are central to his decisions comes from, but with forty years of teaching experience and a choice to return to the profession, it may just be a dedication to the students that keeps them a main focus.

The third area of beliefs that is of importance to Pat is content. Pat believes that content determines how he will teach. In response to the biggest influence on how he will teach he responds, "The topic of the day and how I can connect it with the kids the best. Some days that is going to be lecture, some days Socratic discussion, some days problems to explore." But even with all the influence that content, students and his focus on problem solving have on his daily lessons, the state standards appear to have a powerful influence in an over-arching way. When deciding what he will teach he explains that, "The state standards dictated a curriculum…" This curriculum or content, as explored earlier, is then

one of the defining factors for the daily classroom activities for Pat. He states that, "In Core-Plus I essentially teach what is there."

It appears that Pat's beliefs have been influenced by the many experiences he has had in his long teaching career. His beliefs about the importance of focusing on students, content, and problem solving seem to guide his daily actions and decisions in the classroom. These beliefs about mathematics impacted the choice to switch to the Core-Plus curriculum at Suburban High School. Pat's beliefs about content, however, influenced his teaching prior to these state standards and his focus on problem solving permeates other aspects of his career. So, although the state standards have had an impact on Pat's current curricular choice, they do not seem to have changed his beliefs but have provided him an opportunity to put his beliefs into practice with a curriculum that also supports the state standards.

Jamie. Jamie's beliefs about the mathematics classroom are centered on doing what is best for students. She uses her own experiences as a student to create an environment that reflects this. For example, she makes herself available before and after school to her students and this is "really important to me." She reflects on her student teaching experience as something that was very much "lecture based" and states that, "I can see now that I have taught something that is not as lecture based I feel like it is a lot less boring." Her focus on students also includes being available before and after school as this was very meaningful to her when she was a high school student. Daily decisions regarding how she will teach are swayed by her students and she tries to look at things from a student's point of view. Although Jamie's beliefs about students have been influenced by her experiences, her daily decisions regarding content taught and pacing

are greatly influenced by her colleagues and the collaboration they share. There appears to be a professional collegiality that permeates many of the daily planning decisions, including quizzes and tests. These decisions, however, are still dominated by the fact that the state standards have shaped the curriculum.

Jamie's beliefs about mathematics teaching include focusing on thinking, problem solving, and understanding how things work. For her these areas consist of being able to tackle new problems, she explains, "Even if you never see that same problem again, you have a new way to approach another problem." She talks about having, "those skills to solve or to think about those deeper problems." And she explains that while still teaching algebra skills she is also teaching more real-world connections like "here's where you might see a parabola in real life. We are connecting it with that but we are still teaching why are these the x-intercepts." Overall she believes that mathematics "is the understanding as to why things work the way they work." The beliefs about including other methods and real-world context seem to reflect that pivotal moment in her methods course where she realized that although the traditional way worked for her, it may not work for all students. Her beliefs about the importance of focusing on students and helping them achieve are clearly reflective of her experiences as a student and the help she received from a caring teacher. The focus on content seems to be driven by Suburban High School and the intense collaboration that is present. Superseding the content, however, is this notion that the state standards dictate what will be taught in the school. Jamie's beliefs and experiences seem to be interwoven. Jamie's interview responses indicate that she has had a variety of both traditional and *Standards*-based experiences. Jamie's methods class in college became a pivotal moment when she was forced to look

at both curricular styles and figure out what was best for all students. Her professor encouraged her to have, "other strategies to make it meaningful for kids" and this seems to have stuck with her. According to the survey, Jamie now seems to favor a more *Standards*-based approach. Jamie's decisions are influenced by the collaboration with her peers as well as the curriculum, state standards and her students.

Dana. Dana presents an interesting mix of experiences and beliefs. Dana seems to have more experience teaching traditional mathematics than the other participants as she taught very traditionally outside and within the U.S. She believes in *Standards*-based ideas but has a few areas that indicate that she may hold some more traditional beliefs such as a quiet classroom and more of a focus on facts than the other participants. Dana is greatly influenced by her colleagues regarding the daily content she presents. She explains that they are "doing the same thing" in class each day. This area is expanded upon by Dana when she states that one of the biggest influences on her classroom decisions is departmental policy. Dana reflects on using the traditional methods and her dislike of it. She explains, "The traditional method, I did not like it because you give them the formula. Ok, this is the formula and these are examples. We used to do that in traditional. But here I clearly emphasize my goals, so this is what we are going to do today and this is the application." This experience left her believing in the importance of students knowing why they are doing the mathematics they are doing and applications of that mathematics. It appears that Dana's experiences with traditional mathematics have influenced her beliefs because she was not satisfied with what she saw before and she now believes in the importance of real world contexts, conceptual understanding, and that learning mathematics means "understanding what is going on." Dana expressed the

adherence to the state standards when making curricular decisions and the influence of students, or student knowledge, on her classroom decisions.

Anne. Anne's survey responses indicate she believes in a *Standards*-based environment. Her big ideas for beliefs include mathematics as a process and preparation for college. She believes that mathematics is a, "process of thinking mathematically and whether that is learning how to solve real life situations in everyday life or whether it is going to lead to a career that more directly uses math." She talked about mathematics as, "learning all of the skills and procedures and solving problems, problem solving, literal problem solving is important but also that just helps…your thinking becomes so much more developed and sophisticated and that spreads out to other areas in life." She believes that mathematics learning is helpful to get students "ready for college mathematics" and she is "teaching them to think on another level."

Her experience as a student prior to teaching was very traditional. She explained that she her "education courses I was disappointed in." And that during her mathematics methods course the instructor "didn't mention a word about integrated math. I student taught here and I didn't hear about it until the first day I came to student teach." She has only taught at Suburban High School and came during a time of turbulence and change to Core-Plus. Her initial experience with Core-Plus was not very good, "So I wasn't real impressed with it when I student taught." Her professed beliefs on the survey seem to align with a *Standards*-based curriculum such as Core-Plus. She did indicate that more difficult topics make it harder to use the discovery method and she then relies on more teacher-directed instruction. Anne believes that her past experiences with the curriculum and her work with other teachers are highly influential to her teaching. She explains that "We

work really close together as a team." Adding that, "We write the tests together and make a rubric for how to grade it so we are really lined up and we give tests and quizzes on the same day and we work really close together." This explanation includes her present work with Dana. She also explains that for certain topics "If it is something I am confused about or don't feel like I am doing effective or don't know how to approach it I talk to other people." Anne talks about students influencing her decisions in the classroom. She explains that one of her biggest influences is, "Each class, their personality and their ability level."

Kelly. Kelly holds a core belief that math should not be boring. She recalls experiences where she felt math was boring to her and works hard to make the subject interesting for her students. "I try to keep in mind what it was like to be a student. I know that when I found myself being bored I didn't want to do anything because I was bored and I didn't want to pay attention." When she adds or changes a lesson, it is often in reaction to her students appearing bored or her feeling like they might get bored. This idea of boredom and Kelly's experiences have pushed her toward believing that an integrated curriculum is beneficial for students, "It was clear to me that probably in my junior year that I didn't really want to teach a traditional program because I found it so boring." Kelly had to write a paper in her math methods course comparing traditional and integrated math. She explains that, "The paper we had to write kind of looking at the pros and cons of both did kind of push me toward the integrated." When student teaching, Kelly worked in a traditional math environment but worked hard to add hands-on activities to the curriculum in an effort to engage students. Kelly is also greatly influenced by the team of teachers she works with. The planning and pacing they do

together is instrumental in her decision making process, especially the first time through the curriculum. "The first time through the course I am kind of basing it on what other teachers have noticed and where their students have struggle in the past." After that, she is influenced by her students and what they are able to do, "I found myself making a lot of notes of they need a lot more time on this topic, they don't need nearly as much time as we have devoted here." Her responses to the interview indicate that her past experiences as student, in her methods course, and student teaching have influenced both her current beliefs about mathematics. These beliefs are centered on an integrated curriculum and daily activities that will not bore her students.

Table 7

Summary of Information from Interview

	Responses on continuum	Experiences	Other Influences on teaching (bold items reflect those with "biggest" influence)
Pat	4, 4, 4, 4	• Math Degree • Math team/ writing math exams • Focus on problem solving • Brief time out of teaching for engineering • Student taught modular scheduling • Variety of innovative curricula used	**Students** **Topic** Standards Textbooks
Jamie	3, 4, 4, 3	• Good at math in school • Traditional high school experience • Methods class was a turning point • Student taught elementary NSF curricula • Student taught traditional high school	**Curriculum** **Standards** **Students** **Teachers/collaboration**
Dana	2, 3, 4, 4	• Math was easy • Taught in traditional program outside the US Applied math as undergrad • Traditional teaching in other district • Student taught in traditional • Methods course improved content	**Cooperation/other teachers** **Departmental policy** **Student knowledge** Curriculum Lesson Standards
Anne	3+,4,3,3	• Teaching is a second career • Very traditional k-12 • Math methods was a disappointment • Student taught some traditional/some Core-Plus at Suburban	**Past experience with curriculum** **Teachers/teamwork** Students struggling Standards
Kelly	3, 3,4,3	• Elementary math had manipulatives • 7-8 very traditional • Math was sometimes boring • Math methods had to write a paper on traditional versus integrated and moved her toward integrated • Student taught traditional	**Students** **Team of teachers/collaboration** Curriculum pacing Standards

In summary, these teachers suggest several common areas of influence on their teaching practice. Although there is some variation in their responses, the state standards are clearly influential to all. According to the teachers, the decision to follow the state standards clearly impacts which units are taught from the curriculum. All of the teachers

mention the curriculum as central to their decision making. It is explained that the curriculum is used to help determine how and what will be taught and the pacing of the units. The curriculum appears to be central to the decisions made about how the mathematics will be taught in the classroom and what additional materials will be added. A third area common to all the teachers is the students. The participants share different methods for determining what their students know, but they all suggest that knowing and interpreting their students' strengths and difficulties is important to their teaching choices. Finally, four of the five teachers are highly dependent on the other teachers in the department and the collaboration/experience that is shared. The one participant that did not mention collaboration was mentioned by others as being influential in the decisions of the department. These teachers indicate that state standards, curriculum, students, and collaboration are all central to their teaching practice and they influence both long term and short term decisions.

Question 2

2. How are stated beliefs reflected in current practices of these teachers?
    a. Are current practices consistent with stated beliefs?
        i. If so, how is this consistency observed?
        ii. If not, how is this lack of consistency observed?
    b. How are observed differences between beliefs and practices explained?
        ii. What role does a *Standards*-based curriculum have in the relationship between beliefs and practices?
        iii. What role does testing have in this relationship?

To explore the current practices of the 5 participants and the relationship these practices have with stated beliefs, each teacher is observed for a minimum of 3 eighty five minute class periods. Each of these class periods, or blocks, is recorded using field notes, the COSMIC Observation Protocol (Tarr, McNaught &Sutter, 2006), and video tape. To understand any variations between the stated beliefs and current practices, these observations are compared with the beliefs stated in the initial interview. In order to understand why practices do not match stated beliefs, teachers are asked in the final interview to give reasons for any differences that may have been observed. In the initial interview, teachers were asked about the role that Core-Plus and testing have on their teaching and this is used to help understand the relationship the teacher has with the curriculum, the role of testing, and how they both may influence classroom practice.

Pat. The three days of observation for Pat were consecutive. The seats in the classroom were in rows and students moved them when they began to work in groups. Day 1: During this first lesson, Pat began by reviewing a quiz. Students were encouraged to think about why a particular method fit for each of the probability questions and the class tried to identify the type of problem they were trying to solve. This method is taken from the curriculum where they put the problem type in one of four categories to determine an appropriate solution strategy. There was a focus on the answer but after much discussion of the solution strategy that worked. Multiple solution strategies were discussed and students presented strategies that did not work and the faulty reasoning was explained by the teacher or other students. For the lesson, students were introduced to Pascal's triangle and Pascal's identity and they worked through proving this identity. First, students were encouraged to look for number patterns in the

Pascal's triangle. The students appeared excited to find all the different number patterns and seemed eager to share their findings to the class. Students were seated individually, they worked as a class, and the lesson was teacher led with discussion questions. As a class, with student input, they proved Pascal's identity and it was stressed that this would be on the homework, quiz, and test. The book was not used as the main source of information and the problems were introduced on the board but the content was taken from the text. Although the teacher was clearly the leader, discussion was focused on student input and appeared to push them to come up with the answers or ideas that led the class to the next step.

Day 2: This class began with a review of the homework with the students sitting individually. Questions on homework were addressed with input from students on solution strategies. Not all of these strategies were correct and these errors were used to explain how the problem worked. After the homework questions, the lesson made connections to Pascal's triangle that was introduced in day 1 with the topic of binomial expansion. Students were show $(a + b)^2$ and $(a + b)^3$ and then connections were made to the triangle. Students worked in groups on a worksheet made by the teacher that focuses on binomial expansion. The worksheet contains a variety of problems from finding the coefficient of an expansion and finding the constant terms, to a connection with arithmetic progression. This lesson did not contain real life context but focused on connections within the mathematics.

Day 3: Problems from day 2 were reviewed and math induction was introduced by showing two examples on the board. One of the problems had to do with postage stamps the other a more traditional algebraic type of induction problem. Three new

problems/statements were put on the board that students were to think about. For example, "Every odd integer greater than 1 can be expressed as the sum of a prime and twice a square number." Each of the problems was discussed by the students and teacher so that the teacher felt that they understood the statement. Students were then put into groups to work on one of these problems and try to use induction to prove it (or find out it cannot be proven). They were told they would go over their solutions the following day.

Overall the students were highly engaged in the lessons. They were active participants in leading the direction of the discussion and the teacher was adept at fielding difficult questions and responses that may not be correct. The content was led by the book but additional materials were added by Pat and the topic was introduced in ways that appeared thought provoking to the students. For example, there were times that the students were excited about what they saw in Pascal's triangle and appeared intrigued by the induction problems that were put forth. The content clearly follows the curriculum as some of the objectives for Unit 8, Book 4 are:

1. Understand and apply connections among combinations, the Binomial Theorem, and Pascal's triangle
2. Understand and carry out proofs by mathematical induction (CPMP website)

Comparing the observed lessons with Unit 8, Lesson 3 on mathematical induction, it was clear that the content was focused on the same topic but the lesson does not follow the book as the book spends much more time developing the initial idea of induction than what is done in class.

Jamie. The first two days of Jamie's observations were toward the end of a section on the quadratic functions so much of the time was spent reviewing. The third day of observation was not in sequence. The seats in the classroom were in rows and students moved them when they began to work in groups.

Day 1: The format for the day was to go do a warm-up, over the homework, and do a worksheet on the quadratic formula. The warm-up questions were strictly procedural with problems like $5x^2 + 10 = 15$ where students were to solve for x. These problems were done individually with the teacher walking around helping and the students being instructed to later compare with a neighbor. Students were asked how to solve the problems and multiple solutions were accepted. The homework answers were put on the board and the teacher went over questions on how to do the particular problems by factoring. A quiz was given that asked students to factor, get x by itself, and use the quadratic formula. All of the problems were without context. The class reviewed the quadratic formula using a song and then solved an equation with the quadratic formula and then used the graphing calculator to look at the solutions on the graph. For the lesson, students began seated individually and then moved to groups to complete more problems on the quadratic formula from the textbook.

Day 2: Class began with a warm-up that students did individually and then shared with a partner. This warm-up focused on a procedural understanding of the quadratic formula. Students worked individually and then shared their answer with a neighbor. Questions about the warm-up were taken and student responses were solicited as a whole class for help in solving the problems. Two different methods for solving the problems were presented by students. Students then took a homework quiz with two questions on

factoring on one of the quadratic formula. The class then played a teacher made game of math Bingo where they each worked with a partner on the review game of solving quadratic equations using a variety of different methods. It was announced that the quiz the following day will be on FOIL, factoring, and solving quadratic equations using the quadratic formula. The homework consisted of 12 questions of quadratic equations with no context.

Day 3: The class was started with a warm-up so solve for x in an equation with no context. The homework review consisted of going over a quadratic formula review sheet made by teacher. After the review, the book was used to begin the new lesson and the introduction was read aloud. A table presented in the book was explained with help from the students and prompts from the teacher and students began problem one on their own. After discussing this answer as a class, they moved to groups and continued to work on the lesson from the book. This lesson focused on using the quadratic formula within a real world context of selling tickets to a concert. Overall, this class period was a give and take of whole class and group work. The teacher was circulating around the room answering questions and pulling the class together when she deemed necessary.

Overall the students in Jamie's class were very engaged in the lessons, asked many questions, and stayed on task. The first two lessons were not taken from the book and focus more on solving equations without context and review. The third lesson provided a sharp contrast as the book was used at all times except for the warm-up and context was a key focus of the lesson. The first two class periods were the end of Unit 5, Lesson 1 and the book does focus on context, graphing, and algebraic understanding of

the quadratic formula while the lessons and worksheets used in class appeared to focus more on algebraic manipulation.

Dana. All three days of the observation for Dana were in sequential days. The book was used as the primary resource all three days and students were given many opportunities to work in groups and investigate material on their own.

Day 1: Class began with a problem of the day, a homework check from the previous day, and then practice problems from the ACT test. The problem of the day reviewed algebraic identities and the teacher made the connection between these and trigonometric identities which would be the focus of the new lesson. During the ACT practice problems, students were encouraged to do the problem on their own without help from the teacher or having her do it for them. After these problems were gone over as a class with some student input the launch from the book was used to begin the new lesson. The launch is a preliminary problem to get the students thinking about the new content in the lesson. This launch included two trig identities and the teacher had students show that they worked using numerical values. The unit circle was reviewed and they proved the comparative algebraic and trig identities of $x^2 + y^2 = 1$. Students needed help to prove these and they were told to memorize it when finished. The students then began to work in groups on finding solutions to three problems which were the beginning of trigonometric identities, such as sin –Θ, and the teacher emphasized visualizing the unit circle to do the problems and not the memorization of formulas. The seats in the classroom were in rows and when students worked in groups they moved their desks. Homework was assigned from the textbook.

Day 2: Students worked on two Problems of the Day that focused on the trig identities from the day before and they did these problems first individually and then shared with others. As a class, with the teacher leading the discussion, trig identities were used to solve a complex identity. Students were then put in groups to work on one problem with several parts. After a little work time, the class was brought back to a whole group to go over the solution to each part and then released back to their small groups to work. The teacher clearly was comfortable with the students struggling some on their own before showing them the solution. Students gave input into the solutions but the teacher did all the work on the board. She was verbally accepting of alternate strategies for problems but typically focused on one single method while presenting answers on the board.

Day 3: Class began with the problem of the day and then a little time devoted to going over the answers to the previous unit test. The teacher gave a rationale for the problem of the day to lead into the day's lesson. The class then checked the answers to their homework from the answers on the board. To begin this lesson the teacher showed a picture from Sketchpad regarding sine and cosine of angles. The students copied this picture used it to show students how to prove a cofunction identity. Students wrote down formulas and proved one but ran out of time for more. Homework was assigned from the textbook.

Dana's classes were centered on content from the textbook and had a blend of group work and full class work. She showed a passion for wanting students to try on their own or in groups while making sure all students saw a possible solution. She

appeared to be accepting of multiple solution strategies but typically focused on only one for each problem and most of Dana's students seemed engaged and on task.

Anne. Anne's classes were observed the same three days as Dana's and covered the same content. This provided an additional comparison between teachers. Anne's observations were consecutive. The seats were in tables so students were sitting in groups at all times. Most of the groups had 3 students in them.

Day 1: Anne began with a launch which was a review of old information. They were given preliminary information on angles in standard position, angle measure, the unit circle, and other ideas related to trigonometry. The rest of the lesson was from the book, Unit 4, p. 270 on Trig Functions and Equations. The class did the first problem together by students reading it aloud the teacher leading the work of the proof with little student input. Students were then told to begin a new sheet of paper with the heading "Trig Identities." The information was about the formulas for the unit circle and non-unit circle. The remainder of the lesson was done partly in groups and partly as a class. Number two of the lesson from the book was a combination of the teacher showing and the class talking about it with her. For number three students worked on the problem and then they went over the answers as a class. A similar process was done for number four. After some initial time for the students to work, all of the answers were presented with little student input. At the end of the lesson, homework was assigned from the textbook.

Day 2: First questions from the homework from yesterday were answered. Information was then added to the identity sheets that were started yesterday, she said "Pull out your identity sheets" and they were asked to draw three circles marking sine and cosine in quadrant 1 and then a given transformation. They then went over the

conclusions from the day before. The new material began with number five from the investigation they left off with the previous day. Some time was given for students to work individually or in groups for three of the problems but they were mostly teacher led. The teacher led the use of the calculator to create a table and they answered a, b, and c together. They then created another not sheet like the trig identity one called "Examples of Proofs." Students were to copy the proof from the book and they then talked about each step as a class with student input. The same process continued with the rest of the lesson with the teacher leading and seeking some student input.

Day 3: The class began by going over the homework and the last unit test. This took a large chunk of the class period. The introduction from the textbook was then read out loud and notes on complementary and supplementary angles were given by the teacher. Students did a little work on their own but it was again mostly teacher led. The first problem was done together as a class with a little student input. Later in the lesson students were given a few problems to work in their groups and the teacher walked around to watch them work and answer individual questions. Homework was again assigned from the textbook.

Anne's classes were seated in groups but they were really only used for small periods of time and the rest of the class time was used for teacher led discussion of the material. There was some lecture when notes were given but the dynamic was more like a teacher led discussion/work group using the problems in the text. Anne seemed more focused on getting the solutions than discussing multiple solution strategies or group work. Most of Anne's students seemed engaged and on task for these lessons.

Kelly. Kelly teaches the same course as Jamie and one of the class periods was observed on the same day as Jamie's. Kelly's students were seated in groups of three and four at small tables.

Day 1: The textbook was used for the entire lesson. The class began with a warm-up and a few questions from the students on the homework. Students were then instructed to work in their groups on problem 4a regarding graphs of quadratic function and the results were shared with the class. In general, students worked both in groups and as a class with a back and forth of the two as they worked through the rest of the lesson. Students were called upon to present solutions to the class (in the front of the room). The students showed examples of graphs of quadratic functions that would produce zero, one, and two solutions. Students then went back to their groups to work on problem five to find solutions to quadratic functions using the graphing calculator. Class finished with a summary by the teacher of what was worked on in class. Homework consisted of a procedural worksheet and one problem from the textbook.

Day 2: Class began with a warm-up and questions on homework. The warm-up had students solve a $-4x = 36/x$ which was what they had worked on the day before. Students went to the board to show different solution strategies. The introduction from the book was read aloud and students then worked in groups on questions one and two from the book. Students were then focused on the teacher to lead a class discussion with student input on the solutions to those problems. They did this same process for the rest of the lesson and then were given time tow work on their homework. Again, like Day 1, the class was a back and forth of group and whole class work to go over solutions.

Day 3: Class again began with the warm-up from the Core-Plus materials and the answers to the homework on the board. This was a review of some older material on distance, rate, and time. The rest of the period the class was reviewing for a test. This review was teacher led but included much student input. Students were given a few questions to do on their own and then were given time to ask questions of the teacher. The review was altered from the original setup to meet the needs of the students, based on their questions. Again, students moved from whole group to small group discussions and back as the questions were posed. The class ended with a homework quiz.

Kelly used the book for most of the lessons and homework. Her class was a give and take of group work and whole class discussion. There was a large amount of student input throughout the whole class. Students in the class were engaged and seemed to do well going from the large to small group setting and since they were sitting at tables, no actual movement is necessary.

Current practice versus stated beliefs

The current practices of each teacher are influenced by many factors, one of which is his/her beliefs. To understand the influence of these beliefs, a comparison of the current observed practices with the stated beliefs needs to be conducted. For each participant, this includes comparing what was observed to the stated beliefs from the survey and initial interview.

Pat. Pat's beliefs and practices were consistent in that his class clearly focused on problem solving. This problem solving took the form of looking for alternate solution strategies, exploring new problems using prior knowledge, and making connections between several mathematical ideas. He taught in a way that students were regularly

asked why and were encouraged to look for solutions or alternate solutions to challenging and non-trivial problems. Another area of consistency is the focus on students. Pat's lessons slowed and sped up as the students dictated. He freely listened to student responses and questions and moved at a pace that was comfortable for the students. As he indicated in his survey, his problem sets did focus on practice. It may be argued, however, that these were not rote problems with excess repetition but challenging problems that practice the necessary skills with a variety of subtle differences that make the students think. He indicated that the textbook was an influence in his teaching and it appears that this is the case as his content, but not necessarily all the activities, matched that of the textbook. Overall Pat's beliefs and practices seemed to be closely aligned.

Jamie. Jamie's beliefs and practices have both areas of consistency and inconsistency. Jamie indicated on her survey that she focused on problem solving while the review lessons seemed to focus more on the use and memorization of the quadratic formula and factoring with little or no context. This may simply be that she was reviewing but it does indicate that a major focus of the lessons was procedural. She also indicated that her homework does not mainly focus on rules and procedures but two of the three assignments were primarily practice using skills. When looking only at the new lesson and not the review lessons, Jamie's beliefs became much more aligned with her practice. She used more group work, focused on the understanding of the content, and did not assign as much practice. Consistent with her survey, Jamie did little teacher lecture but provided more teacher led discussion and group work with high levels of student input. The classroom observations indicated that the curriculum content was clearly an influence on her teaching as are the students. She was continually interacting

with the students to have them ask or answer questions and to monitor their work. Jamie's beliefs and practices were only partially aligned when looking at all three days of observation but examining only the new lesson, her beliefs and practices were closely aligned.

Dana. Dana presented material in ways that encourage the students to explore the mathematics both individually and in groups. Her suggestion to students to visualize the unit circle instead of memorizing the new formulas seemed to indicate a greater focus on understanding than on manipulation to get a correct answer. Although time was spent with teacher led discussion, Dana spent little time directing the topic or content beyond introducing the problems to be solved. She encouraged students to try problems on their own instead of relying on her to do the problems for them. She used student input and answers to guide the pace and direction of the lessons. Dana indicated in her survey that she preferred a quiet classroom however this was not the case in the classroom except when she was leading the discussion. She encouraged students to talk with one another and to share their solutions. It is possible that this is the kind of quiet that Dana meant by her answer to that questions. The beliefs Dana professed and the practices she used seem to be in close alignment.

Anne. From these observations it appeared that Anne spent most of the teaching time in front of the room guiding the discussion. Student input was used to help answer questions but not necessarily to guide the content or pace of the day. This was fairly consistent with what Anne's responses in the interview because, although she mentioned struggling students as influencing her teaching, she did not state that students guide her teaching as much as other factors. Although she did not lecture, Anne spent most of the

time leading the class through the lesson with little group work and student input only to answer questions. This did not indicate a focus on getting students to "think mathematically" as her initial interview indicates. Anne explained that her past experience teaching this curriculum is influential on her daily choices about how to teach it is possible that this may have influenced her choices on these days. Anne's stated beliefs and practices seem somewhat inconsistent based on these observations.

Kelly. Kelly's classes had a clear routine each day with a warm-up, homework review and then new (or review) material. Kelly used the book for most of the lesson, warm-ups and homework. Students appeared to be a primary focus for Kelly and this was consistent with her stated beliefs. She focused on student understanding and encouraged them to share solution strategies without leading them in a particular direction. She focused on problem solving over correct answers and this is clear when observing her students present the solutions because she looked at the process and multiple strategies more than the product. Her homework included some problems in real-life context but focused more on practicing skills, just as her survey indicates. She had a lot of interaction with her students while they were working and continually monitored their progress. Overall her students were engaged and working well in their groups and her practice was consistent with her stated beliefs.

Explanation of differences

In order to answer this part of the question, teachers were interviewed after the observations. This final interview asked the teachers *Would you describe the three days that I observed typical of how you usually teach? Why or why not?* This question gave the teachers a chance to explain why they may not have taught the way their beliefs

suggested they would and to give an overall picture of why they did what they did in the classroom.

Pat. When asked if the three observed days were typical he responded "Pretty much so." Pat explained that he added material that "went beyond the book" because the class that was observed was an honors class and they needed additional material but it was pretty much how he usually teaches. He did share that some days he uses the text that way it is written because the "investigations are well worded in terms of they ask the same kind of questions I would ask." Pat explained that if he adds to the material it is to "enhance" it. He explained he adds problems sometimes to "to explore, to really hammer home a concept." When asked about the problems he added and if they are practice he responded, "It is definitely practice but most people would say it is practice in problem solving as opposed to practice in procedures." He added, "I think the things I add for 4x are trying to get them to think at a deeper level. Look for the subtleties." He reiterated that his main goal for students is to "think mathematically rather than do mathematics. I want them to know what they are doing. And I think you have to spend a lot more time talking about the hows and whys." Pat's observations and beliefs were closely aligned and he explained why he does not always stick with the text or use group work. His teaching follows his ultimate goal of getting students to "think mathematically" by the questioning and interaction he has with students in class. He does as he explained using a variety of methods for instruction.

Jamie. Jamie pointed out that the third day of the observation, the one that followed the textbook and used group work and large class discussion is more typical of how she teaches. She added that the review days are not "abnormal" but the other day is

"what a class would normally look like." She described her typical class as "we do a lot of either I talk, we do it all together as a class and then they work in their groups and then we come back together or some days we might do a lot as a class and then they work in their groups. Class, groups, class, groups, back and forth." She explains that the review days were there to practice the material. Jamie's explanation does make her teaching fit better with her beliefs. Although she does mention the need for practice and skills, the observations show more focus on the skills than on the mathematical thinking that is part of her belief system. It appears that particular topics, like factoring, influence Jamie's beliefs about mathematics teaching and can alter the classroom environment.

Dana. Dana explained the three observed days, "were more direct teaching instead of just you know group working because the subject was hard." This was because, "We just started a new unit, I needed to remind them a couple of things from past and then starting trig identities is hard for kids." Dana's explanation was interesting because she tended to use group work and let the students work on their own quite a bit but she was critical of herself for not letting the students work on their own more. She explains that she usually uses group work for "class work." The observations indicated a high level of alignment with her beliefs and her response here reveals that she may be searching for something different. Dana's one area that did not align was that she focused less on practice than her initial interview indicated she would.

Anne. Anne did not recall exactly what the lessons were that were observed but thought they were pretty typical. She thought that there was not as much group work as usual but that "just depends on the material." She added, "The higher up you go in the levels the harder it is for them to do the group work on their own." (Note: The

observations were in fourth year of the Core-Plus curriculum, as high as the curriculum goes.) Anne's response did explain why she chose to alter the instruction to include more teacher explanation, which was a low focus according to the survey. For Anne, it appeared that the difficulty of the material overrode her beliefs about mathematics teaching and learning.

Kelly. Kelly thought that the observed days were "…a little bit drier than they typically are just because the material was a little bit harder for the students." She said that she would have liked to add more activities or give more time for group work but because of the difficulty of the material there was not time. Kelly's self-reflection aligned with her desire to not let mathematics be boring for her students. She clearly gave students opportunities to explore and share but was still critical of her delivery methods.

Table 8 summarizes the consistencies and inconsistencies in the observations as well as the reasoning and comments from the final interview.

Table 8

Summary Table for Observations

	Consistencies	Inconsistencies	Reasons/Comments
Pat	• Students were asked to look for solutions and alternate solutions • Homework focused more on practice • Students dictated pace • Textbook was used for content	• Additional resources were used instead of using the lesson as printed in the text	• Material needed to be added for honors course
Jamie	• Little teacher lecture • Curriculum influences content • One of the three lessons focused on problem solving and followed the text closely • High interaction with students	• Two of the three lesson focused on skill practice • Two of the three homework lessons focused on skill practice	• Reviewing for test • Day following the text is more like a typical day
Dana	• Lessons focused on problem solving • Lesson focused on student engagement with the material • Textbook was used for almost the entire lesson each day	• Classroom was not quiet and student communication was encouraged	• More direct teaching than usual because it was a new unit and they needed to be reminded of some old material
Anne	• Textbook was used for almost the entire lesson each day	• Mostly teacher led discussion • Struggling students did not seem to influence pace or teaching • Students did not problem solve on their own for much of the period each day	• The material was difficult so less group work was used
Kelly	• Students appeared to be focused • Focused on problem solving • Textbook was used for most of the lesson each day		• Would have liked more activities to keep it from being boring

Role of a Standards-based curriculum

The role of the Standards-based curriculum in the relationship between beliefs and practices for these teachers was examined through questions in both the initial and final interview. These interview questions, in conjunction with the observations, attempted to provide a clear view of each teacher's interaction with the curriculum and how using this curriculum has influenced beliefs and/or practices. In the initial interview, participants were asked if they like the Core-Plus curriculum and how it has influenced or changed beliefs and practices. The final interview was more specific and tried to focus in on why and when changes are made to the curriculum in both content and pedagogy.

Pat. From the first interview it was clear that Pat liked the Core-Plus curriculum and he stated, "I love it as a device for getting kids to think mathematically." He added that, "it is the language that makes them do the thinking and so if you don't have the language there then you will just have a math course where they will just be manipulating symbols." He commented that seeing math in context is good for kids. He especially liked the fact that it is an integrated curriculum and attributed this curriculum to higher enrollment in mathematics. He pointed out that if a student disliked one unit, the next one is different so they may not hate math just a couple of units. He did not think his teaching changed much due to this curriculum but it has made things easier for him. Pat stated

> I always had to be the one asking the questions to get the understanding. It has freed me from that mode. That would have been my normal teaching mode is to have this discussion direction. I do less and less of that because I know the curriculum well enough that I can depend on it.

He believes that this curriculum has shown him that the students are able to do more without him but that he needs to be there to be the coach and the guide.

This positive view of the curriculum was reflected in his teaching. Pat stuck generally to the content and uses it to guide his practice. He did add material for homework and class work, though. The observations showed that he used the curriculum to guide discussion, content, and homework. His style was fairly consistent with the text in that he used large group discussion to launch new ideas and then had the students work in groups to tackle difficult problems. He did, however, use less group work than a typical lesson from the book includes and more teacher led discussion.

The final interview indicated that Pat uses group work about 50% of the time and chooses to deviate from the book, for this particular honors class, when he needs to add material to extend their learning. He said that he uses additional materials to "enhance" the curriculum when he needs to "emphasize those subtleties" that the book does not. Pat explained that at first he did teach the curriculum as it was presented but that he felt the need to add to make it an honors course. They complete almost the entire text plus additional material for this course.

Pat obviously believes that using this curriculum is beneficial for students. He is a proponent of the content, specifically some of the topics like discrete mathematics, and the questioning techniques. Pat's deviation from the curriculum seems to stem from beliefs about what he should be teaching, his experiences with the curriculum, and the needs of his students. When asked about the success Suburban has had with Core-Plus, he attributes it to the connections that the book focuses on the questions the book asks. This question/discussion format is clearly part of Pat's beliefs about mathematics

teaching and learning and is supported by the Core-Plus curriculum. The relationship Pat seems to have with the curriculum is one where he follows the content closely, uses the pedagogy most of the time, and adds material to extend the content. According to Pat, the curriculum is in line with his beliefs which may be why he is such a supporter of both the content and pedagogy and uses it as he does.

Jamie. Jamie also liked the curriculum. She believed that students need a little more guidance than the book suggested and explained that the teachers of the second course, mostly 10th grade, have added a lot of algebra practice to the curriculum to continue to work on skills. She stated, "I think the kids need that guidance from the teacher. It is supposed to be a guided curriculum, which it is, but I think sometimes they need a little more guidance." This is because, "I want to make sure they can still do it individually." She liked how students had to think and not just memorize. "I think the thing Core-Plus has is that it doesn't just say here's how you do it now do it. And so that's a strength." She believed that Core-Plus had made her a proponent of real-life problems. She admitted that other changes to her teaching may be due to experience or the curriculum and it is difficult to separate the two. Finally, she explains that this curriculum has shown her how many students struggle with reading. Jamie's description of her relationship with the curriculum is clearly shown in her teaching. Although she follows the content of the curriculum in general, she adds a significant amount of practice. The homework that was observed contains mostly problems out of context to practice factoring and using the quadratic formula. When the application problems came up, she focused on getting students to understand the setting that was being used and adding in things (musicians, for example) that are relevant to them.

In the final interview, Jamie explained that she does not think she uses group work the way the authors intend, which see suspects is essentially all the time, but uses a more balanced approach with more class discussion and less group work. She reasons that this is because "it is ok to get stuck sometimes but if they get stuck a lot they get frustrated." Jamie agreed that when she added outside materials it was typically for practice. She relied on what the students were doing in class and her colleagues and their experience to determine when to add this practice. Overall, Jamie's relationship with the curriculum seemed to be one where she relied on the material for content and most of the pedagogy but added material, particularly practice exercises, when she felt the students needed it or her colleagues' experiences suggested it. The curriculum for her was a guide where she used it as a primary resource with small supplements.

Dana. Dana liked the Core-Plus curriculum. She told that she learned new mathematical ideas from it and she stated "I didn't understand some of those stuff until I teach this curriculum." She explained that she liked students to know when to use the mathematics but that the teachers did supplement with practice worksheets, "drill and practice." In terms of changes to her teaching because of the curriculum, she explained that the "preparation time is more than before" with the traditional. She used group work in the observed lessons which she stated, "I had not used it before" Core-Plus and she saw herself as more of a facilitator with Core-Plus than with traditional. She explained that one major difference is that the students were usually on their own for half of the block to work through the material. Before Core-Plus she would have given notes and had students work through examples but now, "sometimes I give them notes because some stuff is from before and I give them some notes but for at least half an hour of the

block they are on their own just to figure out the problem." She stated, "Now I am 100% sure the student can do it if they first of all believe they can do it. So they need to believe they can do math." She talked about focusing on reading the problem, understanding the problem, and communicating with others to problem solve. Dana's observations were consistent with her interview responses about her teaching. Each day she worked through some of the material with the students but she continually encouraged them to keep trying on their own. Her practice reflected her belief in the material itself and she gave students the opportunity to explore and create the mathematics for themselves.

Dana suggested in the final interview that she made changes or additions to the curriculum when what she originally tried does not work. She explains that "as a group" the teachers do not feel there is enough practice in the book so that was why they supplemented the materials. She said that the "dynamic of the class and the goals of the lesson and eventually goals of the school" dictated when she did things differently in the classroom. She attributed the success of the students of Core-Plus to the fact that the mathematics was taught based on understanding and not just practice and memorization and this focused the students on problem solving.

The beliefs that Dana professed align well with her teaching and also what she believed the curriculum did for the students. Like Jamie, the additions to the curriculum were focused on the students and their needs and involved mostly practice exercises. Dana seemed to rely on the curriculum for content and both full class and small group discussions but added practice when she deemed it necessary. The text was her primary resource for teaching.

Anne. When asked about the Core-Plus curriculum she said "I think it is great now but I haven't really taught traditional either except the one class in student teaching." She told that "I see stuff that I never was exposed to in high school itself." She added that she thinks "all the application" is good for the kids. Anne explained that they supplement with a lot of practice and she thinks that is important. She said about the practice, "The black and white drill and I think that is important." She said that Core-Plus has encouraged her to accept more than one solution strategy "For one thing knowing there is more than one way to do things and that's good and that's acceptable and that's what you want and so if a kid has another way to do things to let them share it and maybe that works for some people and that works for others. And so that is one big thing. And just the whole idea of they are taking part in the learning instead of me just shooting it at them." Her beliefs have changed regarding the accessibility of real-life problems and the ability of students to understand why things happened and she thinks that students are able to do this more than she thought they were. "That real life application is very doable because when I was in school we hated word problems and they don't even know what the word problem mean. They are able to think about why things happen more than I thought they were and it is not just plugging things into a formula and spit them out and that math isn't just plug things into a formula and spit it out." For Anne, the Core-Plus curriculum seemed to offer a guide for content and discussion. She still, from her observations, was mostly in front of the room guiding the discussion with small amounts of group work, but she clearly used the curriculum closely during the lessons and worked through the problems carefully.

In the final interview, Anne approximated that she uses group work about "a third to a half of the time" and she uses it for practice more than new material. When asked if she used group work as much as the authors intended she stated, "I don't think we use it as much as because it is too hard, they can't do this level." Anne's practice seemed to include more teacher led discussion than group work and her responses to the interview showed that she agrees with that notion. Although Anne's beliefs from the survey and initial interview are quite Standards-based, her practice and final interview answers indicated more traditional leanings. She talked about group work being used more for practice than for exploration and problem solving as her earlier responses may have indicated. She seemed to follow the Core-Plus content fairly closely but pedagogically she chose to use large group discussion instead of small group exploration due to her beliefs and experiences that suggested to her that the material was too difficult for the students to explore on their own. Anne seemed to use the text as the primary resource for content and supplemented practice when she and her colleagues deemed appropriate.

Kelly. Kelly liked the Core-Plus curriculum. She believed that more practice was necessary and she therefore supplemented it. "There isn't a lot of rote practice in there especially when it is needed. Like I said for the factoring, it is one lesson of one section so the kids really don't get it just by doing it one day so we find ourselves kind of supplementing extra factoring problems." She liked that students "understand a lot more of what they are doing. They are not just going through these processes." She thought that the questions in the book "are good at leading them in right direction" to understand the material. She was amazed at what students, especially struggling students, were able to with this curriculum if they were just willing to work through it. She saw great gains

in students that are willing to "hang on and work the problems." Kelly's responses were favorable for the curriculum and her practice seemed to support this high level of confidence in the curriculum. She very carefully followed the curriculum and gave students many opportunities to work in groups and share their solutions both with the whole class and in their small groups.

In the final interview, Kelly guessed that she used group work "somewhere between 50 to 75% of the time" and typically "every day". With regard to group work she thought "the authors intend for it to be used 100% of the time and I struggle with some of what the students are supposed to gain. The way the investigations are written they are not going to understand what the authors are trying to get them to see or they're just not going to make those connections." She attributed additions to the curriculum to conversations between the different grade level teachers. They discussed the areas that students are struggling in and give them more practice in those areas. "We have a lot of vertical dialogue between 1,2…2,3…and 3,4, just to kind of make sure that the kids are seeing what they need to see and they are strong enough to move on so if there's places that their not that is where we go back and add." Kelly thought that much of the reason for the mathematical success with Core-Plus at Suburban was due to the emphasis on problem solving. She explained that "one of the really huge benefits of Core-Plus is that it shows kids how to solve problems not just follow algorithms and not just follow a rote process a million times over again." This format of seeing problems "from lots of different angles" helps them prepare for tests and students are able to piece things together.

Overall, Kelly used the curriculum in ways that were consistent with her beliefs. Her worry that mathematics may become boring was reflected in her analysis of her lessons. Although she engaged students and used the problems in context, she was still looking for more ways to make the mathematics exciting for the students, particularly with activities. The relationship that Kelly seemed to have regarding her beliefs, the curriculum, and her practice was one where the text was held central to her course with additions of both practice and activities to help reinforce the learning and excite her students.

Summary of the role of the curriculum

From the observations, Dana and Kelly seemed to follow the curriculum the closest in both content and pedagogy. They use the questions from the book to have students work in groups and then pull them back together to make sure all students understand the material. This reflects the pedagogy of the curriculum with the beginning being a Think About this Situation done as a group and then group work for the lesson and then back to the full class for a summary or Check Point. They both admitted to adding skill practice to their homework and this was evident from Kelly's homework but not Dana's. Jamie also used the curriculum closely when the new material was introduced but used more practice when reviewing. She used both group work and class discussion to work through the lesson questions. Anne used the material closely but mostly as a guide to class discussion instead of using the lesson for group work. Some of the time was used to work in groups but the majority of the class periods were spent in whole class discussion and working through the lesson questions. Pat seemed to use the materials to guide the content of his course but added challenging problems to this. He

spent time in class discussion to get the students prepared for their group work and then circulated to help them in their groups. For these observations, Pat clearly adhered to the goals of the content but deviated in terms of specific questions, keeping students engaged by the discussion and not with the book.

All of the teachers used the book to guide curriculum and pedagogy in some ways. The most remarkable observation was the lack of teacher lecture in any of the classes. The type of lecture referred to here is when the teacher talks and gives information and the students write it down with little or no discussion or interaction. The predominant form of teaching was teacher led discussion with significant student participation together with group work. Students were clearly listened to and part of the mathematics learning in these classrooms. As several of the teachers explained in the interview, although they have a high level of collaboration, each teacher still teaches in his/her own way. This was clearly the case. In addition, the specific topic being taught seemed to have a large influence on the classroom teaching. Core-Plus was liked and therefore shaped the content but it was used in different ways on different days. This indicates that all students were introduced to real-life applications, group work, class discussion, and integrated content. Although the exact pedagogy may differ from classroom to classroom, it seemed that this was still radically different from the traditional experiences that these teachers described having when they were students. This curriculum, therefore, seems to have enough support that these teachers are willing to do things differently than they experienced and go with their beliefs about mathematics teaching and learning. Although some of the observations indicated that the suggested pedagogy of the curriculum was not always followed (e.g., group work) the pedagogy

still presented a dramatic shift away from long periods of teacher lecture. This, combined with the changes in content to an integrated curriculum, was a finding of significance and interest in this research.

Role of testing on beliefs and practice

Pat indicated that, "The state standards dictated a curriculum" because they said that students need more graph theory and more statistics. This led Suburban High School to choose Core-Plus. He believed that having an administration that supported one curriculum, versus one for the low and one for the high ability students was a big positive for Suburban. Jamie explained that the standards were used to align the curriculum. The actual state test was not focused on very much except for a few practice problems right before the test. Dana explained that the state standards and the results of the testing are very important. And, as Jamie indicated, the standards were used to make sure they were teaching what needed to be taught. Anne's statement concurred with Dana and Jamie with regard to aligning the curriculum with the standards. Kelly added that there are parts of units that have been cut because they are not necessary for the standards.

This consistent information from the teachers presented a view that the state standards hover above all the decisions regarding content, curriculum, and pedagogy. These standards have dictated the curriculum and continued to dictate the content taught each year. This was a very powerful influence and one that seemed to be taken very seriously by all of these participants.

This chapter provided an in-depth look at each participant's beliefs and practices by looking at data from surveys, interviews, and classroom observations. Chapter 1 provided an overview of information relative to this research. Chapter 2 reviewed the

literature related to teacher beliefs in the context of a *Standards*-based curriculum. Chapter 3 described the methodology and analysis used in this study and analysis and a summary of the data with conclusions and recommendations is provided in chapter 5.

Chapter 5

The publication of the NCTM *Standards* in 1989 launched the development of curricula in 1991 that was supported by the National Science Foundation. These curricula embodied the *Standards* and by the late 1990's they were being implemented in schools across the country. Core-Plus is one of these curricula and it includes an integrated curriculum each year as well as a focus on real-world problems (Schoen & Hirsch, 2003). This integrated content includes algebra, geometry, data analysis, and discrete mathematics embedded within realistic contexts. The pedagogy for the curriculum includes group work and large group discussion with the teacher as facilitator and guide more than lecturer. Suburban High School adopted Core-Plus and has maintained this curriculum since 1998 and the entire district uses *Standards*-based curricula from elementary through high school. Because of the length of time these Standards-based curricula have been used, this district and Suburban High School in particular provide an ideal environment to explore the relationship between beliefs and practice while using a *Standards*-based curriculum. The use of Core-Plus over time combined with the academic success of Suburban High School provide an opportunity to examine beliefs in a situation that is far beyond initial implementation of a curriculum and with teachers who have experienced success with it in the classroom. This research looked at the relationship between beliefs and practices of teachers who use the Core-Plus curriculum at Suburban High School and focused on the following questions:

1. What are the current beliefs surrounding the teaching of mathematics of these teachers?
    a. How are past experiences reflected in these beliefs?
    b. What factors outside the classroom influence these teachers' beliefs and practices?
2. How are stated beliefs reflected in current practices of these teachers?
    a. Are current practices consistent with stated beliefs?
        i. If so, how is this consistency observed?
        ii. If not, how is this lack of consistency observed?
    b. How are observed differences between beliefs and practices explained?
        i. What role does a *Standards*-based curriculum have in the relationship between beliefs and practices?
        ii. What role does testing have in this relationship?

Data

Each of the five participants completed a survey and initial interview, was observed for three 85 minute class periods, and completed a final interview. The survey provides information regarding the alignment of each teacher's beliefs to the *Standards* as well as beliefs about mathematics teaching and learning, specifically problem solving, the role of the teacher, and homework. The initial interview focuses on past experiences, beliefs regarding mathematics teaching and learning, the Core-Plus curriculum, and other influences on mathematics teaching. The observations are used to compare the previously stated beliefs with the actual practice of each of the teachers. The COSMIC (Tarr, McNaught, & Sutter, 2006) observation protocol and field notes are used to

document each observation. This protocol was designed specifically for Core-Plus and has all the intended parts of each lesson included. The final interview is used to clear up areas of discrepancy between the stated beliefs and actual practice. This interview focuses on giving teachers a chance to explain whether or not the three observed lessons were typical of their teaching and then focuses on the Core-Plus curriculum and its use. The data from all of these are summarized in Table 9. The summary begins with the years of experience for each of the participants. The information from the survey that indicates how aligned these teachers are with the Standards and what they focus on in the classroom and for homework (e.g., problem solving, teacher explanation, rules and procedures). From the interview, responses from the continuum of teacher beliefs about mathematics teaching and practice, experiences as a mathematics student and teacher, and other influences on teaching are included. This data can be used to create a picture of each individual teacher and to compare and contrast one teacher with another.

Table 9
Summary of Data

		From Survey		From Interview		
	Years Experience	Alignment with *Standards*-based beliefs	Classroom Practice	Responses on continuum	Experience	Other Influences on teaching (bold items reflect those with "biggest" influence)
Pat	40	Very highly *Standards*-based (40 points)	High focus on problem solving and reasoning, low focus on teacher explanation, homework involves practice on rules or formulas	4, 4, 4, 4	Math degree; math team; writing math exams; focus on problem solving; brief time out of teaching for engineering; student taught modular scheduling; variety of innovative curricula used	**Students** **Topic** Standards Textbooks
Jamie	4	Very highly *Standards*-based (39 points)	Focus on problem solving and reasoning, low focus on teacher explanation, homework does not mainly focus on rules and procedures	3, 4, 4, 3	Good at math in school; traditional high school experience; methods class was a turning point; student taught elementary NSF; student taught traditional high school	**Curriculum** **Standards** **Students** **Teachers/collaboration**
Dana	19	Highly *Standards*-based (38 points)	High focus on problem solving and reasoning, low focus on teacher explanation, homework involves practice on rules or formulas.	2, 3, 4, 4	Math was easy; taught in traditional program outside the US; applied math as undergrad; traditional teaching in other district; student taught in traditional; methods course improved content	**Cooperation/other teachers** **Departmental policy** **Student knowledge** Curriculum Lesson Standards
Anne	13	Highly *Standards*-based (35 points)	Focus on problem solving and reasoning, low focus on teacher explanation, homework does not mainly focus on rules and procedures.	3+,4,3,3	Teaching is a second career; very traditional k-12; math methods was a disappointment; student taught some traditional some Core-Plus at Suburban	**Past experience with curriculum** **Teachers/teamwork** Students struggling Standards
Kelly	4	Highly *Standards*-based (36 points)	Focus on problem solving and reasoning, low focus on teacher explanation, homework involves practice on rules and procedures.	3, 3,4,3	Elementary math had manipulativs; 7-8 very traditional; math was boring; math methods had to write a paper on traditional versus integrated and moved her toward integrated; student taught traditional	**Students** **Team of teachers/collaboration** Curriculum pacing Standards

Survey and Initial Interview Data

The range of experience of the five participants is from four to 40 years and from one to many different schools. All of the participants recall a fairly traditional mathematics experience with success in mathematics when they were students. They all share beliefs that are highly aligned with the *Standards*, according to the survey. This is a very important piece of information since Core-Plus was created based on the *Standards*. This indicates that all five of the participants share beliefs that align with Core-Plus. The survey also indicates that they all focus on problem solving and do not focus on teacher explanation in the classroom. This finding suggests that all five teachers' have beliefs about mathematics teaching which align with the pedagogy of Core-Plus. One response that is not common to all the teachers is the focus of the homework. Three of the five teachers indicate that homework does involve practice on rules and formulas while the other two indicate that it does not mainly focus on rules and procedures. This difference is not seen in the later observations. Interestingly, of the five participants, four of them plan with another one of the participants but their recorded responses in the area of homework are different. This may be attributed to their interpretation of the question or their interpretation of their homework.

Five questions on the initial interview are taken from information in a paper by Thompson (1991) and they indicate each teacher's beliefs about mathematics teaching and learning. With one exception, the responses to *How would you describe what mathematics is?* indicate a conception of mathematics that involves mathematics beyond just a collection of facts but includes interconnected concepts. When looking at *What is the role of the teacher?* The responses on the continuum, where a "4" is considered the

most conceptual with the teacher as guide versus distributor of information and the learner is engaged in learning, all but one response was a 3 or 4. This indicates that all the participants believe in mathematics as more than a collection of facts and procedures, mathematics teaching includes engagement by the students, and there are connections in mathematics that can be explored by students. This is important because these teachers are working with a curriculum that focuses on problem solving with the teacher as facilitator or guide and these responses indicate that believe in mathematics learning that includes engagement by the students and includes more than just teaching facts and procedures. Again, these beliefs are aligned with content and pedagogy of Core-Plus. When the teachers were asked about other influences on their teaching, deciding what and how they will teach, as well as the influence of the state standards on their teaching there were several common responses. All five teachers mention students, the state standards, and the curriculum or textbook as influential on their teaching. Four of the five indicate that collaboration or other teachers are highly influential. These responses, though not shocking, are interesting with regard to the depth and seriousness with which they are relied on. The teachers regard the students as core to their decisions in the classroom and the reasons for how they teach. The overall indication, from their interview, is that they are constantly monitoring how their students are doing in class on daily concepts as well as the long-term retention/success of these students. This brings in the topic of collaboration. Not only did four of the five teachers talk about collaboration as important in planning scope and sequence, they used it to fine tune their daily lessons to meet the needs of the students both today and for the following year. This layered look at student success from both a daily perspective and a yearly perspective is very

interesting and shows a high level of focus on students from these five teachers and those they collaborate with. The influence and reliance on the state standards was another surprising discovery. These teachers all indicate that the state standards, versus the mandated testing, influence the curriculum choice, units to be taught and the focus within those units. This focus on standards instead of testing is surprising in the present school climate where many schools find themselves focusing on the test and test-taking instead of focusing on content. This presents information worth considering and potentially investigating further when looking at how schools prepare their students for state standardized tests.

Data from the Observations and Final Interview

The five participants were observed for three 85 minute class periods and their practices are compared with their stated beliefs. Recall that each teacher's data indicates that he/she has beliefs that align with the *Standards*, believes in focusing on problem solving and student engagement in mathematics learning, and likes Core-Plus. Table 10 summarizes the consistencies and inconsistencies observed during the observations and the reasons given for any inconsistencies. Areas of interest include the presence or absence of problem solving, how the textbook was used, practice of skills or focus on problem solving for homework, and the level of focus on students in the classroom. The COSMIC Observation Protocol (Tarr, McNaught, & Sutter, 2006) helped to determine the use of the textbook by having a checklist of all the area included in a typical Core-Plus lesson. Field notes were taken to document other teacher/student interactions and information about homework and class style.

Table 10

Summary Table for Observatio

	Consistencies	Inconsistencies	Reasons/Comments
Pat	• Students were asked to look for solutions and alternate solutions • Homework focused more on practice • Students dictated pace • Textbook was used for content	• Additional resources were used instead of using the lesson as printed in the text	• Material needed to be added for honors course
Jamie	• Little teacher lecture • Curriculum influences content • One of the three lessons focused on problem solving and followed the text closely • High interaction with students	• Two of the three lesson focused on skill practice • Two of the three homework lessons focused on skill practice	• Reviewing for test • Day following the text is more like a typical day
Dana	• Lessons focus on problem solving • Lessons focus on student engagement with the material • Textbook was used for almost the entire lesson each day	• Classroom was not quiet and student communication was encouraged	• More direct teaching than usual because it was a new unit and they needed to be reminded of some old material
Anne	• Textbook was used for almost the entire lesson each day	• Mostly teacher led discussion • Struggling students did not seem to influence pace or teaching • Students did not problem solve on their own for much of the period each day	• The material was difficult so less group work was used
Kelly	• Students appear to be focused on • Focused on problem solving • Textbook was used for most of the lesson each day		• Would have liked more activities to keep it from being boring

The data indicate that there are inconsistencies between beliefs and practice for most of the teachers but those are explained by some need that the teachers' saw as greater than what was explained in their initial beliefs. Phillip (2007) suggested that teachers can usually explain any differences between beliefs and practice, and this appears to be the case here. Four of the five teachers appear to have some inconsistencies but each gave reasons for their choices. Pat was adding material for the honors course, Jamie was reviewing for a test and felt the students needed more practice, Dana and Anne were beginning a new and "difficult" unit. Kelly, when given the opportunity to explain if things were typical, said that she would have liked more activities. This goes back to her notion that math was boring sometimes and she works very hard to make sure that does not happen in her classroom. While Dana focused on the fact that she thought she did more direct teaching than usual, it was observed that she did not keep a quiet classroom and students were working together to solve problems. Although there are some areas of inconsistency, all of the teachers except Anne seem to have stated beliefs that are quite consistent with their actual practice. This indicates that beliefs and practice are in alignment for four of the five participants and this follows what Remillard and Bryans (2004) suggest that a philosophical match is necessary for proper implementation of a curriculum.

Role of the Curriculum and State Testing

The role of the curriculum and state testing in these teachers' practices is clearly powerful. All five teachers like the curriculum and concur that the standards upon which the state test is developed are the core reason that the Core-Plus curriculum was initially chosen. Beyond that they explain that each course is carefully aligned with the state

standards and specific units are taught or deleted based on these state standards. The state standardized testing itself is not a large focus in the classroom, according to the teachers. Now that the curriculum is in place, it is used by these five teachers in varying ways to help deliver the content. The observations indicate that it is clearly used to determine the order of the content and as a main resource for students by all the participants. All of the classes did supplement the materials in some way or other. For example, warm-ups, supplementary worksheets, or games were added to every class. Some, Dana, Kelly, and Anne, followed it closely each day to guide the lesson. Dana and Kelly also followed the pedagogy of the curriculum by using group work for a large part of the class. Anne used the text as questions for large group discussion with small breaks for students to work on their own or in groups and then come back to the large group. Jamie used the book very closely for one lesson and then deviated for two for a large review. Pat followed the text for content but added additional materials during class and worksheets for homework. The curriculum, although used in varying ways for different lessons, is clearly relied upon by all of these teachers to guide them and give them a way to introduce mathematics through problem solving.

Conclusions

This research examined the relationship between beliefs and practices of teachers who have used a *Standards*-based curriculum, Core-Plus, for an extended period of time. After an initial understanding of each teacher's beliefs their classroom practices are compared to their beliefs and areas of consistency and inconsistency are examined. The data provide a way to look at this relationship and suggest that there are other strong influences on these teachers' practices.

Current Beliefs

Each of these five teachers beliefs appear to be aligned with the *Standards*. They all state that they believe in problem solving, student engagement with problem solving, and mathematics beyond facts and procedures. This alignment is a significant finding because of the relationship between the *Standards* and Core-Plus, which was written to be aligned with the *Standards*. Other studies have shown the interaction between beliefs and practice with a particular curriculum to be significant (Clarke, 1997; Middleton, 1999; Remillard & Bryans, 2004). Sometimes this interaction can change beliefs while other times practice or use of the curriculum can change to fit current beliefs. The question that is difficult to answer in this study is the impact of Core-Plus on beliefs since it is not a new implementation. What is clear is that these teachers all have beliefs that align with the *Standards* and Core-Plus and this makes it possible to look more deeply at these teachers' practices through the lens of the *Standards*.

Beliefs and Experience

The experience of the participants is examined from elementary school through current teaching practice. These responses are gathered in the initial interview in an attempt to gain information about experiences in all four of the chronologies described by Britzman (1991) and to acknowledge Lortie's (1975) view that past experience as student influences teachers' views of the classroom. All of the participants describe experiences in mathematics that are not *Standards*-based; this includes the traditional teacher-led classroom with seatwork. Some of the participants, describe "critical episodes" (Nespor, 1987) that have influenced their teaching. Pat describes teaching 120 students at one time during modular scheduling and how he learned that his lessons needed to be

interesting and engaging to keep students' interest. Jamie and Kelly recall assignments in their mathematics methods course when they had to compare traditional mathematics and integrated mathematics and the influence that had on their beliefs. They both recall that this began to change their beliefs toward more integrated or *Standards*-based thinking. Dana recalls that although she could do mathematics well as a student and has a degree in Applied Mathematics she still learned new material and applications while teaching Core-Plus. Thompson (1984) indicates that sometimes beliefs outside of mathematics take precedence when teaching. One example in this study is how Kelly has a strong internal pressure to keep mathematics from being boring for her students. Some of Kelly's experiences as a student with mathematics made her see it as boring and have strongly influenced her practice. She works hard to make sure that she has enough activities to keep students from being bored while making sure they remain challenged and she is critical when she thinks she has not kept the students from being bored. Anne's student teaching experience included a transition from a traditional mathematics course to Core-Plus and included a teacher that was not completely comfortable with Core-Plus. This experience, along with her traditional background as a student and the lack of influence of her mathematics methods course may be what influences her to move toward more traditional teaching methods in several situations.

Although all of the teachers had experiences as students with traditional mathematics, their career choices have led them to teach a non-traditional *Standards*-based curriculum at Suburban High School. There do appear to be events in each of these teachers' careers as either students or teachers that have helped create their beliefs. Some of these events are very specific like Jamie's paper but others seem to have grown

out of multiple events over time, like Pat's many experiences with a variety of curricula and in many different settings and Anne's experience with more traditional mathematics pedagogy prior to using Core-Plus. Although each teacher's beliefs may be slightly different it is clear that past experiences have influenced current beliefs. These beliefs have come from both positive and negative experiences and seem to be ever changing as these teachers continue to figure out what students are able to do and define what it means to teach and learn mathematics.

Beliefs, Practice, and Core-Plus

Schoen and Hirsch (2003) explain that Core-Plus has redefined the mathematics that students learn and the process in which they learn it. The curriculum itself aligns with the *Standards*. The teachers in this study all hold beliefs that align with the *Standards* and, therefore, Core-Plus. This is interesting because it suggests that all five of these participants are teaching a curriculum that aligns with their beliefs. Both Collopy (2003) and Remillard and Bryans (2004) found that beliefs played a role in how teachers implement a curriculum. Clarke (1997) found that beyond beliefs, weaker content knowledge can influence implementation of curriculum. With curriculum and beliefs in alignment, the next area to examine is practice. The implementation of Core-Plus at Suburban High School was not consistent from one classroom to the next even though all five participants are supportive of Core-Plus. The differences in implementation fall into two categories: additional materials and alternate pedagogy. Additional materials refer to the fact that several of the lessons were supplemented with some type of worksheet or activity that focused on skill practice or that supplemental materials were added to enhance the curriculum. Alternate pedagogy refers to the times

that the teachers chose to present the material in ways other than the large group introduction with small group exploration contained in Core-Plus. Recall that each teacher explained why they made such choices. For skill practice this was added because they believed the book did not have enough practice for the students based on teachers' reporting the following year of the students' achievement. For enhancement, this was done to challenge the honors students and prepare them for the next course. Alternate pedagogy was described as being used for practice or when the material was too difficult for the students based on prior experience. This alternate pedagogy typically took the form of teacher led discussion with the large group by following the text or a review game. It did not, however, take the form of a lecture where the teacher imparted information with little or no student input. The differences in teacher-led discussion and traditional teacher lecture were greater than the two terms may indicate. Traditional teacher lecture typically focuses on the teacher with example problems provided and worked out for the class to observe, copy, and possibly ask questions about or add comments. The teacher-led discussion that was observed focused on working through the exploration in the text by asking students to provide ideas and conjectures to explore the topic at hand. Recall that the text is written for students to do these explorations in small groups. The distinguishing factor in these teacher-led discussions is that they are not in small groups but are doing the group work as a class. Recall that the teachers used this alternate pedagogy when they felt the material was too difficult for students to explore on their own. This may be seen as a way to still encourage exploration while doing more leading than the text was written for. These ideas reflect what Tarr et al. suggested that "the teachers own beliefs and experiences as well as the student's prior knowledge and

motivation influence the ways in which the students interaction with mathematics" (p. 250).

The teachers in this study all profess beliefs that align with the *Standards* and Core-Plus. This alignment seems to break down when teachers choose to use an alternate pedagogy or additional materials. For each of these teachers their beliefs seem to be continually modified by additional information they are receiving, such as feedback from other teachers, student achievement, and past experiences with the curriculum. Student achievement, according to the participants, is linked to success in later courses. For example, the Course 2 teachers rely on the Course 3 teachers to determine what changes need to be made. Kelly explains that the first time through the curriculum she followed it very closely and only made changes later when things did not work. This not working may be attributed to success in the subsequent course or her general feeling about her own course and how the lesson went that day. Anne explains that she chooses to use more teacher led discussion when she knows the material is more difficult for the students and this is similar to Dana's explanation about using less group. Pat used alternate pedagogy when he was introducing additional materials for his honors course and presented problems or new ideas for students to discuss as a class and then later explore. Although these teachers all used the book as the guide to content, pacing, and overall lesson planning and use the curriculum with a large measure of fidelity it appears that they are also willing to alter their use of the curriculum based on perceived needs. They seem to generally follow the idea of Brown, Pitvorec, Ditto, and Kelso (2009) of *fidelity to the literal lesson* or what is written in the book. This took different forms, sometimes following both the content and pedagogy of the lesson very closely while

other times following the content closely but using alternate pedagogy such as teacher-led discussion. This following of the content broke down when students were not doing well in some areas in the following course according to the teacher of the next course. At this point, the teachers then tended to add more drill and practice to the curriculum to insure better results although sometimes additional enhancement materials were added and Kelly mentioned adding activities.

Although there were differences in how the teachers in this study implemented the curriculum they all seemed to adhere to curriculum for the majority of the daily and overall course content. In contrast, the teachers in Remillard and Bryans (2004) study who were using the Investigations curriculum used it in a larger variety ways and were more willing to deviate from the curriculum completely. Two teachers in their study, Peter and Kim, were described as using their own curriculum map instead of using the Investigations curriculum at all. The next level used the curriculum to guide the general structure but selected specific skills and activities to use. All of the participants in the present study used the curriculum with more fidelity than these two categories presented by Remillard and Bryans. Collopy (2003) found similar results when looking at two teachers' implementation of the Investigations curriculum. Collopy found that one teacher followed the curriculum and changed her view of mathematics while the other did not change her beliefs or practices about mathematics and just fit the curriculum to her teaching style. These studies indicate that something different is happening with these five teachers at Suburban High School. Although there are clearly times when the teachers at Suburban do not follow the text, the overall fidelity to the curriculum is high. In addition, according to the teachers, changes to the curriculum were not made on the

basis of prior beliefs or personal feelings but were based on several real and justifiable reasons. Recall that reasons for inconsistencies involved preparing for a test, adding material for an honors course, or knowing, from past experience with the material, that additional large group discussion was necessary because students tended to struggle with the lesson. All of these changes, often to a more traditional approach, were based on past experience and changed when there was a perceived need because of future performance. Recall, however, that sometimes materials were used for enhancement of the honors curriculum and the addition of activities was mentioned in the interview but not observed. So the question remains, why add more practice instead of more exploration? If learning the material by exploration is a belief held by all these teachers, it is interesting that none of them indicated that when students are struggling they added more exploration. These teachers explained that if the text was lacking in something, more practice was added. This seems to reflect a belief that additional practice is really the way to learn material. It is difficult to determine here if practice was added to solidify a procedure or to learn a concept. As Anne indicated, she felt that group exploration was sometimes too difficult for students so that was modified to teacher led discussion. When the curriculum was not meeting the students' needs, it was altered to contain more practice. These findings indicate that these teachers believe that both practice and teacher led discussion make learning easier and possibly more efficient for the student but they do not necessarily reflect the professed beliefs of the teachers about what is better for students. These teachers professed beliefs and practice align when things are going well for the students but not when success, as defined by the ability to do well in the next course, is in question. When that happens, these teachers all seem to revert to more practice to make

sure the students do well. Two teachers, Pat and Kelly, do seem to add more exploration but for reasons other than success in the course. Kelly told that she may add more hands-on activities when lessons were boring. Pat added material to the honors course and the lessons that were observed of Pat indicate a mix of both exploration and practice. So, teachers in the study added practice to improve success and added exploration to keep the course interesting and to challenge honors students.

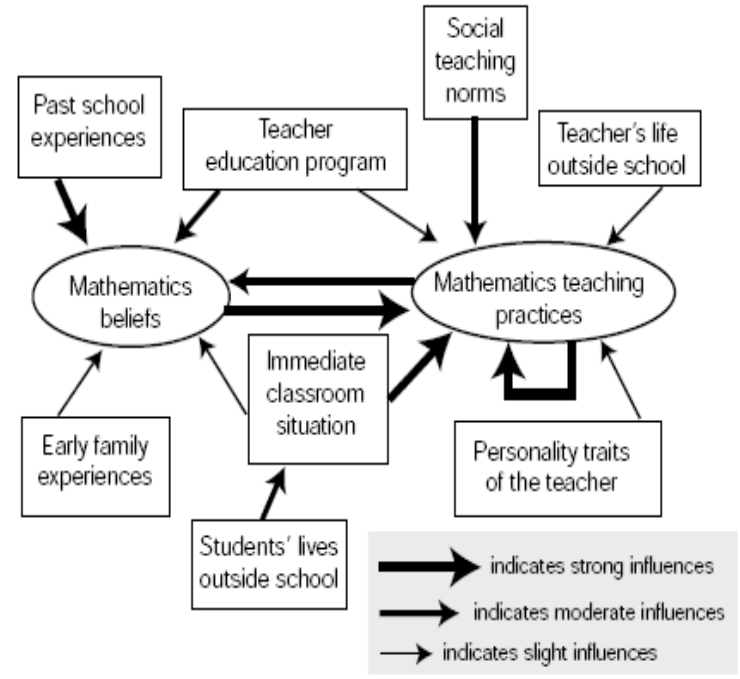
Alignment of beliefs and practice with Core-Plus is evident in many ways in this study. Teachers believe in letting students explore, see problems in context, and learn from an integrated curriculum and these were all witnessed in the classroom. Pedagogically, however, many instances occurred where the curriculum was not followed for a variety of reasons. This presents an interesting mix of alignment and deviation. The alignment was evident in content covered, questioning, and real world contexts evident in the classroom. The deviation was controlled by past experiences with the curriculum, an underlying but unspoken belief that practice will improve skills, and a belief that difficult material needs to be more teacher led than explored in groups. So, even though these teachers beliefs appear to be highly aligned with this curriculum they still choose to alter the curriculum in ways they think meet the needs of their students and these changes move toward the traditional kinds of mathematics instruction.

Additional influences

Raymond (1997) proposes a model for the interaction among beliefs, practice, and other outside influences. This model presents some areas as being more influential than others. Two areas of specific interest in this study are social teaching norms and immediate classroom situation. The category of social teaching norms is shown to be a

moderate influence and includes standardized testing, curriculum, and other teachers. The immediate classroom situation includes the students and the mathematics topic at hand.

Figure 1



Mathematics beliefs: about the nature of mathematics and mathematics pedagogy

Mathematics teaching practice: Mathematical tasks, discourse, environment, and evaluation

Immediate classroom situation: Students (abilities, attitudes, and behavior), time constraints, the mathematics topic at hand

Social teaching norms: School philosophy, administrators, standardized tests, curriculum, textbook, other teachers, resources

Teacher's life: Day-to-day occurences, other sources of stress

Students' lives: Home environment, parents' beliefs (about children, school, and mathematics)

Teacher education program: Mathematics content courses, methods courses, field experiences, student teaching

Past school experiences: Successes in mathematics as a student, past teachers

Early family experiences: Parents' view of mathematics, parents' educational background, interaction with parents, (particularly regarding mathematics)

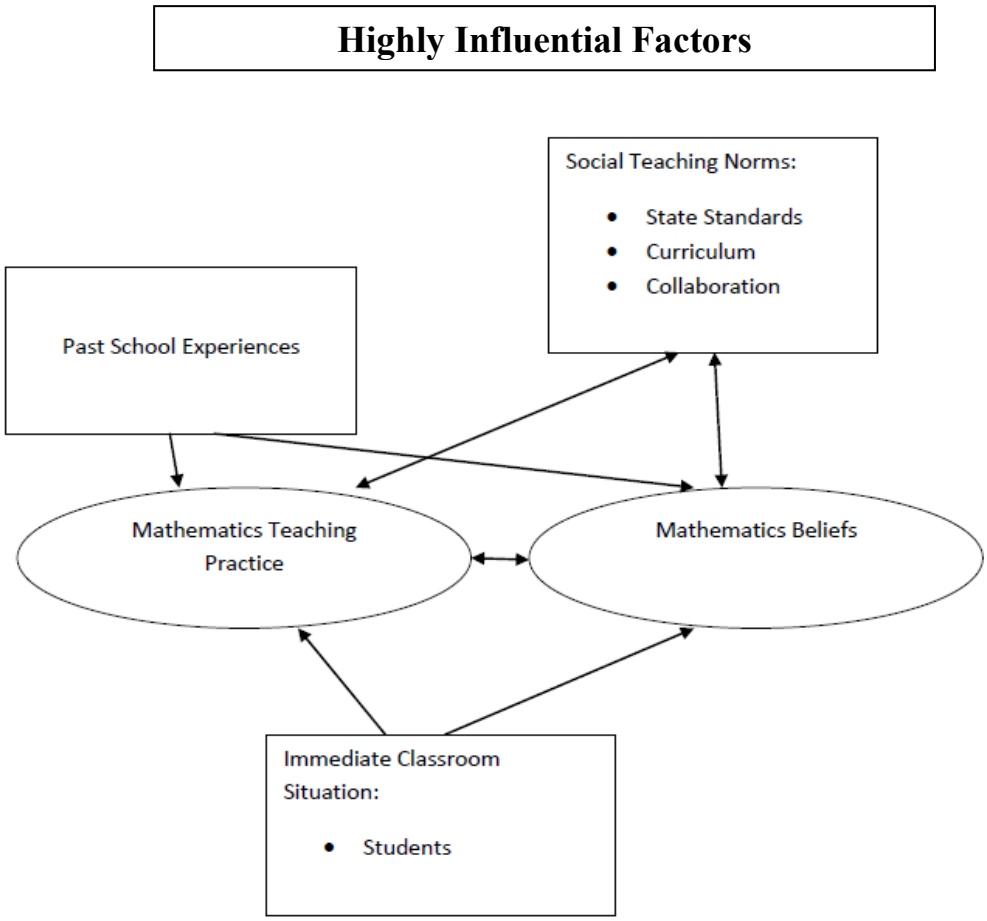
Personality traits: confidence, creativity, humor, openness to change

The study at Suburban High school differs from this model in these two areas in particular. Every teacher in the study talked about the influence of the state standards on the choice to teach Core-Plus in the first place or the level of alignment of each course

with these state standards. Every teacher also described the students as a large influence on their practice. Four of the five teachers mentioned other teachers or collaboration as a big influence on their teaching. These findings suggest a slightly different model at Suburban High School.

The model that has emerged from Suburban appears to have the state standards as an overarching or controlling factor in the choice of content and the curriculum. This is probably due to the fact that state standards influence the high stakes testing for schools and students and this was not present during the Raymond study. The beliefs and practice of these five teachers appears to align with the curriculum and therefore the interaction between beliefs and practice is evident in choices made and the willingness to use the curriculum. The choices made regarding practice is influenced by beliefs about how students learn (i.e., more practice) and beliefs are influenced when teachers see the ability of students through the practice they are implementing. A highly influential factor on practice is the collaboration with other teachers which includes the discussion of student achievement. The student achievement or success with the content is also examined on a daily basis and influences practice regularly. The model presented here for Suburban only includes the major influences found in this study and does not include influences that were not investigated in this study. In general, the only three areas of Raymond's study that appear are social teaching norms, past experience, and immediate classroom situation. These are, of course, in addition to mathematics classroom practices and beliefs that are the focus of this study.

Figure 2



The finding that the state standards are so influential without an intense focus on the state test is interesting but may be expected considering the high stakes of state testing. The Raymond (1997) model does not show standards as influential as this study indicates but it is unlikely that state standards and high stakes testing were as prevalent and important at the time of Raymond's study. The collaboration and influence of the other teachers is surprising. This suggests an environment where the staff works together to best meet these state standards as well as the needs of the students. Notice the focus is

not on the actual state test according to the teachers' responses. This is potentially very different from other schools that spend weeks practicing and preparing to take the exams and may focus more on the test itself than the actual content. It may that the focus on extra practice and what is considered success at Suburban are reflecting the nature of the state tests and therefore are an underlying cause for the addition of the practice in each of the courses. The focus on students while deciding how to teach is indicative of an environment where the education is tailored to fit the needs of the students. This seems to be used in conjunction with the content and curriculum of Core-Plus and altered in ways that these teachers find more effective. The presence and strength of these outside influences presents a different picture than the model proposed by Raymond (1997) while describing the complex nature of decisions in the classroom. This research indicates that Suburban High School clearly follows the state standards which are currently very high stakes for mathematics, they work collaboratively on a regular basis, and they often evaluate their students' success in an attempt to make coursework the most effective for them. This work is all supported by a belief system that was influenced by previous classroom experiences and now appears to align with Core-Plus. The cohesiveness of the belief system and the curriculum seems to foster an environment where the teachers focus on their students and improving achievement and this seems to be working, based on the school's mathematics achievement.

Recommendations for Future Research

I spent several years working in a school that adopted and implemented Core-Plus. The level of implementation varied by teacher as did support for the curriculum. My school had a dual track system where the top students took a traditional curriculum

and the rest took Core-Plus. This system only lasted a few years and Core-Plus is no longer available at that school. The failure of Core-Plus at my school and the success at Suburban High School presents many questions, one of which, the relationship between beliefs and practice, is studied here. From this research many other questions arise when considering the reasons for success of a *Standards*-based or possibly any curriculum.

The culture of Suburban High School presents an environment unlike many others in high school mathematics. This culture includes a strong department chair that supports and advocates for the Core-Plus curriculum and a department that seems to trust and follow him. There appears to be the expectation that each teacher will use the curriculum. An intense collaboration exists that includes daily and yearly planning as well as working on curriculum alignment with the state standards. All of these things exist in a school where the success in mathematics cannot be questioned. Many of the characteristics present at Suburban High School seem to have an intensity that is not present in all other schools. This presents an area for further research and the overall culture at Suburban provides a new lens through which researchers can look at the implementation of *Standards*-based curricula and the alignment between beliefs and practice.

Several issues are worthy of investigation. First, a companion study that examines changes teachers make to a curriculum that aligns with their beliefs could help further the study of the relationship between beliefs and curriculum implementation. Next, the culture of other schools can be compared to see if this powerful structure exists in other schools. The type of culture that respects and follows the knowledge of the department chair in curricular issues, the high expectations set with regard to the use of

the curriculum, and the high level of collaboration. If such a school exists, then comparisons of mathematical success can be made as well as examining the role of the curriculum in this school.

Another area of interest is the influence teachers' beliefs have on their students. Kloosterman, Raymond, and Emenaker (1996) studied elementary students for three years in an effort to determine if students' beliefs about mathematics are stable over time. Twenty-nine students were individually interviewed to gain insight into their beliefs and any changes in student beliefs over the three-year period. In the area of group work, Kloosterman, Raymond, and Emenaker found that students' beliefs changed over time. The study indicates that students' beliefs were related to teachers' practices. Some students related that group work is useful while in fourth grade but in sixth grade, after not using it, found it unnecessary. Other grew to appreciate group work more when they had teachers who used group work. This indicates that teacher's practices do influence student beliefs. It seems reasonable that classroom practices will influence student beliefs about mathematics. By examining student beliefs in the context of teacher beliefs and practices it may be possible to determine if a relationship between teacher and student beliefs exist.

Implications

This study provides a framework for implementation of reform curricula in other schools. Three factors stand out in this school as highly influential factors to successful implementation of Core-Plus. First, the high level of collaboration among these teachers seems to create a culture of acceptance of the curriculum and a support system within which this curriculum can thrive. The teachers mentioned changes to the curriculum both

daily and yearly based on the discussions with other teachers. Teachers who join this staff know that they are entering a community which continues to support Core-Plus through training and on-going teaching interaction. This provides a structure that encourages those who are supportive of such a curriculum and possibly deters those who would rather teach a more traditional mathematics curriculum. Second, the leadership provided by both the administration and the department chair appear to be highly influential in the success and longevity of the use of Core-Plus. The administration made it clear that only one type of curriculum would be used, not a dual-track system as some schools adopted. The department chair continues to share his ideas and experience (40 years) with the other staff about the reasons why Core-Plus is a good choice for their students. The school also sends all new teachers to training for Core-Plus. This solid support from two levels of leadership seems to keep the staff focused on Core-Plus and the successes at Suburban High School.

Third, the teachers at Suburban all talked about the focus on student thinking and students when looking at the curriculum and how to teach. This high level of focus on the students indicates that teachers are not necessarily teaching just what is comfortable to them but what they now believe is best for students and they continually reevaluate to see if what they are doing is working for the students. Finally, these five teachers all had beliefs that aligned with this curriculum. Not all had prior experiences that were similar to teaching or learning like what is included in Core-Plus but their experiences with the curriculum and with students have made their current beliefs align enough to use and like the curriculum. This level of alignment may also be a key to successful implementation and the ability to maintain the curriculum. These four factors together present a

framework for successful implementation of a new curriculum that includes looking at the teachers' beliefs, focusing on student thinking, providing strong administrative support and leadership, and identifying beliefs that are aligned with the curriculum.

Limitations

The teachers in the study were picked by the department chair at Suburban and may not be representative of the entire staff. In future studies it would be important to gather a sample that supports all the different views present in the school and this would provide more areas for comparison. The number of days spent observing may not have been enough to create an accurate picture of how the curriculum is used over time. There was no indication, however, that the teachers altered their lessons in any way to accommodate this research. A final limitation is the school itself. While this school was purposely chosen for its academic achievement and adherence to Core-Plus, the school resides within a highly prosperous community, students with good attendance, and small class sizes (all observed were less than 28). These factors make this school different than most urban schools in all these ways.

This chapter provided conclusions, recommendations for future research, and limitations of this research. Chapter 1 introduced the topic of beliefs and the need for research in the area of beliefs and practice. Chapter 2 provided a more in-depth literature review on the relevant topics to this research. The methodology was presented in chapter 3 and the analysis of the data in chapter 4.

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Appendix A
Teacher Survey

Name_____ Date_____

Email
address_____

Courses you are
teaching_____

_____

Additional courses you have
taught_____

_____

Years of experience teaching_____

Have you taught at another school? Yes No

Have you worked in another profession prior to teaching? Yes No

1. A good learning environment is maintained when instruction is focused on the interests and motivation of the students.	SA	A	D	SD
2. There are many aspects of teaching mathematics which I do not enjoy.	SA	A	D	SD
3. Students in my class are encouraged to look for different ways of solving problems.	SA	A	D	SD
4. I frequently spend time helping students who have difficulty understanding mathematics.	SA	A	D	SD
5. One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures	SA	A	D	SD
6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas.	SA	A	D	SD
7. I was a good mathematics student.	SA	A	D	SD
8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.	SA	A	D	SD
9. I use a variety of assessments to determine a student's learning progress.	SA	A	D	SD
10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.	SA	A	D	SD
11. Student interest is greater if instruction is organized so that the logical structure of mathematics is apparent throughout the course.	SA	A	D	SD
12. Being a mathematics teacher is what I expected the career to be.	SA	A	D	SD
13. A silent classroom is better for students than one with talking.	SA	A	D	SD
14. Teaching mathematics takes a lot of work.	SA	A	D	SD

15. I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas.	SA	A	D	SD
16. Most of the mathematics I assign outside of class is intended to give students practice in using a particular rule or formula.	SA	A	D	SD
17. There are several topics in my mathematics courses that I do not enjoy teaching.	SA	A	D	SD
18. The teacher has only a small influence on students' attitudes about mathematics.	SA	A	D	SD
19. Students who are not making an effort to learn mathematics should not be required to take mathematics courses.	SA	A	D	SD
20. The study of mathematics consists primarily of learning formulas and computational procedures.	SA	A	D	SD
21. The outcomes of a mathematics course are maximized when the rate and depth of learning are about the same for all students.	SA	A	D	SD
22. I often collaborate with other teachers regarding my mathematics teaching.	SA	A	D	SD
23. Students in my class are expected to develop the methods for problem solving.	SA	A	D	SD
24. Students should first ask the teacher for help when having difficulty in the classroom.	SA	A	D	SD

Appendix B

Teacher Interview Protocol

Experience as a student

1. Please describe your experiences as a student in mathematics. If possible, describe experiences from all levels of education such as a student in elementary, secondary and college level mathematics.
2. Please describe your experience in mathematics education courses.

Experience as a teacher

3. Please describe what you remember about student teaching.
4. Please tell me about your teaching career and the experiences you have had so far.

Outside influences on teaching

5. How do you decide what you will teach?
6. What are the biggest influences when you are deciding what you will teach?
7. How do you decide how you will teach?
8. What are the biggest influences when you are deciding how you will teach?
9. What other factors influence your decisions in the classroom?
10. How has statewide or other testing influenced what you do in the classroom?

Curriculum

11. What do you think about the Core-Plus curriculum?
12. Reflect on and share changes you have made to your teaching because of this curriculum. Student communication? Group work? Content integration? Different content? Assessment?
13. How have your beliefs changed regarding what students are able to do as a result of using this curriculum?

Conceptions of mathematics

14. How would you describe what mathematics is?

Collection of facts, rules, formulas, and procedures		Collection of facts, rules, formulas and procedures and but includes an understanding the concepts and principles behind the rules.		Interconnected concepts and ideas found in sometimes seemingly dissimilar situations.

15. What does it mean to learn mathematics?

Memorization and the ability to apply procedures		Learn the facts and procedures as well as some concepts behind the procedure		Investigate and construct mathematical ideas. Understanding grows out of engagement with the material.

16. How would you describe what you are teaching when you teach mathematics?

Progression though a sequence of topics and skills specified in a textbook. Each skill is viewed as a prerequisite for the next and are equally important		Manipulatives are used to help achieve attitudinal goals such as "math is fun". Teaching about problem solving is prevalent versus teaching with problem solving.		How different concepts, procedures, and representation are interconnected in sets of problems and situations. Pictorial and physical representations are used to engage students in tasks.

17. What are the role of the teacher and the role of the student in the mathematics classroom?

Teacher as demonstrator of well-established procedures. Student imitates the procedures until they become habit. Authority lies with the teacher or the book.		Teacher is the same as level 0. Student roles include some understanding of the justification of standard procedures. Authority still lies with the teacher or book.		Teacher provides contexts in which students can explore ideas and generate procedures. Teacher gives opportunities for students to express their ideas and for the teacher to listen to and assess their reasoning. Questioning is intended to stimulate, guide, or focus student thinking rather than for the sole purpose of eliciting answers. Students must engage in mathematical inquiry.

18. How do you know that your students have learned?

Students

19. From a student perspective, what do you think is the best way for students to learn mathematics?
20. What influences do you belief you have on students' learning? Confidence? Attitude? Beliefs about mathematics?

Teaching

21. From a teacher perspective, what do you think is the most effective way to teach math?

Appendix C

comparing options in secondary mathematics:
COSMIC
investigating curriculum

Core-Plus Classroom Visit Protocol

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Melissa D. McNaught
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Funding provided by:

National Science Foundation

DURING THE LESSON

Use your notes from the Lesson Tape to summarize the classroom visit and complete the remainder of this form. For each observable activity during the lesson, identify the corresponding line from the "lesson tape" on the blank following the activity.

HOMEWORK REVIEW (If the teacher did not spend time reviewing homework, check here ____ and proceed to **LAUNCH**.)

1. What was the primary focus of homework review (mark the descriptor that best applies):

√	Activity	Lesson Tape Line
_____	Focus on answers	_____
_____	Focus on procedures	_____
_____	Focus on understanding	_____
_____		_____

LAUNCH (If this class period did not contain a **LAUNCH**, check here ____ and proceed to **EXPLORE**.)

2. Which of the following were observed during the **LAUNCH**? (mark all that apply):

√	Activity	Lesson Tape Line
	The Teacher:	
_____	drew connections to a previous lesson or other knowledge that is prerequisite to the instruction at hand (beyond reviewing homework problems)	_____
_____	made reference to the learning objectives for the class period	_____
_____	utilized the *Think About This Situation* for the lesson from the textbook	_____
_____	did not diminish the problematic nature of the content prematurely by providing unnecessary scaffolding	_____
_____		_____

EXPLORE (If this class period did not contain an **EXPLORE**, check here ____ and proceed to **SHARE & SUMMARIZE**.)

3. Was today's instruction a continuation of a previous day's Investigation? Yes No

   If yes, did the teacher draw connections between the previous day's content and today's? Yes No

4. Which of the following were observed during the **EXPLORE**? (mark one):

√	Activity	Lesson Tape Line
	The Teacher (mark the best descriptor):	
_____	did not circulate around the classroom for a significant portion of the EXPLORE	_____
_____	moved around the classroom primarily interacting with individual students	_____
_____	moved around the classroom primarily interacting with groups	_____
_____		_____

SHARE & SUMMARIZE

(If this class period did not contain a formal **SHARE & SUMMARIZE**, check here ____ and proceed to **APPLY**.)

5. Which of the following were observed during the **SHARE & SUMMARIZE**? (mark all that apply):

√	Activity	Lesson Tape Line
	The Teacher:	
_____	had students work individually on questions from the *Checkpoint*	_____
_____	had students discuss in groups questions from the *Checkpoint*	_____
_____	had students discuss as a class questions from the *Checkpoint*	_____
_____	did not directly provide the students answers to questions from the *Checkpoint*	_____
_____	_____	_____

APPLY (If the teacher did not assign the students problems, check here _____ and proceed to **ASSESSMENT**.)

6a. If *On Your Own* problems were not assigned, check here ____ and proceed to Question 7.

b. Problems were to be worked (circle one): in class outside of class both

c. If in class, the assignment was to be completed (circle one): individually in groups unsure

7a. The teacher assigned problems from (circle all that apply): MORE *Core-Plus* resource materials

teacher-developed assignment source other than the *Core-Plus* materials

b. Problems were to be worked (circle one): in class outside of class both

c. If in class, the assignment was to be completed (circle one): individually in groups unsure

ASSESSMENT (If no summative assessment was given, check here _____ and proceed to **GENERAL CLASSROOM CHARACTERISTICS**.)

8. A written summative assessment was given from (circle one): *Core-Plus* auxiliary materials alternate source

GENERAL CLASSROOM CHARACTERISTICS

9. The teacher brought closure to the lesson (circle one): Yes No

10. Indicate the overall level of student engagement during the class period (mark the descriptor that best applies):

√	Activity
_____	Relatively few students appeared to be off task
_____	About one-half of the students appeared to be off task
_____	The majority of the students appeared to be off task
_____	_____

11. Indicate the technology used during the class period (mark all that apply):

√	Activity	
	Use of graphing calculator:	
_____	by most students	
_____	by the teacher	
	Use of interactive computer software:	
_____	by most students	Software utilized:
_____	by the teacher	Software utilized:

12. Indicate the dominant level of student collaboration for the class period (mark only one):

√	Activity
_____	Most students worked individually
_____	Some students worked collaboratively while others worked individually
_____	Most students worked collaboratively

AFTER THE LESSON

After the lesson is finished, please review your notes on the lesson tape recording sheet and then respond to each of the following sections.

1. Describe the main activities that occurred during the class period and the amount of time devoted to each activity. For example:

Non-instructional activities (e.g., announcements, attendance)	LAUNCH
Warm-up activities	EXPLORE
Homework review	SHARE & SUMMARIZE
Closure	APPLY

Activity	Time

2. Were curricular materials other than the *Core-Plus* textbook used during the lesson? Yes No

If yes, please describe these materials: _____

Overall Ratings

These indicators measure the extent to which the instruction during the class period of your visit aligns with the recommendations and content of the *Core-Plus* textbook. For each rating, choose the indicator that best describes what you observed.

1. Overall rating of *content fidelity*:

1	2	3	4	5
Lower Fidelity		***Moderate Fidelity***		***Higher Fidelity***
The content of the enacted curriculum was *largely inconsistent* with the written curriculum. The textbook was not the primary source of the lesson content because of omissions, significant modifications, and/or supplementation.		The content of the enacted curriculum was *moderately consistent* with the written curriculum. Although the textbook was a source of some of the lesson content, other portions of the lesson could not be attributed to the textbook.		The content of the enacted curriculum was *consistent* with the written curriculum. The textbook was the primary source of the lesson content with little or no deviation or supplementation.

2. Overall rating of the *presentation fidelity*:

1	2	3	4	5
Lower Fidelity		***Moderate Fidelity***		***Higher Fidelity***
The presentation of the enacted curriculum was *not consistent* with the expectations of the textbook authors. During the lesson, the teacher implemented actions/activities that were not recommended *and/or* neglected to implement actions/activities that were advised or recommended. The teacher placed disproportionate emphasis on particular lesson components at the expense of others.		The presentation of the enacted curriculum was *moderately consistent* with the expectations of the textbook authors. During the lesson, the teacher either implemented some actions/activities that were not recommended *or* neglected to implement actions/activities that were advised or recommended. The teacher generally placed appropriate emphasis on each lesson component.		The presentation of the enacted curriculum was *consistent* with the expectations of textbook authors. During the lesson, the teacher implemented recommended actions/activities *and* refrained from actions/activities that were not advised or recommended. The teacher placed appropriate emphasis on each lesson components.

Part III: Selected Elements of the Classroom Learning Environment

	(use rubric) weak ↔ strong
REASONING ABOUT MATHEMATICS	
R1. Students were afforded opportunities to make conjectures about mathematical ideas.	1 2 3 4 5
Supporting examples	
R2. Students' mathematical arguments or justifications were challenged by others.	1 2 3 4 5
Supporting examples	
R3. Mathematical authority rested with *students*, not with the teacher or textbook.	1 2 3 4 5
Supporting examples	
STUDENTS' THINKING IN INSTRUCTION	
ST1. Formative assessment techniques were used to guide instructional decision-making.	1 2 3 4 5
Supporting examples	
ST2. Students' statements about mathematics were used to build a shared understanding for the class or members of a collaborative group.	1 2 3 4 5
Supporting examples	
ST3. Student misconceptions or mistakes were used as a learning site for others.	1 2 3 4 5
Supporting examples	
FOCUS ON SENSE-MAKING	
SM1. Multiple (alternative) solution strategies were encouraged.	1 2 3 4 5
Supporting examples	
SM2. The enacted lesson developed procedural knowledge in meaningful ways	1 2 3 4 5
Supporting examples	
SM3. The enacted lesson developed conceptual understanding of mathematics.	1 2 3 4 5
Supporting examples	
SM4. Connections within mathematics were explored in the lesson.	1 2 3 4 5
Supporting examples	

Appendix D

	Pat	Jamie	Dana	Anne	Kelly
1. A good learning environment is maintained when instruction is focused on the interests and motivation of the students.	A	SA	A	A	SA
2. There are many aspects of teaching mathematics which I do not enjoy.	D	D	D	D	D
3. Students in my class are encouraged to look for different ways of solving problems.	SA	A	SA	A	A
4. I frequently spend time helping students who have difficulty understanding mathematics.	SA	A	SA	SA	SA
5. One of the most important reasons for studying mathematics is that it helps one to think according to strict rules and procedures	SA	SD	A	SD	A
6. Nearly all class time should be spent by the teacher in explaining mathematical ideas, procedures, and formulas.	SD	D	D	D	D
7. I was a good mathematics student.	SA	A	SA	SA	A
8. When working assignments, students should always follow a specific strategy for solving problems even if there are other ways of solving the problems.	D	D	D	D	D
9. I use a variety of assessments to determine a students' learning progress.	SA	A	SA	A	SA
10. In my mathematics classroom there is opportunity for developing and experimenting with different methods of solving problems.	SA	A	SA	A	A
11. Student interest is greater if instruction is organized so that the logical structure of mathematics is apparent	SA	A	SA	A	A

throughout the course.					
12. Being a mathematics teacher is what I expected the career to be.	SD	D	A	A	D
13. A silent classroom is better for students than one with talking.	SD	SD	A	SD	D
14. Teaching mathematics takes a lot of work.	SA	SA	SA	SA	SA
15. I place more emphasis on the reasoning involved in solving problems than on the learning of rules and formulas.	SA	A	SA	A	SA
16. Most of the mathematics I assign outside of class is intended to give students practice in using a particular rule or formula.	A	D	A	D	A
17. There are several topics in my mathematics courses that I do not enjoy teaching.	SD	D	D	D	D
18. The teacher has only a small influence on students' attitudes about mathematics.	SD	D	D	D	D
19. Students who are not making an effort to learn mathematics should not be required to take mathematics courses.	SD	SD	SD	D	D
20. The study of mathematics consists primarily of learning formulas and computational procedures.	SD	SD	SD	D	D
21. The outcomes of a mathematics course are maximized when the rate and depth of learning are about the same for all students.	SD	D	D	D	D
22. I often collaborate with other teachers regarding my mathematics teaching.	SA	SA	SA	SA	SA
23. Students in my class are expected to develop the methods for problem solving.	SA	A	SA	A	SA
24. Students should first ask the teacher for help when having difficulty in the classroom.	D	D	D	D	D

Appendix E

Summary of Data

			From Survey		From Interview	
	Years Experience	Alignment with *Standards*-based beliefs	Classroom Practice	Responses on continuum	Experience	Other Influences on teaching (bold items reflect those with "biggest" influence)
Pat	40	Very highly *Standards*-based (40 points)	High focus on problem solving and reasoning, low focus on teacher explanation, homework involves practice on rules or formulas	4, 4, 4, 4	Math degree; math team; writing math exams; focus on problem solving; brief time out of teaching for engineering; student taught modular scheduling; variety of innovative curricula used	**Students** **Topic** Standards Textbooks
Jamie	4	Very highly *Standards*-based (39 points)	Focus on problem solving and reasoning, low focus on teacher explanation, homework does not mainly focus on rules and procedures	3, 4, 4, 3	Good at math in school; traditional high school experience; methods class was a turning point; student taught elementary NSF; student taught traditional high school	**Curriculum** **Standards** **Students** **Teachers/collaboration**
Dana	19	Highly *Standards*-based (38 points)	High focus on problem solving and reasoning, low focus on teacher explanation, homework involves practice on rules or formulas.	2, 3, 4, 4	Math was easy; taught in traditional program outside the US; applied math as undergrad; traditional teaching in other district; student taught in traditional; methods course improved content	**Cooperation/other teachers** **Departmental policy** **Student knowledge** Curriculum Lesson Standards
Anne	13	Highly *Standards*-based (35 points)	Focus on problem solving and reasoning, low focus on teacher explanation, homework does not mainly focus on rules and procedures.	3+,4,3,3	Teaching is a second career; very traditional k-12; math methods was a disappointment; student taught some traditional some Core-Plus at Suburban	**Past experience with curriculum** **Teachers/teamwork** Students struggling Standards
Kelly	4	Highly *Standards*-based (36 points)	Focus on problem solving and reasoning, low focus on teacher explanation, homework involves practice on rules and procedures.	3, 3,4,3	Elementary math had manipulativs; 7-8 very traditional; math was boring; math methods had to write a paper on traditional versus integrated and moved her toward integrated; student taught traditional	**Students** **Team of teachers/collaboration** Curriculum pacing Standards

Appendix F

Final Interview Protocol

1. Would you describe the 3 days that I observed typical of how you usually teach? Why or why not?

2. I observed you using group work in your class. How often do you think you use group work (a percent is fine) and in what way(s) do you use it? Do you think you use group work as much and in the way that the authors of the curriculum intend? Why or why not?

3. In the first interview you expressed that you like the Core-Plus curriculum and it appears that you generally follow the content. When would you say that you choose to deviate from the content? When you added outside material, it appeared that it was more practice. Do you think this is an accurate observation? If so, why did you choose to add more practice?

4. When you choose to do things differently than what is put forth in the curriculum and the pedagogy for Core-Plus, what influences that decision?

5. What is the main goal you have for the students in your mathematics course?