

A Multiple Case Study Examining Secondary Mathematics Teachers' Perceptions of
Reform-Oriented Instruction and Obstacles to Instructional Change

by

Angeline King Gaddy

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the degree of
Doctorate of Philosophy in Mathematics and Science Education

Middle Tennessee State University
August 2015

Dissertation Committee:

Dr. Angela Barlow, Chair

Dr. Rebecca Calahan

Dr. Nancy Caukin

Dr. Rongjin Huang

Dr. Charles Milligan

I dedicate this to PK.

Thank you for being inspiration, editor, and constant cheerleader. I love you.

ACKNOWLEDGEMENTS

I need to thank the following people who helped make this dissertation a reality:

To Dr. Angela Barlow for guiding, challenging, and opening new doors for me. You gave my love of learning a new outlet.

To Dr. Barlow and the rest of my dissertation committee for their guidance, and especially their patience with the unforeseen detours I encountered while writing this dissertation.

To Dr. Dorothy Craig for starting me on this journey.

To Gwen, Kathy, and Josh for allowing me to invade your school lives. Working with you, hearing your words, and telling your stories were joy for me.

To my Smyrna High School family for adopting me as your own and supporting me as only a family can.

To my daughter, Molly, you will always be my greatest accomplishment.

To Molly and my son-in-law, Nick, for being patient with my preoccupation these past few years and for doing all those chores that I was either too busy or forgot to do.

To my Maddie. Those who know a Maddie understand how restorative she has been to me throughout this endeavor.

To my parents, Porter and Judy King for supporting me, encouraging me, and always being proud of me. I regret my mother did not live to see this project through to its completion, but I know she, like my dad, would be immensely pleased with me and this accomplishment.

ABSTRACT

For more than a century, reform efforts have been suggested in the field of mathematics education. Two of the more recent efforts, by the National Council of Teachers of Mathematics, in 2000, and the National Research Council, in 2001, contributed to the Common Core State Standards of Mathematics, which were published in 2010 and widely adopted across the United States. For many mathematics teachers, achieving the goals described in these standards meant changing their style of teaching from using traditional instructional methods to reform-oriented methods. When studying teachers who attempted to alter their teaching practices in response to past reform efforts, researchers have found obstacles that blocked the implementation of the reforms or prevented their being implemented in the way they were intended. Through an examination of mathematics teachers attempting to transform their teaching practice in anticipation of the implementation of the Common Core State Standards, this case study revealed the beliefs and perceptions the teachers held about their transitioning to using reform-oriented instructional methods.

This study, conducted over a four-month period, employed surveys, interviews, written reflections, and observations, to reveal the beliefs held by the participants about their abilities to use reform-oriented teaching methods, the criteria they used to determine their success, and what obstacles they encountered to changing their practice. Using qualitative research methods, the researcher analyzed the participants' responses, which revealed the participants believed, to varying degrees, that they possessed the ability to teach using reform-oriented instructional methods. To evaluate their success, the

participants described three categories of criteria: students' attitudes and behaviors, participants' questioning skills, and students' presentation of their work. Finally, the obstacles reported by the participants to their implementing their intended reform were time constraints, lack of resources, student concerns, and insufficient training and experience. These results correspond to research findings about teachers during a period of transition. The findings from this research study suggest a need for ongoing training and support for teachers who are undergoing a transition in their teaching practice.

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CHAPTER ONE: INTRODUCTION

Background of the Study

According to the National Mathematics Advisory Panel (2008), the United States demonstrated, by its workforce and its mathematical education, “peerless mathematical prowess” (p. xi) throughout most of the 20th century. The panel went on to caution that barring changes to its educational system, the United States would not maintain its leadership position into the 21st century (National Mathematics Advisory Panel, 2008). The National Research Council (NRC), in its preface to *Adding It Up: Helping Children Learn Mathematics* (2001), explained that an increasingly global society, in addition to having an increasing need for informational technology skills, also emphasizes the need for a mathematically proficient society. However, media reports of ineffective teaching and poor test scores have led to doubts regarding whether students in the United States possess the mathematical skills they need (NRC, 2001).

Mathematics Test Results

Three reports of the test scores mentioned above are from the National Assessment of Educational Progress (NAEP), the Programme for International Student Assessment (PISA), and Trends in International Mathematics and Science Study (TIMSS). As their names imply, NAEP reports findings from students in the United States, and PISA and TIMSS report international comparisons among students’ performance. The following paragraphs describe findings from each of these assessments that caused concern about the mathematical proficiency of students in the United States.

NAEP scores. NAEP mathematics assessments are administered every two years to United States students in grades 4, 8, and 12, and the results of these assessments

become part of The Nation's Report Card (National Center for Education Statistics, 2015a). In the 1990 results, 13% of the students in grade 4 and 15% of the students in grade 8 earned a score that classified them as mathematically proficient or advanced. The 2005 NAEP results are the earliest grade 12 data available for comparison, and, in that year, 23% of the grade 12 students scored mathematically proficient or advanced. By 2013, all three grades had improved: 42% of the students in grade 4, 36% of the students in grade 8, and 26% of the students in grade 12 met or exceeded the criteria for mathematical proficiency. Although all three grade levels showed improvement, the rate of improvement slowed in the past few years, and the scores of more than half of the students in all three age groups reflected a lack of mathematical proficiency.

PISA comparisons. One of the international assessments, PISA, is sponsored by the Organisation for Economic Co-operation and Development (OECD) and compares the mathematical proficiency levels of 15-year-old students around the world (OECD, 2015). Forty-one countries participated in PISA in 2003, and 65 countries participated in 2012. In 2003, the mean mathematics score of the OECD countries participating was 501, and the mean score for students in the United States was 476. About 29% of the students from the United States who tested were classified, by their scores, as low achievers, and about 11% were classified as top performers. In 2012, the mean mathematics score for PISA was 494, and the United States' mean score increased slightly to 481. The percentage of students from the United States classified as low achievers and as top performers both decreased from 2003 to 2012: about 26% were classified, by their scores, as low achievers, and about 9% as top performers. Shanghai-China had the highest scores in mathematics in PISA 2012. In contrast to the scores from United States students, the

mean score of the students testing in Shanghai-China was 613; about 4% of the Shanghai-China students were low achievers, and about 55% were top performers. The 2012 results placed Shanghai-China at “the equivalent of nearly three years of schooling above the OECD average” (OECD, 2014, p. 4). Following this comparison, the United States’ mean score of 481 was the equivalent of less than one year of schooling below the OECD average.

TIMSS results. A third assessment, TIMSS, measures international trends in mathematics and science achievement in students in grades 4 and 8 (National Center for Education Statistics, 2015b). In 1995, with over 40 countries participating, the average score for fourth graders in the United States was 518, and for eighth graders was 492. In 2011, with about 60 countries participating, the average scores for students in the United States had increased to 541 and 509 for fourth and eighth graders, respectively, with a scaled mean of 500. The 2011 scores reflected a significant increase over the 1995 scores, but the United States average scores were lower than those of 10 other countries for grade 4 and lower than those of eight other countries for grade 8. The top two positions in grades 4 and 8 were held by the Republic of Korea and Singapore. For fourth graders, the average score was 606 for Singapore and 605 for the Republic of Korea; for eighth graders, the average score was 613 for the Republic of Korea and 611 for Singapore.

Concerns based on test results. Results from the mathematical assessments that were described in this section led to apprehensions about the mathematical abilities of students in the United States (Cuban, 1993; National Mathematics Advisory Panel, 2008). Concerns about mathematical proficiency precipitated calls for change in mathematics curricula as well as improvement in methods of teaching mathematics (Battista, 1994;

Cuban, 1993; Klein, 2003). The following section provides a description of the response to anxieties regarding the mathematical abilities of United States students.

Response to Concerns

Two of the organizations that responded to the public's concerns about how students in the United States compared mathematically to students in other countries were the National Council of Teachers of Mathematics (NCTM) and the NRC. In 2000, NCTM released *Principles and Standards for School Mathematics (PSSM)* (NCTM, 2000a), and in 2001, the NRC, in *Adding It Up*, described mathematical proficiency and how to achieve it. A more recent response to concerns about students' mathematical performance is the Common Core State Standards for Mathematics (CCSSM) (Common Core State Standards Initiative, 2010). These three reform efforts and how they attempted to change mathematics education are described in the following sections. Reform-oriented instructional methods comprise recommendations from these three reform efforts. These methods are briefly defined later in this chapter and in more detail in the next chapter.

PSSM. Released in 2000, *PSSM* was the fourth standards document produced by NCTM. Preceding it were *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989), *Professional Standards for Teaching Mathematics* (NCTM, 1991), and *Assessment Standards for School Mathematics* (NCTM, 1995). With these three documents, NCTM attempted “to develop and articulate explicit and extensive goals for teachers and policymakers” (NCTM, 2000a, p. ix). In *PSSM*, NCTM acknowledged the different areas in which mathematics is needed in a changing world and recognized that

mathematics education must continue to improve in order to meet the needs of current and future generations.

As its name implies, *PSSM* presented both principles and standards to help achieve the goal of improving mathematics education. The five principles (i.e., the Equity Principle, the Curriculum Principle, the Teaching Principle, the Learning Principle, and the Assessment Principle) were intended to provide guidance for teachers, administrators, and others making educational decisions (NCTM, 2000b). The standards presented in *PSSM* were separated into two groups: content standards and process standards. The first group described mathematical content goals in the areas of number and operations, algebra, geometry, measurement, and data analysis and probability. With the process standards, NCTM recommended students' engagement in the processes of reasoning and proof, representation, problem solving, communication, and connections. *PSSM* did not have the desired impact on many mathematics teachers, as they continued using the instructional methods they had used previously (Klein, 2003; Nesmith, 2008; Nie, Cai, & Moyer, 2009). The influence of *PSSM* was evident, however, as the five process standards were incorporated into the CCSSM, which are described in a later section.

Goal of mathematical proficiency. Concerned “that too few students . . . are successfully acquiring the mathematical knowledge, the skill, and the confidence they need to use the mathematics they have learned” (NRC, 2001, p. 1), the Mathematics Learning Study Committee was established, in 1998, by the NRC of the National Academies. The chair of this committee acknowledged that “public concern about how well U.S. schoolchildren are learning mathematics is abundant and growing” (NRC, 2001, p. xiii). The 16-member committee was tasked with synthesizing the existing

research on mathematics learning, providing research-based recommendations for educators, and giving “advice and guidance to educators, researchers, publishers, policy makers, and parents” (NRC, 2001, p. 3).

The report from the Mathematics Learning Study Committee, entitled *Adding It Up: Helping Children Learn Mathematics* (NRC, 2001), recommended “fundamental changes . . . in curriculum, instructional materials, assessments, classroom practice, teacher preparation, and professional development” (NRC, 2001, p. 10). The goal of these changes was for all students to achieve mathematical proficiency, which the committee defined as “learn[ing] mathematics successfully” (NRC, 2001, p. 5). Mathematical proficiency was described as having five “interwoven and interdependent” (NRC, 2001, p. 5) strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. Like NCTM’s process standards, the five strands of mathematical proficiency were incorporated in the CCSSM, which are described in the following section.

CCSSM. Despite the recommendations made by NCTM in *PSSM* and NRC in *Adding It Up*, many mathematics teachers did not reform their instructional practices (Bostic & Matney, 2013; Nesmith, 2008). In 2009, the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) convened an advisory group that led to the formation of the Common Core State Standards Initiative (CCSSI), which was committed to developing common standards nation-wide in language arts and mathematics (CCSSI, 2015). In 2010, the NGA Center and the CCSSO, aided by professional organizations including NCTM, released the Common Core State Standards, which included the CCSSM.

The CCSSM comprised two sections: the Standards for Mathematical Content (SMC) and the Standards for Mathematical Practice (SMP). The high school SMC “specify the mathematics that all students should study in order to be college and career ready” (CCSSI, 2010, p. 57), and the SMP “describe varieties of expertise that mathematics educators at all levels should seek to develop in their students” (CCSSI, 2010, p. 6). In drafting the CCSSM, the authors used the NCTM process standards and the strands of mathematical proficiency from *Adding It Up* as a foundation for the eight SMP (CCSSI, 2010): make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning.

The CCSSM were published in 2010, and shortly thereafter individual states began adopting the standards. At the time of this study, 45 states, three territories, and the District of Columbia had chosen to adopt the mathematics standards (CCSSI, 2015). Each of these states and territories had either fully implemented the CCSSM or were transitioning toward full implementation by the 2014-2015 school year (CCSSI, 2015). Unlike their response to previous recommendations and standards, states adopted the CCSSM to replace their existing standards and, therefore, replaced their existing state-level content assessment systems with ones more aligned with the CCSSM (CCSSI, 2015).

Assessments with the CCSSM include assessments not only of mathematical content, but also of mathematical practice, and teachers recognized they were not

prepared to be reform-oriented teachers (Editorial Projects in Education, 2013).

Mathematics teachers who had not heeded earlier calls to reform their instructional practices were unfamiliar with how to modify their instruction to meet the expectations of CCSSM, evidenced by the call for training teachers in implementing the SMP (Bostic & Matney, 2013; Parker & Novak, 2012; Zbiek, Martin, & Schielack, 2012). The change in expectations that resulted from the change in mathematics curriculum has led to a need for change in instructional practice.

Change in Instructional Practice

In recent years, mathematics teachers have grown accustomed to periodic changes in their curriculum (Lambdin & Walcott, 2007; Reys & Reys, 2011), culminating in the adoption of the CCSSM (CCSSI, 2010). With the adoption of these mathematics standards, school systems have adopted more than a curriculum change. The authors of *Making It Happen* described these new standards as “a detailed description of content expectations and mathematical practices” (Zbiek et al., 2012, p. 1). Although, in some states, the SMC require a realignment in course curricula, the biggest change for teachers may be the ideological change (Hobbs, 2012; Paulson, 2013) recommended by the SMP. Rather than teaching different material using traditional methods, teachers following the SMP must change *how* they teach as much as *what* they teach (Hobbs, 2012; Strauss, 2011; Wilkerson, 2011).

Teachers who attempt to change their style of teaching to be consistent with the expectations of the CCSSM move from a teacher-centered classroom to one in which the teacher and the students share responsibility in the learning (Hudson, Miller, & Butler, 2006; McWilliam, 2008). The lesson plans and learning tasks they previously used in

their roles as traditional mathematics teachers do not meet the needs they have as reform-oriented teachers (Hudson et al., 2006; Lotan, 2003; McWilliam, 2008; Schrock, Norris, Pugalee, Seitz, & Hollingshead, 2013). Another change for teachers who transition to using reform-oriented methods is how they evaluate their own teaching (Gabriele & Joram, 2007). Because the criteria they used in the past do not reflect the characteristics of their new role, reform-oriented teachers, not recognizing their progress, may become discouraged and hesitant to continue their reform efforts (Gabriele & Joram, 2007).

Summary of Background of Study

Various assessments of mathematical proficiency revealed students in the United States did not compare favorably with their international counterparts (NCES, 2015a, 2015b; OECD, 2015). Concern about the poor test scores led to a series of efforts to reform mathematical teaching (NMAP, 2008), culminating in the development of the CCSSM. These standards were widely adopted and included a change in state-level mathematics assessments (CCSSI, 2015). Teachers who had not followed the recommendations of previous reform efforts now struggle to transition from using traditional instructional methods to the reform-oriented methods required to meet the expectation of the SMP (Bostic & Matney, 2013; Parker & Novak, 2012; Zbiek et al., 2012).

Problem Statement

Research indicates mathematics teachers should practice reform-oriented instructional methods in their classrooms (Gruows & Cebulla, 2000; Hiebert, 2003). Despite research findings and suggestions from organizations such as NCTM and NRC, many mathematics teachers continue to use the traditional instructional methods with

which they are accustomed (Bostic & Matney, 2013; Parker & Novak, 2012; Zbiek et al., 2012). With the adoption of the CCSSM and state testing that is aligned with the CCSSM, teachers are attempting to transition toward using methods that will support meeting the expectations of the new standards (Bostic & Matney, 2013; Davis, Choppin, McDuffie, & Drake, 2013). Little research exists on the teachers themselves and their thoughts and perceptions about their abilities, success, and obstacles during this period of transition.

Statement of Purpose and Research Questions

The purpose of this qualitative multiple-case study was to examine and describe the beliefs and perceptions of three Algebra I teachers who were attempting to transition from using a traditional style of mathematics instruction to a reform-oriented style of instruction. Through this examination, I anticipated gaining insight into how the participants judged their own abilities and successes as they attempted to transition their style of teaching to align with the expectations of the CCSSM.

The following research questions served to guide my study:

1. How do Algebra I teachers who are attempting to transition from using traditional instructional methods perceive their abilities to teach using reform-oriented instructional methods?
2. What are the criteria teachers attempting to transition from teaching with traditional methods utilize to determine their success as reform-oriented teachers?
3. What obstacles do teachers face as they attempt to transition from teaching with traditional methods?

Rationale and Significance of Study

Mathematics teachers nationwide are in a period of transition from using traditional instructional methods to reform-oriented ones. The significance of this work lies in its ability to expand the research on how inservice teachers evaluate their role as reform-oriented mathematics teachers. The results of this study inform what beliefs and perceptions inservice teachers hold about their abilities and their success in becoming reform-oriented teachers. The results also reveal what obstacles teachers perceive to their using reform-oriented instructional methods. In addition, this work helps to determine what kinds of additional support teachers need during their transition to reform-oriented teachers and maintaining their new role.

Definitions of Key Terms

To increase the reader's understanding, four terms need to be defined: *traditional instructional methods*, *reform-oriented instructional methods*, *Common Core practices* and *meaningful instructional tasks*. In addition, the terms *Common Core style* and *math task* need clarification.

Traditional Instructional Methods

Traditional instructional methods are teacher-centered practices in which a typical classroom scenario includes the teacher reviewing homework answers, explaining new material, and then making an assignment for students to begin, if time permits (Hiebert, 2003).

Reform-oriented Instructional Methods

In contrast to traditional methods, *reform-oriented instructional methods* are aligned with the *PSSM* (NCTM, 2000a) and include engaging students as active

participants in the processes of reasoning and proof, representation, problem solving, communication, and connections. To the participants in this study, the term *reform-oriented teaching methods* was interchangeable with the term *Common Core style*. Reform-oriented teaching methods will be discussed further in the next chapter.

Common Core Practices

The CCSSM are intended to be goals for instruction and “do not dictate curriculum or teaching methods” (CCSSI, 2010, p. 5). Specifically, the SMP, which were described previously, are targets for mathematical instruction, and do not describe instructional practices. Despite the intended purpose of the CCSSM, many educators use the term *Common Core practices* to describe instruction that achieves the expectations of the CCSSM. Throughout this dissertation, when I use the phrase *Common Core practices*, I use it in that capacity.

Meaningful Instructional Tasks

Meaningful instructional tasks have more than one solution path, require perseverance in solving, build student understanding, require student discussion and collaboration, and have a strong mathematical foundation (Lotan, 2003; Schrock et al., 2013). The participants in this study used the term *math task* to indicate a meaningful instructional task.

Chapter Summary

Although the United States had earlier been regarded as an exemplar in mathematics (National Mathematics Advisory Panel, 2008), by the late 20th century, they no longer enjoyed their distinguished status. Poor scores on mathematics assessments, which were revealed by agencies such as NAEP, PISA, and TIMSS, provided the impetus

for seeking changes in the United States educational system. Even before public alarm was raised, organizations such as NCTM and NRC sought to reform mathematics education, but many teachers did not respond to the recommendations. With the adoption of the CCSSM, and new assessments aligned with its standards, teachers recognized they were unprepared. Many teachers recognized they needed to change their ideology about teaching mathematics (Hobbs, 2012; Paulson, 2013; Strauss, 2011; Wilkerson, 2011) and adopt more reform-oriented mindsets.

The following chapters present an examination of three mathematics teachers during a period of transition, such as the one described above. Of particular interest to this study are the teachers' thoughts and perceptions about their abilities to transition to using reform-oriented teaching methods and about how to gauge success in those efforts. Also of interest to this study are the obstacles to their transition efforts that were recognized by the teachers. Studies involving teachers during a time of transition constituted one field of research that informed this dissertation study. Two related bodies of literature informing this study were a historical examination of reform efforts in mathematics education and a comparison of traditional instructional methods to reform-oriented methods. The next chapter includes a review of the existing literature about these three areas of research as well as a description of the conceptual framework for this study.

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

For over a century, changes have been recommended for mathematics education in the United States (Klein, 2003; Lambdin & Walcott, 2007; Schoenfeld, 2004). Some recommendations resulted from a belief that if schools in the United States were more productive, the United States' global economic status would improve (Cuban, 1993; Schoenfeld, 2004). Other changes stemmed from concerns that the United States was falling behind other nations in mathematics and science proficiency (Burris, 2005; Daggett, Gendron, Heller, 2010; Klein, 2003; Reys & Reys, 2011). Some of the reform efforts in mathematics education are described in this chapter, with closer attention given to the most recent one: the CCSSM (CCSSI, 2010). Also described in this chapter are teaching methods modeled after suggestions intended to improve mathematics education, and instructional methods that are considered more conventional. Following the descriptions of the two teaching methods is a presentation of literature examining the beliefs of educators who are in a period of professional transition, along with some of the barriers they perceive to meeting the goal of their transition. Closing this chapter is an explanation of how the literature I examined formed the conceptual framework for my study.

History of U.S. Mathematics Education Reform

For more than the past century, mathematics education has been in a cycle of change (Klein, 2003; Lambdin & Walcott, 2007; Reys & Reys, 2011; Schoenfeld, 2004). Mathematics curriculum reforms were suggested as early as the late 1800s, when a standardized high school curriculum of algebra, followed by geometry and more algebra

was recommended (Reys & Reys, 2011). William Heard Kilpatrick, who was considered an influential leader in progressive education in the early 1900s, opposed those course recommendations and declared that studying algebra and geometry in high school was “an intellectual luxury” (Klein, 2003, p. 3). Which students would be offered the opportunity to learn mathematics beyond a single year of arithmetic or algebra remained a topic for debate through much of the 20th century (Schoenfeld, 2004). In *An Agenda for Action*, NCTM (1980) disagreed with elitism in offering mathematics courses, and years later the NRC (1989) and NCTM (1989) again promoted depth in the high school mathematics curriculum for all students.

Efforts to reform both mathematics curriculum and instructional practice in the United States continued throughout the 20th century and into the 21st century (Burris, 2005; Klein, 2003; Reys & Reys, 2011). At the beginning of the millennium, with *PSSM* (NCTM, 2000a) and the goal of mathematical proficiency (NRC, 2001), mathematics teachers and educational leaders were given suggestions for changes to improve mathematics education. The most recent reform effort, the CCSSM, recommends goals for instruction in both mathematics content and mathematical practice (CCSSI, 2010). *PSSM* and the CCSSM are described later in this chapter.

This section is an examination of changes in mathematics education beginning in the early part of the 1900s and continuing to the present day. The changes described here begin with the drill-and-practice phase of the 1920s and end with the publication of the CCSSM in 2010.

Drill-and-Practice

Thorndike and his theories about learning through connections (Bossé, 1995; Klein, 2003; Lambdin & Walcott, 2007; Lefrançois, 2006) were significant in the drill-and-practice era of the 1920s. He claimed that learning took place through the formation of bonds, or connections, between stimuli and responses (Klein, 2003; Lambdin & Walcott, 2007), and these bonds were created and strengthened through repeated practice (Klein, 2003; Lambdin & Walcott, 2007; Lefrançois, 2006). To prevent students from creating incorrect bonds in their learning, closely related mathematical ideas were not taught close together in time (Klein, 2003), and students had difficulty forming mathematical connections with their own previous learning or to the world around them. By the beginning of the 1930s, the trend in the United States was toward making the mathematics taught in schools more meaningful to the students.

Meaningful Arithmetic

With the 1930s and the Great Depression came a focus on learning mathematics as a life skill (Klein, 2003; Lambdin & Walcott, 2007). The focus in mathematics education turned from “an emphasis on drill for drill’s sake to a focus on attempting to develop mathematics concepts in a ‘meaningful’ way” (Lambdin & Walcott, 2007, p. 7). Brownell (1947) emphasized that meaningful arithmetic was not simply a reaction against traditional arithmetic, but was “instruction which is deliberately planned to teach arithmetical meanings and to make arithmetic sensible to children through its mathematical relationships” (p. 257). In the meaningful arithmetic era, there was an emphasis on mathematical relationships and connections as well as learning through real-world activities and problems (Lambdin & Walcott, 2007). In the 1940s, some

educational leaders questioned whether most students were intellectually able to attend college or have skilled occupations, and recommended high schools offer those students mathematics courses that were deemed appropriate, such as consumer buying and home budgeting (Klein, 2003). Despite increases in school enrollment, numbers and percentages of students enrolled in algebra and geometry decreased during the 1940s and 1950s (Klein, 2003; Schoenfeld, 2004). Fears that students in the United States were falling behind their international counterparts spelled the end of the meaningful arithmetic era and the beginning of the next era in mathematics education (Klein, 2003; Lambdin & Walcott, 2007; Schoenfeld, 2004).

New Math

A watershed moment in the history of mathematics education was the launching of the Russian satellite *Sputnik 1* in 1957 (Burris, 2005; Lambdin & Walcott, 2007; Schoenfeld, 2004). Recommendations for how mathematics should be taught and learned had previously gone through several phases (Klein, 2003; Lambdin & Walcott, 2007; Reys & Reys, 2011), but Russia's launching of the first space satellite focused attention on the quality of mathematics and science education in the United States (Burris, 2005; Klein, 2003; Lambdin & Walcott, 2007). Concern that the nation was falling behind the rest of the world triggered reforms that became known as New Math (Cuban, 1993; Klein, 2003; Lambdin & Walcott, 2007; Schoenfeld, 2004).

A participant in an early New Math conference characterized the beginnings of the New Math movement as “the collision between skills instruction [drill and practice] and understanding” (Bossé, 1995, p. 180). The New Math phase, which lasted through the 1960s and 1970s, was characterized by a focus on properties, proofs, and

mathematical structures (Burris, 2005; Lambdin & Walcott, 2007). High school mathematics curricula were organized into a recommended four-year sequence (Lambdin & Walcott, 2007) and abstract topics were introduced in earlier grades than before (Klein, 2003; Lambdin & Walcott, 2007; Schoenfeld, 2004). Censured for “instances in which abstractness [was] for its own sake” (Klein, 2003), New Math was criticized by students, parents, and often teachers. These groups were concerned and confused by the changes in mathematics education and questioned the usefulness of what was being taught (Klein, 2003; Lambdin & Walcott, 2007). The backlash against New Math led to the Back to Basics phase of the 1970s.

Back to Basics

The Back to Basics movement in mathematics education was characterized by an emphasis on rote memorization of prescribed algorithms and arithmetic facts by drill and practice (Burris, 2005; Klein, 2003; Lambdin & Walcott, 2007). Arithmetic was taught in the first eight grades of school, and algebra, geometry, and sometimes trigonometry were reserved for teaching in high school (Schoenfeld, 2004). The style of mathematics instruction during this period was similar to that of the 1920s and 1930s with its emphasis on rote memorization of facts and algorithms (Lambdin & Walcott, 2007). According to Schoenfeld (2004), this refocus on skills and procedures was “in compensation for the ‘excesses’ of the 1960s” (p. 258). This return to teaching basic mathematical skills did not produce the desired results, and mathematics educators were concerned that students were not being prepared for life beyond high school (Klein, 2003; Lambdin & Walcott, 2007). NCTM responded, and a focus on problem solving and critical thinking began (Burris, 2005; Klein, 2003; Lambdin & Walcott, 2007; Reys & Reys, 2011).

NCTM and Problem Solving

In its *An Agenda for Action* in 1980, NCTM recommended a new direction for school mathematics that included a focus on problem solving (Klein, 2003; Lambdin & Walcott, 2007; NCTM, 1980; Reys & Reys, 2011; Schoenfeld, 2004). With this document, NCTM (1980) also called for “at least three years of mathematics for all high school students” (Reys & Reys, 2011, p. 10). This suggestion was echoed by other professional organizations, and many states raised the number of mathematics courses required for students to graduate from high school (Reys & Reys, 2011). The recommendations in *An Agenda for Action* were organized and released as national standards or goals with the publication of *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). In addition to problem solving, these standards focused on meanings, communications, connections, and patterns (Burris, 2005; NCTM, 1989) and deemphasized paper-and-pencil computations, rote memorization of rules and algorithms, and finding exact answers (Klein, 2003; Lambdin & Walcott, 2007; NCTM, 1989). One characteristic of the problem-solving movement was a distinction made between teaching *for* problem solving and teaching *through* problem solving (Lambdin & Walcott, 2007). Part of the emphasis on problem solving was an emphasis on students working in groups and verbalizing their reasoning (Klein, 2003; Lambdin & Walcott, 2007; NCTM, 1989; Schoenfeld, 2004). In 2000, NCTM synthesized the standards documents released in 1989, 1991, and 1995 (Burris, 2005; Piburn & Sawada, 2000) and released its *Principles and Standards for School Mathematics*, or *PSSM* (NCTM, 2000a).

Earlier reform movements “focused on revising the content of school mathematics” (Sztajn, 2003, p. 55), but the suggestions in the 1980s focused also on how

to teach the content. *PSSM* made recommendations for what mathematical content students should learn as well as how they should learn it (Burris, 2005; NCTM, 2000a; NCTM, 2000b). The first five standards, which were goals in specific content areas (i.e., number and operations, algebra, geometry, measurement, and data analysis and probability), described what mathematics students should learn, and the second five standards described processes by which students should engage in learning the content (NCTM, 2000b). The five process standards in *PSSM* were problem solving, reasoning and proof, communication, connections, and representation (NCTM, 2000a). Teaching practices that actively engage students in these five processes contribute to what is called reform-oriented methods of instruction (Gabriele & Joram, 2007). These methods of mathematics instruction will be described later in this chapter.

CCSSM

In an effort to clarify what students are expected to learn and strengthen future United States citizens functioning in an international arena, the Common Core State Standards were published in 2010 by the National Governors Association Center for Best Practices and the Council of Chief State School Officers (Gurl, Artzt, & Sultan, 2012; Zbiek et al., 2012). According to the What Parents Should Know page of the CCSSI website, these standards “establish[ed] clear, consistent guidelines for what every student should know and be able to do in math and English language arts from kindergarten through 12th grade” (CCSSI, 2015, para. 1). Because of their widespread adoption, the Common Core State Standards approached consistency and unity in mathematics curriculum and education across the United States (Daggett et al., 2010; Gurl et al., 2012; Locke, 2012; Reys & Reys, 2011; Wu, 2011). The mathematics portion of these

standards, the CCSSM, is a “substantial answer” (CCSSI, 2010, p. 3) to the need for a curriculum that is more focused and coherent than mathematics curricula of the past (Klein, 2003; Reys & Reys, 2011; Schoenfeld, 2004).

The CCSSM comprise two sections: the SMC and the SMP (CCSSI, 2010), and together they express “expectations for improving the teaching and learning of mathematics” (Gurl et al., 2012, p. v). The high school SMC “specify the mathematics that all students should study in order to be college and career ready” (CCSSI, 2010, p. 57). These are not grade-level standards, but are organized for high school content into six broad, conceptual categories: number and quantity, algebra, functions, modeling, geometry, and statistics and probability (CCSSI, 2010). The CCSSM emphasizes that the SMC and the SMP are not designed to operate independently of each other. “Educators should not regard [the SMC] narrowly, as a checklist. Rather, CCSSM stresses that it is essential to connect its Standards for Mathematical Content with its Standards for Mathematical Practice” (Zbiek et al., 2012, p. 10). The second part of the standards, the SMP, plays a more prominent role in this study than do the SMC.

The SMP do not describe what teachers should do, but rather suggest goals for how students will demonstrate their mathematical proficiency (CCSSI, 2010). Recognizing the important roles NCTM and NRC played in mathematics education, the drafters of the SMP used the contributions made by those organizations (CCSSI, 2015). The process standards from *PSSM* (NCTM, 2000a) and the strands of mathematical proficiency (NRC, 2001) were incorporated into the eight SMP: make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate

tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning (CCSSI, 2010). The goals for mathematics instruction expressed in the SMP are evident in reform-oriented teaching methods, which are described in the next section.

Summary of Section

The historical progression described in this section culminated with the adoption of the CCSSM, which is the most recent event affecting mathematics education. These standards, specifically the SMP, “rest on important ‘processes and proficiencies’ with longstanding importance in mathematics education” (CCSSI, 2010, p. 6). The following area of literature examines reform-oriented teaching, which reflects the ideologies on which the CCSSM rest.

Reform-Oriented Instructional Methods

Reform-oriented instructional methods are those that attempt to utilize teaching methods espoused by efforts to reform education. In the case of mathematics education reform, the instructional methods currently referred to as reform-oriented reflect the recommendations described above by NCTM (2000a) and NRC (2001). As described in a previous section, this body of recommendations formed the foundation for the SMP (CCSSI, 2010), and teachers modeling reform-oriented methods will reflect these recommendations in their practice. Reflecting the connection with *PSSM*, reform-oriented teaching methods are frequently called standards-based methods. Described in this section are some characteristics of these methods and a description of how they differ from more traditional teaching methods.

Students' Role

In a reform-oriented classroom, the focus is on the students and their opportunities to learn (Hiebert, 2003; Hudson et al., 2006; Nesmith, 2008). With reform-oriented instruction, learning is an “active, social, and interactive process” (Hudson et al., 2006, p. 22). In a reform-oriented classroom, students talk more than the teacher does, and most of the students' conversations are with other students (Piburn & Sawada, 2000). Students are actively responsible for their own learning as they build connections between their existing knowledge and ideas and their new experiences (Battista, 1994; Hudson et al., 2006; Le et al., 2006; Lewis, 2014; Nesmith, 2008). To facilitate building connections, students engage in developing methods of solving real-life mathematical problems (Lewis, 2014) and presenting and defending their solutions to their classmates (Grouws & Cebulla, 2000). As part of their solution process, students work within a group and “learn to take responsibility for their learning and their peers' learning by formulating conjectures, presenting partial and sometimes incorrect solutions for peer feedback, and work to revise their and others' work” (Lewis, 2014, p. 400).

When students discover solutions to mathematical problems, as described above, they should struggle to develop and implement a solution path (Hiebert & Grouws, 2007; NCTM, 2014). Their struggle should not be “needless frustration or extreme levels of challenge created by nonsensical or overly difficult problems” (Hiebert & Grouws, 2007, p. 387). Rather, the productive struggle expected in a reform-oriented classroom involves “students expend[ing] effort to make sense of mathematics, to figure something out that is not immediately apparent” (Hiebert & Grouws, 2007, p. 387).

As evidence of their active learning, students make conjectures, discuss alternative problem-solving strategies, write reflections (Schoen, Cebulla, Finn, & Fi, 2003), engage in cooperative group discussions, agree and disagree among themselves, use exploration as a means of learning (Lloyd, 1999), and provide justifications for their solutions (Le et al., 2006). In short, students in a reform-oriented mathematics classroom are actively engaged in processes that will support the attainment of the SMP (CCSSI, 2011). The teacher's role in a reform-oriented classroom corresponds closely with the student's role. Characteristics of teachers' roles in reform-oriented instruction are described in the following section.

Teachers' Role

A teacher utilizing reform-oriented instructional methods encourages students to engage in the behaviors described above. Not so much responsible for planning a daily lecture, "the teacher's role in reform-based mathematics is to organize and plan appropriate experiences so students will construct mathematical meaning" (Hudson et al., 2006, p. 22). Teachers in a reform-oriented environment do not have central roles, but they do have active roles (Lewis, 2014; McWilliam, 2008). During instructional time, teachers using reform-oriented teaching methods are "facilitators for student-led explorations of mathematics, discussions, and development of mathematical ideas" (Lewis, 2014, p. 400). Teachers exhibiting characteristics of reform-oriented instructional methods are listeners, resources in student investigations (Piburn & Sawada, 2000), and "usefully ignorant coworker[s] in the thick of the action" (McWilliam, 2008, p. 265).

With *Principles to Action*, NCTM (2014), in an effort to provide support for teachers implementing reform-oriented instructional methods, described eight

Mathematics Teaching Practices, which “provide a framework for strengthening the teaching and learning of mathematics” (p. 9). Three of the practices in which teachers should engage are “facilitate meaningful discourse, pose purposeful questions . . . and support productive struggle” (NCTM, 2014, p.10). These three practices correspond with the student characteristics described in the previous section.

Teaching methods exhibiting few or none of the reform-oriented characteristics described above are considered traditional teaching methods. What follows is a description of traditional teaching methods.

Contrast with Traditional Methods

There is some evidence that teachers teach how they were taught, and those who did not observe reform-oriented methods when they were students find it more familiar to use traditional teaching methods in their own classrooms (Ball, 1988; Hiebert, 2003). These methods are teacher-centered (Hudson et al., 2006; McWilliam, 2008; Simon, Tzur, Heinz, Kinzel, & Smith, 2000) and focus on memorizing rules, executing procedures, and substituting values into formulas (Gabriele & Joram, 2007; Hiebert, 2003; Nesmith, 2008; Stigler & Hiebert, 1999). The emphasis on memorizing facts, rules, and procedures gives students a body of disconnected information (Cai, Moyer, Nie, & Wang, 2009).

Simon et al. (2000) described the students’ role in a traditional classroom as to “passively receive mathematical knowledge by listening to and watching others, usually mathematics teachers, and by reading about mathematics (in textbooks)” (p. 593). Comparably, Smith (1996) described the duties of a teacher using traditional teaching methods:

[The] teachers' central task is to provide clear, step-by-step demonstrations of each procedure, restate steps in response to student questions, provide adequate opportunities for students to practice the procedures, and offer specific corrective support when necessary. If students do not master a procedure, teachers should repeat their demonstration. (pp. 390-391)

In short, teachers using traditional teaching methods take a more active role in their students' learning than the students do (Hiebert, 2003; Hudson et al., 2006; McWilliam, 2008).

Teachers who previously used traditional instructional methods and adapted their style of teaching to use reform-oriented instructional methods can be described as in transition. The following section is an examination of literature about teachers during a period of transition.

Teachers in Transition

The previous sections in this chapter described mathematics education reform efforts in the United States, gave characteristics of reform-oriented instructional methods, and contrasted those methods with more traditional teaching methods. This section is an examination of literature concerning teachers who are in a period of transition in their teaching practice, specifically the transition from using traditional instructional methods to reform-oriented methods. Fennema and Nelson (1997) stated that “transition implies a passage or evolution from one . . . style to another. It is an active and never-ending process” (p. x). Others shared this view of transition as an ongoing process toward a goal (Goldsmith & Schifter, 1997; Simon et al., 2000). The motive for teachers to opt to use reform-oriented instructional methods could be “a desire to be current pedagogically, a

sense that existing teaching methods are not adequately serving some students,” (Goldsmith & Schifter, 1997, p. 46), or perceived pressure to conform to administrative demands (Barrett Paterson, 2009; Samaniego, 2013). Irrespective of their motivation, teachers play a vital role in the effort to reform mathematics education toward a standards-based manner of thinking and teaching (Battista, 1994; Charalambous & Philippou, 2010; Gooya, 2007; Le Fevre, 2013; Lloyd, 1999; Samaniego, 2013).

As teachers attempted to transform their teaching practice, Andreasen, Swan, and Dixon (2007) noted four stages through which the teachers progressed: (1) resisting change, (2) talking about changing, (3) mimicking change, and (4) changing practice. This progression could reassure or encourage the educators who find the process of altering their teaching practice to be challenging (Lloyd, 1999), “terrifying, seemingly unproductive, [or] frustrating” (Goldsmith & Schifter, 1997, p. 46). Additionally, transforming a style of teaching from traditional to reform-oriented “entails more than posing different problems [and] calling on different students. . . . It demands that teachers make changes in their basic epistemological perspectives, their knowledge of what it means to understand and thus learn mathematics” (Franke, Fennema, & Carpenter, 1997, p. 255).

The following section is an exploration of research on teachers’ beliefs about mathematics and how those beliefs affected their attempts to transform how they taught mathematics. A subsequent section is an examination of literature studying the barriers teachers found when undertaking the process of transitioning to using reform-oriented instructional methods.

Teachers' Beliefs about Mathematics

For the purpose of this literature review, teachers' beliefs are their "underlying assumptions about how students learn, the nature of subject matter, expectations for students, or what constitutes effective instruction" (Coburn, 2003, p. 4). Coburn's definition, although intended to describe the beliefs of any teacher, summarized the ideologies employed by mathematics teachers as they set goals regarding what and how to teach and also how they determine whether they successfully achieved those goals (Lloyd, 1999). However, when mathematics teachers are in the process of transforming their instructional methods, their beliefs can also be transformed (Coburn, 2003). Goldsmith and Schifter (1997) explained that "teachers' relationships with . . . mathematics itself begin to change as they become less intent on helping students acquire facts and procedures, and more involved in building on what (and how) their students understand" (p. 23).

Beliefs and practice. Researchers reported a relationship, albeit a complex one, between teachers' beliefs and their mathematical classroom practice (Franke et al., 1997; Handal & Herrington, 2003; Mewborn & Cross, 2007). Handal and Herrington (2003) described how some researchers found it difficult to determine causality in the relationship between beliefs and practice, with some studies reporting teachers' beliefs influencing practice and others suggesting instructional practice influencing beliefs. Mewborn and Cross (2007) reported that teachers' beliefs could affect how they approached instruction and cited several contrasting beliefs that would influence a teacher's decision between using traditional instructional methods or reform-oriented ones. One of the pairs of contrasting beliefs listed was whether the goal of working a

mathematics problem was to determine the correct answer or “to make sense of the problem, the solution process, and the answer” (Mewborn & Cross, 2007, p. 259).

Another pair of contrasting beliefs portrayed the student in a passive role and the teacher in an active role versus both the student and the teacher assuming an active role in the learning process. Teachers’ beliefs as they relate to reform efforts are explored further in the following paragraph.

Beliefs and reform. Although several authors (e.g., Battista, 1994; Franke et al., 1997; Handal & Herrington, 2003; Lloyd, 1999) discussed the role played by teachers’ beliefs during a period of reform, the authors did not examine the same aspects of teacher beliefs during educational reform. In one study of teachers during a reform effort, equal groups of teachers occurred in one of three categories: teacher beliefs changed before practice, classroom practice changed before beliefs, or changes in beliefs and practice were concurrent (Franke et al., 1997). The researchers in that study concluded a change in teachers’ beliefs was required in order for the teachers to make substantial changes in their classroom practice (Franke et al., 1997). When a reform effort requires teachers to reconceive their instructional role, the enactment of the reforms “can pose significant challenges even to the most committed teachers” (Lloyd, 1999, pp. 228-229). When educators were not as committed to making changes as the teachers just described, their beliefs that were incompatible with the reform efforts were able to cause problems with or even block the implementation of the reform itself (Battista, 1994; Handal & Herrington, 2003). Some of the factors that adversely affected educational reform were a mismatch between the promoted curriculum and the tested one, teachers designating importance to their existing instructional practices, and a mismatch between teachers’

beliefs and the school system's curriculum goals (Handal & Herrington, 2003). The following paragraphs describe research studies in which teachers' beliefs altered or impeded instructional reform efforts.

Although teachers' beliefs can block reform efforts (Battista, 1994), some studies found that the participants' beliefs about teaching mathematics redirected the intended reform (Gooya, 2007; Samaniego, 2013; Sztajn, 2003). Teachers whose beliefs prevented them from abandoning their previous instructional methods for reform-oriented ones thought of themselves as using two entirely different styles of instruction (Samaniego, 2013). The participants referred to the days they used reform-oriented teaching methods as CCSSM days, and labeled the days they used traditional methods with the name of their state's exit exam (Samaniego, 2013). In another study, geometry teachers were involved in a reform process that resulted in a curriculum and an approach to teaching that was dramatically different from the teachers' previous one. The researcher found that the teachers in that study recognized they omitted problems and activities from their reform materials when the problems and activities did not align with the teachers' existing beliefs about mathematics (Gooya, 2007). Two other studies (Moore, Edwards, Halpin, & George, 2002; Sztajn, 2003) described teachers who chose which portions of their current reform documents and of their new curriculum they would use based on their beliefs about what was appropriate for their students.

Perceptions about reform. Rather than selecting reforms based on the students' perceived needs, Samaniego (2013) found high school mathematics teachers enacted or rejected certain reforms based on their own perceived features of each reform and how that reform aligned with the teachers' beliefs about teaching mathematics. If the teachers

did not understand a reform, or if a reform did not align with the teachers' beliefs, the teachers opted to reject rather than enact that reform (Samaniego, 2013). Regardless of their beliefs, teachers enacted reforms they assumed would help their students score well on the state exit exam for that course (Barrett Paterson, 2009; Hargreaves, 1998; Samaniego, 2013), and they enacted reforms that produced performance data for which the teachers were held responsible (Samaniego, 2013). The participants of the research studies described in this paragraph purposefully altered recommended reforms based on their own beliefs about teaching mathematics. The next paragraph describes teachers who did not recognize they had not implemented their school system's reforms in the manner they were intended to be.

One study of high school mathematics teachers reported that teachers' beliefs and experiences played a role in how they interpreted and implemented the CCSSM (Javier, 2015). Although the study's participants professed positive beliefs about the CCSSM, Javier (2015) described how their descriptions of key features of the standards showed a disconnect between their beliefs and their instructional practice. Similarly, mathematics teachers from a variety of grade levels strongly expressed their beliefs in some of the major principles of reform-oriented instructional methods, but, when they were observed, their actual teaching practice did not reflect the reform methods they claimed to advocate (Barrett Paterson, 2009).

Formation of beliefs. Studies explained that teachers' beliefs were often formed when they were students in traditional classrooms (Coburn, 2003; Gwyn-Paquette & Tochon, 2003; Nesmith, 2008). Teachers who learned in those traditional backgrounds found it simpler and more comfortable to use the methods with which they were familiar,

even when their methods were in contrast with reform efforts (Coburn, 2003). As Nesmith (2008) explained, teachers “are part of the system they are being asked to change” (p. 4). Preservice teachers begin training for their careers when they begin kindergarten, and the remaining years are an observation period during which the teachers form their beliefs about mathematics and about teaching (Ball, 1988; Gwyn-Paquette & Tochon, 2003). Le Fevre (2014) described teachers’ attempts to abandon the methods by which they were taught as possible “institutional homicide” (p. 57). Studies found that the beliefs some teachers formed during their tenure as students were difficult to abandon in order to meet the expectations of suggested reforms (Coburn, 2003; Gwyn-Paquette & Tochon, 2003; Nesmith, 2008). In short, teachers often teach how they were taught (Ball, 1988, 2003; Battista, 1994).

Summary of beliefs section. This section examined the relationship between teachers’ beliefs and efforts to reform mathematics education. Some of the studies described how teachers altered reforms to correspond with their own beliefs (Gooya, 2007; Samaniego, 2013; Sztajn, 2003), and other studies found the development of teachers’ beliefs was an explanation for teachers’ reluctance to implement reforms (Coburn, 2003; Le Fevre, 2014; Nesmith, 2008). The following section explores other barriers for teachers attempting to transition to employing reform-oriented instructional methods.

Barriers to Transition

The previous section examined beliefs teachers maintain about mathematics and about teaching. When teachers’ beliefs are in opposition to reform efforts, or when they perceive barriers to the reforms, then it is unlikely the reform will unfold as it was

intended (Handal & Herrington, 2003). In some cases, teachers balked at implementing recommended reforms because they simply found it was easier to continue teaching using the methods they had always used (Zimmerman, 2006). In one study, the teachers who were most critical of the reform efforts were also the most comfortable with the methods to which they had been accustomed (Charalambous & Philippou, 2010). The following paragraphs describe literature concerning the various barriers that teachers perceive to their implementing reform-oriented instructional methods. The studies described below fell into two categories: barriers to transition related to the classroom and barriers to transition related to the teachers.

Barriers related to the classroom. Several authors described teachers' coping with what was unfamiliar to them as a barrier to their implementing recommended reforms. In two instances, the authors described the anticipation of change itself as inspiring fear in the teachers (Goldsmith & Schifter, 1997; Zimmerman, 2006). In addition to the unfamiliarity of an actual change, teachers resisted reform efforts when they considered unclear or insufficient the information they had been given about the impending reforms (Fullan & Miles, 1992; Handal & Herrington, 2003). Fullan and Miles (1992) described the problem that teachers perceived: "It's hard to get to a destination when your map doesn't accurately represent the territory you're to traverse" (p. 744). Studies of barriers to transition that related to the classroom comprised three groups: teachers' abilities to implement the reform, resources needed to support the reform, and time needed to plan for and teach using reform-oriented methods. The following paragraphs describe those three categories of barriers.

Teachers' abilities. Similar to being deterred by the unfamiliar from implementing reform efforts, studies found some teachers questioned their abilities to meet the demands of reform successfully. Two authors described teachers as believing they simply did not know enough to implement the changes they were asked to make (Charalambous & Philippou, 2010; Handal & Herrington, 2003). Results of another study (Nesmith, 2008) specified teachers' needing a new type of mathematical knowledge (Ball, 2003) was a barrier to their transitioning their classroom practice. Several authors explained that in order to transition from using traditional instructional methods to reform-oriented ones, teachers needed a new skill set for their classroom practice (Battista, 1994; Goldsmith & Schifter, 1997; Gwyn-Paquette & Tochon, 2003; Handal & Herrington, 2003).

Lack of resources. Rather than lacking the skills they needed to implement reforms in their teaching practice, some teachers expressed their lack of necessary resources as a barrier to their implementing reform efforts (Charalambous & Phillipou, 2010; Handal & Herrington, 2003). Le Fevre (2014) found that teachers were frustrated by their inability to find or create the perfect lesson to utilize in their mathematics classrooms. Another resource barrier to transition mentioned in study results was the reliance on textbooks being reduced or even removed (Le Fevre, 2014; Nesmith, 2008). Le Fevre (2014) explained that teachers were encouraged to incorporate a wide range of resources when planning reform-oriented lessons for their classes.

Time constraints. Teachers' concern about time also emerged in studies as a barrier to teachers' transforming their instructional practice. Although one study found that teachers considered their loss of control of time as a barrier to implementing change

(Le Fevre, 2014), other studies cited the lack of adequate classroom and planning time as a barrier (Charalambous & Phillipou, 2010; Terhart, 2013; Timperley & Robinson, 2001). Charalambous and Phillipou (2010) specified that teachers felt they did not have adequate time to cover their entire mathematics curriculum.

Like the barriers to transition described above, the ones in the next section are also barriers to teachers' transitioning their instructional methods to more reform-oriented methods. The above barriers relate more directly to teachers' classroom practice, and the ones in the next section relate more to teachers' perceptions that lead to barriers.

Barriers related to teachers. Some teachers felt they were forced to participate in reform efforts, and their perceived lack of control emerged as a barrier to transitioning their classroom practice (Moore et al., 2002; Terhart, 2013). Many teachers, especially those who were considered experienced teachers, resented being required to make changes, rather than being given the opportunity to actively pursue the changes for themselves (Moore et al., 2002). Some teachers felt justified in not having pursued changes by their perception that previous reform efforts had failed or been abandoned (Terhart, 2013; Zimmerman, 2006). Studies in the second category of barriers to transition, those related to teachers, included three categories: concerns related to students, anxieties about teachers' evaluations, and frustration with perceived conflicting agendas. The following paragraphs elaborate on those categories.

Teachers and students. Several studies found barriers to teachers' transitioning their classroom practice that focused on students, their behavior in the classroom, and their learning. One barrier mentioned by teachers was that students were accustomed to traditional mathematics classrooms and were not prepared for the abrupt shift to reform-

oriented teaching methods (Timperley & Robinson, 2001). One study found that because of the dissimilarity between a reformed style of teaching and a traditional style, teachers believed the reform-oriented methods were appropriate for only their high-performing students (Desmione, Smith, Baker, & Ueno, 2005). The teachers believed that, with the exception of the high-performing students, their classes could not adapt to the recommended methods of instruction (Desmione et al., 2005). Teachers accustomed to using traditional instructional methods and evaluating their students' performance on procedural tasks perceived they would be unable to recognize evidence of their students' understanding of mathematical concepts, as the evidence would be demonstrated using reform-oriented techniques (Gabriele & Joram, 2007).

Le Fevre (2014) reported a barrier to teachers' implementing reform recommendations was their perception of a loss of control in their classrooms. Teachers believed that without the structure of a traditional lesson, they could not manage their students' behavior and the classroom would appear chaotic (Le Fevre, 2014). Needing to be their students' instructional safety net was another perception held by teachers that impeded their using reform-oriented instructional methods (Goldsmith & Schifter, 1997; Hiebert & Gruows, 2007). Teachers who do not allow productive struggle in their classrooms "want students' learning to be painless and continually progressive. . . . Teachers who feel responsible for safeguarding their students from feelings of frustration or temporary lack of success may find it difficult to watch students struggle with ideas" (Goldsmith & Schifter, p. 47).

Evaluating teachers. Educators' employing reform-oriented instructional methods reported trouble determining their success as teachers, because their criteria for

success had shifted from ability to demonstrate mathematical procedures to facility for helping students understand mathematical concepts (Gabriele & Joram, 2007). Teachers no longer determined their value based on the quantity of skills their students learned in a given amount of time (Ponticell, 2003). Another perception maintained by teachers was a belief that they would lose their previous success rate on state-mandated tests, as a result of their transition to using reform-oriented teaching methods (Ponticell, 2003). To the teachers, their loss of exit exam success meant they would be considered failures as teachers (Ponticell, 2003).

Conflicting agendas. Similar to teachers' concerns about their loss of standing was their dissatisfaction with what they considered "attempts to implement multiple, sometimes even conflicting agendas" (Le Fevre, 2014, p. 57). Mayer (1998) reported that teachers' anticipation of a mismatch between the recommended reforms and existing standardized tests was an obstacle to teachers' implementing the reforms. Teachers described being expected to implement reform-oriented instructional methods, although the standardized tests they administered assessed computational skills (Handal & Herrington, 2003; Le Fevre, 2014; Mayer, 1988; Nesmith, 2008). Terhart (2013) reported teachers' description of existing in two worlds: one for recommended reforms and one for their actual practice.

Summary of barriers section. Regardless of whether teachers supported reform efforts in mathematics education, they perceived barriers to implementing those reforms. In the studies described above, one group of literature centered on perceived obstacles in the classroom, and one group of literature focused on perceived barriers regarding the teachers. Classroom-related barriers maintained by teachers included their lack of ability

(Charalambous & Philippou, 2010; Handal & Herrington, 2003; Nesmith, 2008), resources (Charalambous & Philippou, 2010; Handal & Herrington, 2003; Le Fevre, 2014; Nesmith, 2008), and time to use the prescribed teaching methods (Charalambous & Philippou, 2010; Le Fevre, 2014; Terhart, 2013; Timperley & Robinson, 2001). Barriers perceived by the teachers relating to themselves included concerns for their students (Desmione et al., 2005; Le Fevre, 2014; Timperley & Robinson, 2001), for their evaluations (Gabriele & Joram, 2007; Ponticell, 2003), and about following two different agendas (Le Fevre, 2014; Mayer, 1998; Nesmith, 2008; Terhart, 2013).

The following section explains how the literature presented in this chapter, along with the research problem and the methodology, form the conceptual framework for this study.

Conceptual Framework

The conceptual framework is an opportunity for me, as the researcher, to clarify what I intended to investigate and how I intended to achieve my goal (Bloomberg & Volpe, 2012). An indicator of my intent was the phrasing of my research questions, which are framed from a teacher's perspective. I wanted to know how teachers, when attempting to reform their practice relative to their state's adoption of the CCSSM, perceived their abilities to complete the transition process; what criteria they used to determine their success; and what obstacles they perceived during their transition process. My purpose with this study was neither to determine whether the participants were achieving the goals described in the CCSSM (CCSSI, 2010) nor to establish whether they should attempt to achieve those goals.

To achieve my goal of learning about teachers' beliefs and perceptions, I wanted to collect data that used the participants' own words. I designed surveys, interview protocols, and writing prompts that would allow the participants to express the thoughts and opinions they maintained about their teaching practice and the changes they were experiencing at that time. These data collection instruments are described in the following chapter. Because they would yield data outside the scope of my study, I chose not to use instruments that would measure reformed teaching, such as the Reformed Teaching Observation Protocol (Piburn & Sawada, 2000).

When I selected the literature to review for this study, I purposefully avoided research that investigated the instructional methods with which students experienced greater success. Those studies would not further the achievement of my research goals. My intent with my examination of the literature was to create an image of historical efforts to reform mathematics education in the United States, form a clear picture of reform-oriented and traditional instructional methods, and learn what teachers have experienced while they attempted to reform their teaching practices. From the history of mathematics education reform and the comparison of instructional methods, I was able to build a foundation that helped me frame my research questions and empathize with the participants. The insights I received from my examination of studies regarding teachers during periods of transforming their teaching practices informed the connection between the data I collected, how I analyzed it, and how it revealed the individual and comparative case descriptions.

Chapter Summary

For over a century, mathematics education in the United States has been the focus of reform efforts. Recommendations from NCTM (2000a) and the NRC (2001) formed the foundation for the most recent attempt to improve mathematics education: the CCSSM (CCSSI, 2010). Educators who altered their teaching practice in order to achieve the goals for instruction described in the CCSSM shifted from a lecture-based, teacher-centered classroom to an active, student-centered environment. The ease and success of the transition between the two styles of teaching was influenced by the beliefs the teachers maintained about teaching and about mathematics, and by their perceived obstacles to implementing new instructional methods. This qualitative research focused on three teachers during a period of transition like the one described above, and the next chapter describes the methodology I used for my case study. The literature reviewed in this chapter influenced the methodology for my study, as I described in the conceptual framework.

CHAPTER THREE: METHODOLOGY

Introduction

Research exists on mathematics teachers' need to reform their methods of teaching (Ball, 2003; Boaler, 2002; Eisenhart et al., 1993) and suggestions have been made regarding what changes they should make (Dean, Hubbell, Pitler, & Stone, 2012; NCTM, 2000a; NRC, 2001). With the adoption of the CCSSM and state end-of-course tests aligned with these standards, teachers in many states recognize they need to make recommended reforms in their teaching practice (Bostic & Matney, 2013; Davis et al., 2013). Many teachers, in response to recommendations by the SMP (CCSSI, 2010), have attempted to change how they teach more than what they teach (Hobbs, 2012; Strauss, 2011; Wilkerson, 2011). Although research exists on the need for teachers to reform and how they should reform, little research exists about the teachers themselves and how they feel about the transition they are attempting to make.

In this dissertation study, three Algebra I teachers were examined as they attempted to transition their teaching style to a manner more aligned with the reform-oriented methods necessary to meet the expectations of the SMP. The particular focus of this examination was the teachers themselves and their beliefs and perceptions about their abilities and success as reform-oriented teachers. Also of importance in this study were the obstacles that these teachers believed impeded their attaining their goal. In this chapter is a brief background of this study, an explanation of the research design, a description of the data that was collected and how it was analyzed, and finally some caveats about the study.

Background of Study

Early in 2013, I became involved with Teaching Algebra (a pseudonym), a professional development project described later in this chapter. Part of my involvement in the project was as a member of the team conducting the professional development, and I discovered that three of the participants in Teaching Algebra taught Algebra I at the same high school. Throughout the professional development, I recognized that they composed an informal collaborative team. Only one of the three participants had taught Algebra I the previous year, but they would all be teaching Algebra I together during the upcoming school year. The participant who was a returning Algebra I teacher had been part of a collaborative Algebra I team at the school the previous year, and I expected she and the remaining two participants would continue that practice. In addition to the participants' working together, I perceived that all three had positive attitudes about transitioning to the CCSSM and planned to teach using reform-oriented methods. Because of these characteristics shared by the three teachers, I identified them as potential participants for further study.

Research Questions

Prior to data collection, I presumed the three participants, described in the previous paragraph, would follow through with their plans to teach using reform-oriented methods and also presumed they would continue to collaborate as they had during the professional development and as the Algebra I team before them had done. Anticipating these behaviors, I framed my study around learning the following: (1) how Algebra I teachers who are transitioning from using traditional instructional methods perceive their abilities to teach using reform-oriented instructional methods, (2) how these teachers

perceive their success as reform-oriented teachers, and (3) how they collaborate with other teachers to find, adapt, and create meaningful instructional tasks. Early in the data collection process, however, I recognized that the participants had not persisted with their efforts to transition their teaching styles, nor had they maintained the collaborative behaviors that had been exhibited in previous years. The following paragraph describes how the research questions were reshaped to accommodate the evolving picture of the participants that was revealed as the data was collected.

Patton (2002) warned that qualitative research cannot be completely determined in advance. The qualitative researcher must be prepared for the research problems and methodology to “evolve as understanding of the research context and participants deepens” (Gay, Mills, & Airasian, 2009, p. 7). Creswell (2007) described qualitative research methodology as emerging as it is shaped by “the researcher’s experience in collecting and analyzing the data” (p. 19) and explained that the researcher “continually revises questions from experiences in the field” (p. 17). From the information that was revealed during the data collection phase, I recognized that the original guiding questions for the study were no longer appropriate. I reshaped the questions to reflect the “new paths of discovery” (Patton, 2002, p. 40) revealed during data collection and analysis:

1. How do Algebra I teachers who are attempting to transition from using traditional instructional methods perceive their abilities to teach using reform-oriented instructional methods?
2. What are the criteria teachers attempting to transition from teaching with traditional methods utilize to determine their success as reform-oriented teachers?

3. What obstacles do teachers face as they attempt to transition from teaching with traditional methods?

Although the questions guiding the research were revised during the data analysis process, a qualitative case study methodology remained the logical choice to reveal more information about teachers who were attempting to transition their teaching methods. The following section is a description of the methodology and the sampling strategy that were used in this study.

Research Design

In designing this study, I reflected on what I wanted to learn from the study and evaluated what research methodology was appropriate as well as what sampling strategy should be used. This section explains the decisions I made about the design of the study and presents the rationale for those decisions.

Qualitative Case Study Methodology

Through this study, I sought insight into the participants' beliefs and perceptions about their attempting to implement the teaching methods they used in their Algebra I classes and recognized that using qualitative research methods would provide me with that insight. Gay, Mills, and Airasian (2009) explained that "the effort to understand the participants' perspective requires researchers using qualitative methods" (p. 7). This view is shared by Creswell (2007) as his list of characteristics of qualitative research included "reality is subjective and multiple, as seen by the participants in the study" (p. 17). In addition to understanding the participants' viewpoint, the qualitative researcher can "obtain in-depth understandings about the way things are, why they are that way, and how the participants in the context perceive them" (Gay et al., 2009, p. 12). Further,

Patton (2002) explained that in order to “know what [a topic] *means* to them, how it affects them, how they think about it, and what they do about it, you need to ask them questions, find out about their experiences, and hear their stories” (p. 13). After concluding that qualitative research methods were appropriate for this study, I then had to determine which form of qualitative research to use. The following paragraph describes how I identified case study research as the appropriate method to obtain the in-depth information I needed for this study.

Yin (2014) described case study research as investigating “a contemporary phenomenon in depth and in its real-world context” (p. 237). In case study research, the phenomenon being examined exists within boundaries defined by time, setting, context, or event (Creswell, 2007; Patton, 2002; Yin, 2014). Yin (2014) explained that the boundaries for the case can be ambiguous, but will “help to determine the scope of [the] data collection” (p. 34). Distinguishing itself from other qualitative research methodologies, case study research does not attempt to explore the life of an individual, understand an experience, develop a theory, or interpret a culture, but instead it has as its goal the development of an in-depth description of a case (Creswell, 2007). Yin (2014) explained that the research questions help determine when to use case study research. Three conditions determine when case study research is the appropriate research method: (1) the research questions ask how or why, (2) the researcher has no control over the events studied, and (3) the focus is on contemporary, rather than entirely historical, events (Yin, 2014). Table 1 describes how this study met those criteria.

Table 1

Case Study Research Criteria

Criteria	Study
How or why research questions	I described <i>how</i> participants, who were attempting to transition to teaching using reform-oriented methods, perceived their ability and success.
Researcher's control of events	The participants conducted their customary teaching and planning activities throughout a typical school day.
Contemporary events	The participants were, at the time of the study, attempting to transition to using reform-oriented teaching methods.

Based on the information in Table 1, case study research was appropriate for this study. More specifically, this was a multiple-case study. In this type of case study, also called a collective case study, “one issue is selected . . . but the inquirer selects multiple case studies to illustrate the issue” (Creswell, 2007, p. 74). The issue in this study was how teachers who were attempting to transition from using traditional methods of teaching to more reform-oriented methods perceived themselves, their successes, and the obstacles they faced during that transition. The data collection was confined to three Algebra I teachers in a single high school. The case description from this study is a description of each of the participants’ efforts to transition to a reform-oriented style of teaching plus a cross-case comparison among the three cases. For the cross-case comparison, I examined “the results for each individual case and then [observed] the pattern of results across the cases” (Yin, 2014, p. 238). The case description does not

attempt to explain, interpret, or theorize on the decisions the participants made, according to Creswell's (2007) specification. Rather, it attempts to provide an in-depth description of the participants' beliefs and perceptions throughout the duration of the study.

Sampling Strategy

In addition to determining qualitative case study as the research methodology used in this study, I also decided on purposeful sampling as the sampling strategy for this study. The participants in this study were also participants in the Teaching Algebra program and were purposefully selected based on their ability to "inform an understanding of the research problem" (Creswell, 2007, p. 125). I wanted to study Algebra I teachers who planned to alter their teaching in favor of a reform-oriented style, and who possessed a knowledge of and experience in observing reform-oriented teaching methods. In purposeful sampling, "the researcher selects the sample using his experience and knowledge of the group to be sampled" (Gay et al., 2009, p. 134). In addition, participants are selected based on their ability to contribute information to the study (Creswell, 2007; Patton, 2002). Patton (2002) claimed the "logic and power of purposeful sampling" (p. 46) is in its ability to provide in-depth understanding and recommended selecting cases that are "information rich" (p. 40) in order to learn a great deal about the issues important to the research.

Given the three participants' backgrounds and experiences, I determined that they could make a distinctive contribution to an understanding of the research problem. Through Teaching Algebra, they had studied reform-oriented instructional methods and had also experienced being students in sessions that were taught using these same methods. In addition, they expressed a desire to implement what they had learned in their

own teaching practices. The criteria mentioned above resulted in my purposefully selecting these three participants for this study. The following section is a description of the school system and the school where the three participants taught Algebra I. This school system and school provided the research context for this study.

Research Context

During 2013-2014, which was the school year in which data were collected for this dissertation study, King County School District, the participants' employer, was a school system of approximately 4,600 students and was located in the central part of a southeastern state. (King is a fictitious name used to protect the school system's identity.) According to its state's Department of Education website, approximately 59.1% of the students in the school system were classified as economically disadvantaged. The ethnic breakdown of King County Schools, during the 2013-2014 school year, was 90.9% Caucasian, 5.2% Hispanic, 3.0% African American, and 0.9% of other ethnic classifications. King County High School (also a fictitious name), where the three participants were teachers, was the only high school in the school system. At the time of this study, the school served approximately 1,700 students and had an ethnic breakdown similar to that of the school system. The three participants in this study comprised the Algebra I department at King County High School.

I became familiar with King County High School through Teaching Algebra. This externally-funded project supported the implementation of the CCSSM by providing professional development to high school mathematics teachers. The goals of Teaching Algebra were (1) to improve teachers' content knowledge in the areas of algebra, functions, and modeling, and (2) to improve teachers' pedagogical practices. In order to

meet the goals, Teaching Algebra participants engaged in pre- and post-classroom observations, four Saturday meetings, and one five-day summer workshop. During the summer workshop, the participants completed content assessments, open-ended surveys, written reflections, and interviews. At the end of the workshop, the participants were given a \$200 allowance in order to purchase classroom materials of their choosing. The materials could include consumable supplies, such as pads of chart paper, or nonconsumable supplies, such as books of mathematical tasks. Teaching Algebra spanned the 2013 calendar year.

Although I am a veteran high school mathematics teacher, I had not taught in King County and was not familiar with King County High School before my work with this professional development project. A description of each participant in this study is part of each participant's individual case, which is presented in the following chapter.

Data Collection and Timeline

To develop the case description, Creswell (2007) recommended the researcher utilize "detailed, in-depth data collection involving multiple sources of information" (p. 73). Sources of information for case study research include direct observations, interviews, documents and reports, and participant observations (Creswell, 2007; Yin, 2014). Following Creswell's (2007) and Yin's (2014) recommendations for data collected in qualitative case study research, the sources for information in this study were documents, interviews, and observations. Each of these sources is explained in this section, and also described in this section is the researcher as an instrument in the study.

Documents

The participants' responses to two types of documents (i.e., surveys and reflective writings) served as data sources in this study. I asked the participants to complete three different surveys: a Participant Background Survey (see Appendix A), a Participant Beliefs Survey (see Appendix B), and a Survey of Teacher Mathematical and Discourse Beliefs (see Appendix C). In addition to responding to the three surveys, the participants also provided reflective responses to writing prompts provided by the researcher. Each of these documents is described in the following paragraphs.

In early November of 2013, I obtained approval from my university's Institutional Review Board (see Appendix D) and began collecting data for this study. To begin the data collection phase, the three participants completed a Participant Background Survey (see Appendix A) and a Participant Beliefs Survey (see Appendix B), both of which I designed. The intent of the Participant Background Survey was to acquire information regarding each participant's educational and teaching history. The participants' responses to the Participant Background Survey were in narrative form and included a combination of short-answer questions and elaborations on the answers to those questions. The intent of the Participant Beliefs Survey was to gain insight into the participants' attitudes and familiarity with the CCSSM. The Participant Beliefs Survey contained five-point Likert scale items and included an area for the participant to explain the response for each item. For each of these surveys, the participants had the option of a paper copy to complete by hand or a digital copy to complete using Microsoft Word, and each participant chose to complete the surveys electronically. I e-mailed each participant the surveys, which they completed and returned to me via e-mail.

Also at the beginning of the study, the participants were asked to complete the Survey of Teacher Mathematical and Discourse Beliefs (Lishka, 2012). This multiple-choice survey measured “beliefs about the nature of mathematics, teaching mathematics, learning mathematics, and classroom discourse” (Lischka, 2012, p. 57). I used the information gleaned from this survey to craft writing prompts and interview topics for the participants. As with the other surveys, the participants had the option of a paper copy to complete by hand or a digital copy to complete using Microsoft Word. Again, each participant chose to complete the survey electronically, receiving and returning the survey via e-mail.

Reflective responses to writing prompts were a second type of document used for information in this study. I e-mailed each of the three participants the same set of writing prompts. The prompts asked the participants’ feelings about upcoming lessons, self-evaluations on recently taught lessons, and thoughts on reform-oriented instructional methods. Additional topics were included as extensions to topics introduced in earlier writings (see Appendix E for writing prompts). The participants had the option of when throughout the day to respond to the writing prompts, and they returned the writings to me via e-mail when they were completed. Two of the participants chose to respond to some of their writing prompts orally rather than in writing. In this case, I audio recorded the participants’ responses and included the transcripts with the written responses. The intent of the reflective responses was to illuminate the participants’ perceptions of their abilities, their criteria for and evaluation of their success as reform-oriented teachers.

Interviews

The documents previously described were the largest source of data in this qualitative research study, but another important source of information was interviews with the participants. Each participant was interviewed at the beginning of the study and more than once throughout the study, and all three were interviewed as a group at the end of the study. Each initial interview took place in early November, after the participants had completed their background survey and beliefs survey. From these interviews, I gained insight into the participants' own educational experiences and had an opportunity to follow up on any responses that needed clarification from the background survey and the beliefs survey (see Appendix F for the Initial Interview Protocol).

In addition to the initial interviews, the participants were each interviewed three times over the course of the study. All of the interviews were conducted by me, and I used the Participant Interview Protocol (see Appendix G) as a guide. The same protocol was used for all of the interviews, but the “actual stream of questions . . . [was] fluid rather than rigid” (Yin, 2014, p. 110). The purpose of some of the interview questions was to gain new information from the participants, while the purpose of other questions was for clarification on reflective responses to writing prompts.

Two of the participants, Joyce and Kathy, were each part of additional interviews, which were conducted following my observation of their teaching an algebra lesson. Joyce was observed and interviewed one time, and Kathy was observed and interviewed two times. These postobservation interviews did not follow a predetermined protocol, but were an opportunity for me to gain insight into the participants' thoughts about what had

transpired during the observations. The classroom observations are described in the observations section, which follows this interviews section.

In early March of 2014, the data collection phase of the study ended with my conducting an interview with all three participants. I created and used a protocol to guide the final interview (see Appendix H for the Final Interview Protocol), but, as in previous interviews, I used the participants' responses to produce additional questions that were not on the protocol. Although I had observed informal interactions among the participants, the final interview was an opportunity to observe their collaborating on responses to questions and plans for the following school year.

With the exception of one interview conducted at the participant's request via telephone, all of the interviews were conducted in person and occurred either during the participant's planning period or after school. The time of each interview was determined by the participant being interviewed. The individual interviews, including the initial and postobservation interviews, averaged 15 minutes in length, and the final interview lasted 40 minutes. All interviews were audio recorded, and I occasionally made brief notes throughout the interviews. I used the transcripts of the interviews and my notes to analyze the insights revealed through the participants' interviews. Information for each of the three research questions was ascertained from these interviews. From the interviews, I gained insight into the participants' perceptions about their abilities and judgments about their successes as reform-oriented teachers and also what obstacles they believed were impeding their success.

Observations

As previously mentioned, I had the opportunity to observe two of the participants as they each taught an algebra lesson. Part of the Teaching Algebra project included a pair of researchers from the project observing each participant teaching in his or her own classroom. Although I was a researcher on this dissertation study and with Teaching Algebra, I was not assigned to observe the three participants in the dissertation study for the purpose of collecting data for Teaching Algebra. Joyce's and Kathy's scheduled observations for Teaching Algebra occurred during the data collection phase of this dissertation study, and I was given permission by the participants to be an additional observer during the lessons. Because Michael's scheduled observation occurred before data collection for this study began, I was not able to observe his teaching and collect data for this dissertation study. As Joyce and Kathy taught their scheduled lessons, each of which occurred during a single class period, I observed and made field notes. Within a day of observing the lesson, I conducted a postobservation interview with each participant. The postobservation interviews were described in the previous section.

Early in the second semester, Kathy shared with me her plans for an upcoming lesson and agreed to my observing that lesson. Unlike the previous observed lesson, this one occurred over a two-day period, and I observed all six classes taught by Kathy on both days. I took field notes on both days and also made notes of follow-up questions for the participant. Over the course of the two days, Kathy and I engaged in several informal conversations, which I summarized in my field notes. Because of the ongoing conversations, the postobservation interview for this lesson was brief and was not audio

recorded. In my field notes, I included notes from the interview. Neither Joyce nor Michael taught another reform-oriented lesson for me to observe.

Researcher

The documents, interviews, and observations described above were measuring instruments in this study, and I, as the researcher, was another measuring instrument (Patton, 2002). As “instrument[s] of both data collection and data interpretation” (Patton, 2002, p. 50), qualitative researchers must provide a description of their background and experiences that qualify them to conduct the study in which they are engaged. As described below, I am an experienced teacher with training and experience as a qualitative researcher.

I graduated with a Bachelor of Science in Computer Science and Mathematics and worked in the banking industry for seven years before returning to college and earning a Master of Education in Curriculum and Instruction. I taught in a small, rural school system, first teaching mathematics to eighth-graders for six years and then teaching Algebra I and Algebra II at the high school level for nine years. After teaching 15 years in that school system, I relocated to another part of the same state and taught Algebra I and Algebra II at the high school level for another five years, this time in a large, suburban school district. At the time of this research study, I was on leave from my high school teaching post in order to complete my doctoral studies.

While continuing in my new teaching position, I earned an Educational Specialist degree with a concentration in Technology and Curriculum Design. As part of the requirements for this degree, I completed coursework in qualitative research methods and conducted two research studies in which I analyzed, coded, and interpreted qualitative

data. Following completion of my Educational Specialist degree, I began a doctoral program concentrating on mathematics education. For two years, I continued as a high school mathematics teacher and then resigned to pursue my doctoral studies full time. As part of my doctoral program, I completed additional coursework in qualitative research methods and was involved with analyzing, coding, and interpreting data in qualitative studies. Another segment of my doctoral program was a study of reform-based teaching practices. This study was accomplished through courses taken, training outside of coursework, individual research and study, and involvement in the externally funded professional development described earlier.

Timeline

From the participants' consenting to take part in this study until the completion of data collection spanned several months. Table 2 details the data collection timeline for this study.

Table 2

Data Collection Timeline

Event	Time period
Participants sign consent forms	October 30, 2013
Participants complete surveys	November 1- 2, 2013
I conduct initial interviews	November 13-14, 2013
Participants respond to writing prompts	November 2013-February 2014
I conduct miscellaneous interviews	November 2013-February 2014
I conduct group interview	March 5, 2014

The documents, interviews, observations, and I, as the researcher, all contributed to the data that were collected for this research study. The next section describes how I analyzed these data for the information they could reveal about the participants and their attempted transition from using traditional teaching methods.

Data Analysis

Creswell (2007) described data collection, data analysis, and report writing in qualitative research not as steps, but as a spiral. These three processes “are interrelated and often go on simultaneously” (Creswell, 2007, p. 150). Throughout the course of this study, I continually worked with the data as I moved between preparing and organizing, reading and memoing, describing and interpreting, and representing (Creswell, 2007). This section is a description of how I worked within the spiral to analyze the data collected in this multiple-case study. This section also provides a triangulation matrix, which aligns the research questions with the sources of data.

Preparation and Organization

Preparation and organization of instruments is the first process of the data spiral described above. Some of the instruments used in this study were media files, and others were documents that were in paper or in printable format. With the exception noted above of one postobservation interview, all of the interviews in this study were audio recorded. I made more than one copy of each of the media files, using appropriate pseudonyms when naming the files. The audio recordings for each of these interviews were then transcribed, again using the appropriate pseudonym for each of the participants. Originally, the transcripts of the interviews were organized chronologically by participant.

Three types of instruments utilized in this study were in paper or printable format: surveys, reflective responses to writing prompts, and my field notes of classroom observations. I printed multiple copies of each of the electronic documents, replacing the actual participant names with the pseudonyms used in the study. I also made multiple copies of the original field note documents, again replacing the actual participant names with the appropriate pseudonyms. Originally, the paper documents were organized chronologically by participant.

Although the transcripts and other paper documents were originally organized chronologically, I reorganized them repeatedly, throughout the data analysis process, according to the phase of data analysis. During some phases a chronological organization was appropriate, while at other phases, an organization by instrument was appropriate. I allowed the information that was being revealed to determine the organization that was needed at each phase.

Examination and Note Taking

The second process in the data spiral, examination and note taking, occurred in conjunction with the preparation and organization phase. With data collection and analysis running concurrently, I began examining the surveys, writings, and transcripts shortly after they were printed. Using the paper copies of each instrument, I carefully read each document several times. As I read, I made notes or memos in the margins of the document of ideas that I wanted to revisit. Creswell (2007) described these memos as “short phrases, ideas, or key concepts that occur to the reader” (p. 151). These ideas included words or phrases that seemed to reveal the participant’s beliefs or perceptions,

thoughts that I wanted the participant to clarify in a later conversation or writing, or concepts that I sensed might also occur in other instruments.

As I finished examining and memoing similar documents, I moved back to the preparation and organization phase and used the memos I made as guides to arrange the participants' comments and responses by category. This process of repeated examining and memoing instruments continued until I was no longer gaining new insights into the participants' thoughts and perceptions about their attempted transition from using traditional teaching methods.

Description and Interpretation

In the next phase of data analysis, I “describe[d] in detail . . . and provide[d] an interpretation in light of [my] own views” (Creswell, 2007, p. 151). I used the concepts that were revealed in the participants' documents and created categories or codes. As my examination and analysis continued, I changed the categories as needed to align with the themes that continued to emerge. Although I was looking for recurring concepts and themes, if a participant's idea or comment did not reoccur in another response, I did not necessarily disregard that idea. As Creswell (2007) explained, “the case study researcher looks at a single instance and draws meaning from it without looking for multiple instances” (p. 163). I used my insights and understandings to develop a description of the participants and their transition from traditional mathematics teachers to reform-oriented ones based on the patterns and concepts I found in the data (Patton, 2002).

After preparing a description of each of the participants, I then repeated the data analysis process looking this time for similarities and differences among the three

participants. This analysis, which was organized according to the three research questions in this study, formed the cross-case comparison among the individual cases.

Data Triangulation

In order to determine the consistency of my analysis, I collected data from multiple sources (Creswell, 2007; Patton, 2002; Yin, 2014). Patton (2002) explained that no one source of information can provide a complete perspective of the situation being studied. By using multiple sources of information, the researcher can use the strength of one data source to compensate for the weakness of another (Patton, 2002). I used three different data sources to examine each of the three research questions guiding this study. Table 3 illustrates the data source used for each research question.

Table 3

Triangulation Matrix

Research Question	Data Source #1	Data Source #2	Data Source #3
How do Algebra I teachers who are attempting to transition from using traditional instructional methods perceive their abilities to teach using reform-oriented instructional methods?	Participant Belief Surveys administered at beginning of study	Participant interviews conducted throughout study	Reflective writings by participants throughout study
What are the criteria teachers attempting to transition from teaching with traditional methods utilize to determine their success as reform-oriented teachers?	Participant initial interviews	Participant interviews conducted throughout study	Reflective writings by participants throughout study
What obstacles do teachers face as they attempt to transition from teaching with traditional methods?	Participant initial interviews	Participant interviews conducted throughout study	Reflective writings by participants throughout study

By triangulating the data sources in this manner, I “increase[d] the accuracy and credibility of [my] findings” (Patton, 2002, p. 93).

Limitations of the Study

One limitation in this study was my reliance on the participants’ own interpretation of events. With the exception of the classroom observations, each data

source was subject to the participants' biases, backgrounds, and recall. This limitation is a recognized weakness in using participants as observers (Yin, 2014). By using multiple sources for the same or similar information, however, I attempted to overcome this limitation.

Previously in this chapter, I described my opportunity to observe Joyce and Kathy as they each taught an algebra lesson. In that section, I explained that I did not have the opportunity to observe Michael as I had observed his colleagues. My lack of observational data for Michael is a limitation in this study. I believe the other data I collected for Michael attempts to compensate for this limitation.

Another limitation in this study is the lack of member checking. Yin (2014) explained that in order to strengthen the validity of a qualitative study, the researcher should allow "the informants and participants in the case" (p. 198) to review a draft of the report and be given "the opportunity to challenge a study's key findings" (p. 199). Other researchers (Bloomberg & Volpe, 2012; Creswell, 2007; Gay et al., 2009) agree that the researcher should conduct member checks in order to reinforce the validity of the study before the researcher shares the final report. Upon completion of the first draft of the individual cases, I e-mailed each of the three participants the draft of their case with a request that they review and comment on the report. I contacted the participants via e-mail three additional times plus one time via text message. One of the participants responded that she was speaking for all three of them and explained that they were too busy to read and comment on the draft. I attempted to gather feedback from the participants regarding my interpretations of their data. Their decision not to provide this feedback was beyond my control and is, therefore, a limitation in this study.

Delimitation of the Study

A delimitation in this study was the selection of a small, rural school as the location of the study. Because this school possessed characteristics unique to it and similar schools, the findings from this study may not generalize to schools with a different demographic from the school in this study. Qualitative case study research is recognized as having a lack of generalizability to a large population (Creswell, 2007; Gay et al., 2009; Yin, 2014). This study focused on Algebra I teachers attempting to transition from using traditional teaching methods to using reform-oriented methods. The final report of this study is a description of these teachers, but it does not claim that the description is representative of all teachers attempting the same type of transition or even all Algebra I teachers attempting the same type of transition. Gay, Mills, and Airasian (2009) noted that “the power of qualitative research is in the relevance of the findings to the researcher or the audience of the researcher” (p. 378) not in its ability to generalize to a larger population.

Chapter Summary

Across the country, many mathematics teachers have responded to the call for reform in how and what they teach. For many teachers, their attempt to use reform-oriented teaching methods is an immediate result of their state’s adoption of the CCSSM and the state’s end-of-course tests that will be aligned to those standards. This case study examined three Algebra I teachers as they attempted to transition from using traditional instructional methods to reform-oriented methods. The participants’ words—collected primarily through surveys, interviews, and writings—were used to gain insight into their beliefs and perceptions about their abilities and success as reform-oriented teachers as

well as the obstacles they found to their attempted transition. In the next chapter, I will use the participants' words to describe how those insights formed each of the individual cases plus the cross-case comparison among the three participants.

CHAPTER FOUR: FINDINGS

Introduction

In response to the wide adoption of the CCSSM, teachers across the United States are attempting, or need to attempt, to reform their instructional practice (Cogan, Schmidt, & Houang, 2013; Daggett et al., 2010; Gewertz, 2013; Rothman, 2012). Organizations such as NCTM (2000a) and the NRC (2001) have long recommended reform in mathematics education, but along with the adoption of CCSSM came a change in state-wide mathematics assessments (Daggett et al., 2010). Many teachers, who are using traditional instructional methods (i.e., teachers lecturing and students memorizing and practicing procedures and formulas), are beginning to use reform-oriented teaching methods. Reform-oriented instructional methods reflect the recommendations by NCTM (2000a) and the NRC (2001) and the goals described in the CCSSM (2010). This case study examined teachers attempting to make the transition from using traditional teaching methods to using reform-oriented ones.

With case study analysis, the goal of the study helps determine the analytic strategy used by the researcher. In this case, my goal was to develop a description, both individually and comparatively, of the three participants. With my goal in mind, I carefully studied the participants' responses and allowed categories of their responses to emerge. The following seven categories, with the participants' responses as evidence in each category, formed the outline for each case: background as a student and path to teaching, teaching style in previous years, training and experience with reform-oriented methods, beliefs regarding mathematics and reform-oriented methods, description of reform-oriented classroom, attempts to change teaching style, and obstacles to change.

With their responses, the participants revealed, in the individual cases, their beliefs about the CCSSM and reform-oriented teaching. In the first part of this chapter, I will present the individual cases for Joyce, Kathy, and Michael, using their own words as descriptive evidence.

In addition to the individual case studies described above, I also performed a cross-case comparison of the three participants. Keeping in mind the three research questions in this study, I again studied the participants' responses, allowing categories of responses to emerge. This portion of the data analysis formed the comparison among the three individual cases. In the cross-case comparison, the participants revealed their beliefs about themselves and their attempt to alter their style of teaching. In the second part of the chapter, I will present the cross-case comparison among the three participants, again using their own words as descriptive evidence.

Joyce's Case

Born and raised in King County, Joyce continued to live there with her husband and three high school and college-aged children. She was active in church activities, including teaching a Sunday School class and helping organize the annual Vacation Bible School. Joyce displayed a no-nonsense, but casual and caring, attitude toward her students, and they behaved both comfortably and respectfully toward her. In the following sections, I present Joyce's case, using the seven categories listed previously as a guide.

Background as a Student and Path to Teaching

Joyce learned mathematics in what she described as "absolutely traditional" (Initial Interview, 11/13) classrooms, and she believed that the traditional style was an

appropriate instructional style for her. As a student, she was comfortable learning mathematics in an environment where the teacher wrote examples on the board, she copied them down and did her homework, and later she took a test. Although she was, by her own description, always a good mathematics student, it was in a high school Algebra II class that she became enthusiastic about the subject, and she began to see mathematical connections she had not seen before. This was her portrayal of that teacher and classroom:

I didn't really get hooked on math until I got in high school. I mean, I was always good at it, but it was a very traditional teacher that began to connect the dots for me. I started to see how everything fit together, but she had her overhead projector and grease pen, and she sat in the front of the room. But, something about her hooked me into math. (Initial Interview, 11/13)

Receiving an undergraduate degree in computer science with a minor in mathematics, Joyce did not originally plan to teach. She worked as a computer programmer for twelve years and then operated a business out of her home for several years, while also working as a substitute teacher and then as a teaching assistant. Joyce wanted to spend more time with her three children and decided to become a mathematics teacher. She was part of the first cohort of an alternative teaching licensure program presented by her state's department of education and began teaching mathematics in the fall of 2007. Joyce's first teaching experience was two years at a junior high school, and, at the time of this study, she was in her fifth year of teaching mathematics at King County High School.

Teaching Style in Previous Years

When I asked Joyce to compare her teaching style to that of her own mathematics teachers, she said she was not like them at all and “was a very nontraditional math teacher from the beginning” (Initial Interview, 11/13). One of the first classes she taught was a technical geometry class, and she was required to have additional training in order to teach the course. She “had a great instructor” (Initial Interview, 11/13), and it was from this instructor that Joyce learned to have her students work in groups and use projects for assessments. Recalling her first year and the technical geometry course, Joyce said she “just went with it. You know, we did a project for every test. We had a project and we sat in groups” (Initial Interview, 11/13).

According to her own description, Joyce was, from the beginning of her career, spontaneous and enjoyed using a variety of activities in her classroom. She credited being mothers with the ability she and a colleague shared of being able to adapt and think quickly when they needed to. “I mean we think on our feet. We were moms first and then teachers, and I think we both draw on that flexibility that you have to develop” (Initial Interview, 11/13). Joyce recognized that her desire to use what she considered atypical activities in the classroom created the opportunity for failure. She explained how she would rather teach a novel lesson imperfectly than an ordinary one flawlessly: “I love doing different stuff. It may not be perfect the first time, and it won’t be, but I love it. I would much rather do [something distinctive]” (Interview 1, 11/21).

Training and Experience with Reform-Oriented Methods

Joyce’s desire for variety in her teaching style was one factor in her decision to participate in a project through which she would learn more about teaching practices that

would realize the expectations of the CCSSM. Joyce was part of Teaching Algebra and thought of what she learned in that professional development as her model for reform-oriented instruction. She said, “What [they] did shows me what it could be” (Initial Interview, 11/13). Joyce also participated in a three-day training that was provided by her state’s department of education in preparation for their implementation of the CCSSM. Using the Participant Beliefs Survey, I asked Joyce to recall some of the views she held at the beginning of the school year about the CCSSM. On the five-item Likert scale, Joyce responded with a three on each question, indicating that she had a positive attitude toward the upcoming transition, was familiar with the CCSSM, and was prepared to teach in a method aligned with those standards. She attributed her beliefs to Teaching Algebra and the state training she attended as well as to the guidance and education she received from the instructional coordinator at King County High School.

Although at the beginning of the academic year she felt confident about her ability to teach in a manner aligned with Common Core expectations, as the year progressed, Joyce recognized that she did not feel confident enough to be comfortable using those practices when she was teaching specific skills that were new to her students. I asked Joyce about one of her lessons that she believed was, or was similar to, a reform-oriented lesson and whether the students learned the mathematics she intended them to learn. She replied that they did learn the mathematics and explained that she designed a lesson in which “they were already to a point where they would know [the skill] and would know how to use it” (Interview 1, 11/21). Given that she was typically confident in her teaching abilities and enjoyed trying new activities and approaches in her classroom, I questioned Joyce about the source of her hesitation to teach reform-oriented lessons more

frequently and for mathematical skills that were new to her students. She explained that her lack of experience and her desire for additional training were the bases for her doubts. Although she considered some of her earlier training to be exceptionally good, she did not “feel like I am trained enough, that I’m knowledgeable enough to be doing it every day and be doing a good job with it” (Initial Interview, 11/13).

Joyce’s self-doubt about using Common Core practices when she taught new skills did not extend to when she helped her students review or consolidate previously learned skills. In addition, her training helped her feel confident about her ability to create mathematically rich tasks, “if I had unlimited time” (Writing Prompt Interview 1, 12/19). In lieu of the unlimited time, Joyce thought a book of mathematically rich tasks intended to correlate with the CCSSM and with her textbook would be helpful. She explained that she would still spend much time on her preparation for class:

I mean, there would still be time spent in reading them and seeing it, because you have to understand the problem fully yourself. You would have to do your homework and study, but [a book of math tasks] would be a huge [help]. (Initial Interview, 11/13)

Throughout this study, the amount of time associated with teaching using more reform-oriented methods was a recurring theme in Joyce’s responses.

Beliefs Regarding Mathematics and Reform-Oriented Methods

A fourth category that emerged through Joyce’s responses included the beliefs she held about mathematics itself and about reform-oriented methods of teaching mathematics. In her responses to the Discourse Survey, Joyce revealed that she believed mathematics students needed to be involved in mathematical investigations and

mathematical conversations, and her role as the teacher was to pose problems that engaged students in these activities. Joyce's statements in interviews as well as behavior I observed in her classroom supported these selections she made on the survey. Whether they were involved in a discovery lesson or following their teacher's lead, Joyce's students often engaged in mathematical dialogue as they worked in class. In Writing Prompt 1 and its following interview, Joyce described her students' conversing within their groups to develop explanations and solutions for their given problems. Also in the Discourse Survey, Joyce responded that when she prepared lessons, it was important for her to consider "activities or investigations that will assist my students in developing their own understanding about the key mathematical ideas" (Discourse Survey, 11/01) apart from any information that she conveyed. The teacher's role in a mathematics classroom, according to Joyce, was to facilitate the students' questioning each other and to ask questions that "encourage further student exploration and, if necessary, change the direction of the lesson" (Discourse Survey, 11/01). Joyce also noted the importance of students' explaining their reasoning and presenting their solutions and of her using any misconceptions that were revealed to propel instruction. Although Joyce valued students' explanations and presenting their solutions, when a lesson could not be completed within one class period, students' presenting their solutions was the portion of the lesson that would be omitted.

In order to learn what portions of a mathematics lesson she deemed important, I asked Joyce, with Writing Prompt 8, to rank in order of importance these five phases: teacher explanation, student exploration of lesson (both individually and as a group),

student explanation of work, teacher questioning students, and students questioning other students. Her response is given below:

#1: Student exploration of the lesson. I think that is the best way to learn.

#2: Teacher questioning students. I don't mean just the leading questions. If they are just exploring without direction then it's not real productive.

I think #1 and #2 are just right there together. They're working, they're exploring but the teacher is making sure they are productive and heading in the direction she wants them to go in.

#3: Students questioning other students.

#4: The student explanation of work.

#5: Teacher explanation.

This kind of fits with how I have done Common Core lessons. I tend to not focus on the explanation even though I know that is important, but in my mind, clearly, it isn't as important. I'm more about them working, talking, and figuring things out more than I am with the presentation part of it. If the teacher is explaining, that is the least productive because the teacher is doing all the work. (Writing

Prompt Interview 2, 2/04)

Joyce's ranking of the five lesson parts listed above was consistent with the lessons she described when she attempted to align her teaching with Common Core practices.

Although she considered the teacher's explaining as the least productive part of a lesson, in an upcoming section, I will describe how, as the year progressed, Joyce's explaining the mathematics became her predominant style of teaching.

Joyce's beliefs about mathematics included her thoughts on how well students learned when taught with different methods. She believed that when teachers employed reform-oriented teaching methods, their students had better recall of what they learned and were better able to transfer that learning to other subjects and situations. In contrast, she had found that, with a lecture, the students were "not going to take it any further than what they need to do for their homework" (Writing Prompt Interview 2, 2/04). Although Joyce advocated mathematical investigation and reform-oriented methods as "the way to go" (Final Interview, 3/05), she believed that because of time constraints, she could not teach in that style every day. She explained, "It's not realistic" (Final Interview, 3/05). At the time of that interview, Joyce was no longer attempting to utilize any form of student-centered lessons. She acknowledged that in preparation for the exit exams her students would take, she was employing very teacher-centered methods.

Although Joyce valued reform-oriented teaching methods, she valued traditional teaching methods as well. In addition to the traditional mathematics teacher who inspired Joyce in high school, she also admired other traditional teachers with whom she had worked. She explained how she learned structure from two former colleagues and added, "You have teachers like [names omitted] who are amazing teachers, but they are very traditional" (Initial Interview, 11/13). Joyce reported finding advantages to both traditional and reform-oriented teaching methods, and she resisted categorizing teachers and styles as either traditional or reform-oriented. "I think that the terms 'reform-oriented' and 'traditional' [have] too narrow a focus to classify teachers as one or the other. I think teachers can be successful in either style, and that students can be successful in either style. I think a good teacher will use a mixture of both" (Writing

Prompt 5, 1/14). Joyce's giving equal standing to two seemingly disparate methods of teaching was testament to her own contentment with using either style. Using students' frustrations, time constraints, or content suitability as explanation, Joyce could justify, to her own satisfaction, her daily choice of teaching method.

Another belief Joyce held about mathematics concerned ability-grouping algebra classes. Some of her Algebra I classes were classified as honors classes, and the others were classified as standard classes. In the interview following Writing Prompt 9, Joyce revealed her belief that having ability-grouped mathematics classes was beneficial for the students in each group:

Joyce: Then you can just go at the pace that the group needs to go and you do not have to switch gears all the time. I like those with the same abilities in the same groups.

AKG: If lessons were always taught, as you described before, in a very, very Common Core style, do you think you would still need the different ability group classes?

Joyce: I would still want it. (Writing Prompt Interview 2, 2/04)

Joyce described how the students in standard classes struggled more with reform-oriented teaching methods than students in honors classes did. When I asked why the difference in the two groups, Joyce explained that students in standard classes were not as interested in investigations and "they tend to just want to know what they need to do" (Interview 1, 11/21). An additional problem she recognized was that some students can be overwhelmed with the amount and type of reading required by the assessments used in conjunction with the CCSSM. As she said, "Common Core is not directed to kids that

struggle with reading and comprehension” (Final Interview, 3/05). Joyce believed that she did an equally good job teaching each ability level, and asserted that each class accomplished more when they were sorted into homogeneous groups.

Description of Reform-Oriented Classroom

The previous section described Joyce’s beliefs about reform-oriented teaching methods; this section reveals her beliefs about the classroom itself. Joyce exhibited her experience in the business world when she responded to my asking her to describe a reform-oriented teacher in the classroom:

Joyce: I think it would be more like a business operation where the students are responsible for their job, and it is more of a supervising, a facilitating. They would be responsible for their own work, like you are in the real world, and then you report to somebody that keeps track and makes sure you are doing what you should be doing. The shift in responsibility is on the student and not on the teacher. I think that’s what, in the perfect world, it would look like. Everybody would work as a team to produce a product which is the learning but you could still think of it as a product.

AKG: So, during class? I think you have given me a picture of what the students are doing but what is the teacher doing?

Joyce: Well, channeling, directing and that kind of thing. Instructing, because you still have to instruct. You can’t just say, “Here, do this” [or] they won’t know what they’re doing. You’re instructing but it’s not, “Look at me, look what I do and copy what I do.” It is, “I have given you the tools to do this. You’ve got the tools to do this project or assignment, so draw from your toolbox.” But since you

have taught the tools, they have got a good background to do what you have given them. The lesson is very thoughtful, not just something that looked good and you want to see what they would do with it. The lesson is very thoughtful as to what you are even giving them. Planning is huge for a teacher in this scenario and [so is] just keeping them focused and getting them to where they are trying to get to. Also, the prerequisite skills to be able to accomplish what you have told them before, you have got to know that they have that. So, the sequence is important. (Initial Interview, 11/13)

In the scenario described above, the teacher was the supervisor of the business. By previously teaching the necessary skills, the supervisor ensured that the students had the appropriate tools, which the students were then responsible for using. The teacher in the reform-oriented classroom also checked the students' work for accuracy, kept them progressing in the teacher's intended direction, and was responsible for creating thoughtful lessons. Joyce later described thoughtful lessons as ones that focused more on mathematical concepts than mathematical procedures. The classroom that she described above, like Joyce's own classroom, included characteristics of more than one style of teaching. In our Initial Interview (11/13) together, Joyce described her teaching as less traditional than it had been in previous years. She added that her exposure to reform-oriented teaching methods changed "how I do traditional lessons" (Initial Interview, 11/13). She depicted lessons in which her students had a conventional guided practice worksheet to complete, but at a point where she typically told her students what to do, she had begun letting them figure out what was needed in the problem. She wanted her students to figure out what to do, and she also wanted them to verify with her that they

were moving in the direction she intended. When we were discussing a lesson I had observed, Joyce explained that her “classroom is not real quiet, but that is by design. I don’t want [the students] to feel like they have to be quiet. So, I just try to listen and, if they get off task, I’ll just get them back” (Post Observation Interview, 12/02). Joyce believed she gave her students a measure of freedom and responsibility, and these examples reveal that she, as the teacher, was the ultimate authority and guide.

Periodically, I asked Joyce to reflect on a recent lesson and evaluate herself, using her own criteria, as a reform-oriented teacher. She felt like a reform-oriented teacher when she refrained from telling her students a component of the day’s lesson and, instead, let them discover it for themselves. In one lesson, for example, she gave her students a set of data, and they realized that one piece was different from the other pieces. She had not introduced the concept of outliers previously, and her students noticed the dissimilarity in the data:

They had to figure out that there was one that was not with the rest of them. They had to say, “Does that mean something?” or “What does that mean?” I think that was pretty spot on. They had to figure out the meaning of the outlier because I didn’t tell them. (Interview 1, 11/21)

She believed she was “a little bit like a reform-oriented teacher” (Writing Prompt Interview 1, 12/19) when she taught a thoughtful lesson, as described earlier, and let her students discover a connection to a previously learned skill rather than teaching them a procedure for making the connection.

Included in her description of a reform-oriented classroom was an explanation of how frequently this teaching method should be implemented. With her being adequately

skilled as an indication of perfection, Joyce said, “In the perfect world, you would do everything that way” (Writing Prompt Interview 1, 12/19), meaning she would teach using reform-oriented methods every day. Given the constraints of time and her inexperience, she would be content with teaching a reform-oriented lesson “in the beginning of a topic, a broad topic, not a daily topic, to introduce one of the big things. Then, I would like to have one after every skill, as we go along” (Writing Prompt Interview 1, 12/19). Joyce’s desire to teach a mathematical skill using direct instruction before she reinforced that skill with a mathematical task reemerges in the later section addressing obstacles to teaching using reform-oriented methods.

Attempts to Change Teaching Style

The two previous sections provided an image of Joyce’s beliefs about and her description of reform-oriented teaching methods. This section follows her attempts to modify her own style of teaching to what she described. During approximately the first 15 weeks of the school year, Joyce reported that she taught five or six lessons that she considered completely reform-oriented. She did not “go 100% very often” (Interview 1, 11/21), but she attempted to use daily some of the techniques that she had learned from Teaching Algebra. Joyce thought a realistic goal was to teach two or three fully reform-oriented lessons during each unit of study. Although she did not teach all of her lessons in what she called a Common Core style, Joyce did not simply work problems on the board for her students to copy. These are, in her words, changes that she observed:

My questioning [produces] much more higher-level thinking. I really do not do the “I do, we do, you do” anymore, and I did a lot of that last year. I really don’t do it. The only time I do it is if I get so frustrated that I just tell them, “Okay, just

look at this,” but, that hasn’t happened very often, it really hasn’t. I have gotten completely away from that. (Initial Interview, 11/13)

Describing her attempted transition, Joyce said, “I’m on the way, but I’m not there or even close to there . . . My feet [are] in the water, [and I’m] trying it out” (Interview 1, 11/21).

Reflecting on a recent lesson, Joyce described her teaching style as not completely reform-oriented, but she did let her students lead the lesson more than she had in the past. As noted earlier, Joyce believed the ultimate responsibility in her classroom lay with her. Part of her task then was to determine what mathematics the students would learn and what path they would follow to accomplish their learning. Providing the opportunity for a student-led lesson was unfamiliar to Joyce, and she was pleasantly surprised with the results. She observed that because her students led the lesson “we did things a little differently than I probably would have taught it” (Interview 1, 11/21). She reported happily that it was still a good lesson, the students learned the mathematics they needed to learn, and both she and the students enjoyed the experience. The unexpected bonus for Joyce was the excitement her students exhibited when they began realizing what they had discovered in the lesson. As she said, “You could see all the little light bulbs just glowing. I love that” (Interview 1, 11/21). Joyce concluded the lesson that day by pointing out to the students a connection she wanted them to make between their new learning and something they learned previously:

We have been working on systems all week and I keep going back to that, “Now, what does the solution look like? Remember you found it the first day.” Because sometimes when they get bogged down in the method of substitution and

elimination, they forget that their answer needs to look like an ordered pair. They find the variable and think they are done. Then, I remind them what the solution needs to look like. So, that has been good, to bring that forward. (Interview 1, 11/21)

Although she attempted to change her style of teaching, Joyce maintained that she could not complete a reform-oriented lesson in one of the seven 45-minute class periods in a school day at King County High School. She also did not think she had the luxury of allowing a lesson to continue to a second day. “I just have one day and I [don’t] feel like I [can] take the time to spread it out” (Interview 1, 11/21). When describing a recent attempt to teach using Common Core practices, Joyce believed she was on the right track with the group discovery and student conversation portions of the lesson, but these components took the entire class period. She wanted the groups to present and justify their work to the other students in the class, but time constraints prevented that phase of the lesson, and she believed they needed to begin a new lesson the following day. She explained:

The length of the class holds you back because we just have 45 minutes, so you always see things that you could have taken further, done more of the presentation. . . . It would just work a lot better if we had a longer class to do it in. (Interview 1, 11/21)

Related to her concern about finishing a lesson in one class period was the pressure Joyce felt to teach a large number of skills in a short amount of time. After one lesson, Joyce reported that she did not feel like a reform-oriented teacher because she had a deadline, needed her students to know the material, and gave them a guided practice

sheet to complete without exploration. “I felt like I was being traditional in that we had a list of things to do in two days and we checked them off” (Writing Prompt Interview 1, 12/19). Joyce regularly compared which state standards she had taught this year to which she had taught at the same point in previous years, and wanted to maintain at least the same pace she had before. “We are almost a full chapter behind where we were last year, I know, because we still have the checklist” (Writing Prompt Interview 1, 12/19). She noticed that her students were dissatisfied as she, in order to stay on schedule, became more and more traditional in her practice. When talking about her shift away from using reform-oriented teaching methods, Joyce commented, “I have noticed, as I have gotten more and more traditional, [the students] don’t like it. But, if I can throw [a good activity] in there and hook them in, then it goes a little better” (Final Interview, 3/05).

Joyce discontinued her attempt to change her teaching style and, in February, shared that she was “not even thinking about Common Core right now [and was teaching] traditional lessons. We are in the grind toward EOC” (Writing Prompt Interview 2, 2/04). Joyce was pleased with her students’ performance on the exit exams in previous years, but she was frustrated because she was unclear how the style and content of the current year’s test would compare to the tests in previous years. Her understanding from the state department of education was that their year-end test would be different, but she did not know how it would be different. She explained, “So, all I know to do is what I have done before” (Writing Prompt Interview 2, 2/04). Joyce was neither pleased nor displeased about abandoning her attempts to employ practices aligned with the CCSSM. Instead, she was matter-of-fact about doing what she needed to do given the circumstances at hand.

“You have to do what’s in front of you and make do with what you have” (Final Interview, 3/05).

At the beginning of the school year, Joyce, like the other two participants, was excited about teaching in a style they considered to be on target with the SMP. As the year progressed, according to Kathy, Joyce “began saying we had to get moving. So, we had to put [the new practices] to the side” (Final Interview, 3/05). By the beginning of the second semester, Joyce’s goal was to teach the skills she needed to teach before early April, when her students took the state exit exam. “My concern is getting all the little things checked off the list, and, since we still have a list, I am concerned about the list” (Writing Prompt Interview 2, 2/04). She reasoned that she could not complete her checklist of mathematical skills while utilizing reform-oriented teaching methods, and she reverted to using more direct instructional techniques. Joyce described herself as panicking over “how much we have to get done in the amount of time left” (Final Interview, 3/05). She did not visualize being able to teach the amount of material she still needed to teach, unless she used the teaching methods with which she had been successful and her students had scored well in the past.

Obstacles to Change

The final category that emerged from my analysis of Joyce’s data was the perceived obstacles to changing her teaching style that she revealed. Joyce began the year with apparent enthusiasm for the CCSSM, and, when she began to falter, I wanted to know more about the obstacles preventing her from keeping on her path. Throughout our conversations, Joyce described several barriers to her transitioning to using reform-oriented teaching methods as often as she had planned. These obstacles were grouped

into four categories: the differences between her current state standards and the CCSSM, the increased time and experience required for her to teach using her new methods, her state's evaluation and assessment requirements, and her state's commitment to the CCSSM. Each of the four groups of obstacles to Joyce's transitioning to using reform-oriented teaching methods is described in the following paragraphs.

Differences in standards. One obstacle Joyce felt during her attempted transition was the differences between the standards she had been following and her state's new standards. The academic year of this study was considered a transition year between her state's existing high school mathematics curriculum and the CCSSM. Although the Common Core State Standards were supposed to be implemented and teachers were presumed to be using the SMP as their goals for instruction, the end-of-course assessment would be fundamentally the same as it had been in the past. At the end of the school year, Joyce's students would be required to take the multiple-choice EOC exam over the existing curriculum. Joyce was "very, very disappointed with the state for having us still accountable" (Writing Prompt Interview 2, 2/04) for the items that would be tested on the exit exam. In anticipation of the full implementation of the CCSSM and the administration of the Partnership for the Assessment of Readiness for College and Careers (PARCC) exam that would come in an ensuing year, Joyce, and other mathematics teachers in her state, administered throughout the school year benchmark tests that contained items similar to those on the PARCC exam. Joyce found it very difficult to plan and teach in what she saw as two very different styles. "It has just been a struggle to try to transition, and I knew it would be, because they are so diverse from one another—what the old [state standards and testing were] about and what Common Core is

about” (Writing Prompt Interview 1, 12/19). Having taught Algebra I for several years, Joyce was familiar with the type of questions that would appear on the exit exam, and she recognized that the style was substantially different from the PARCC assessment items she had previewed. She did not believe that students who were taught mathematics conceptually could do well on multiple-choice exams that tested mathematical knowledge that was more procedural than conceptual. In Writing Prompt 5, I asked Joyce what she thought about studies that found students from reform-oriented classrooms scoring as well or better on standardized tests than their peers from traditional classrooms. She responded, “I think statistical results can be manipulated to show what one wishes them to show” (Writing Prompt 5, 1/14). In venting her frustrations over attempting to teach in a transition year, Joyce said she has “a foot in each door when they’re not even in the same building” (Writing Prompt Interview 2, 2/04).

Time and experience required. A second obstacle Joyce revealed to changing her teaching methods was the time required to teach using reform-oriented methods and her lack of experience doing so. I asked Joyce, with Writing Prompt 3, how many times per week a teacher should implement a fully reform-oriented lesson, and what factors—under her control or not—prevented her from teaching reform-oriented lessons as frequently as she would like. Ideally, according to Joyce, she would teach every day in a reform-oriented fashion, but, in reality, she was teaching less than one lesson per week using some aspect of reform-oriented methods. When I asked what was hindering her from teaching more Common Core-style lessons, she responded, “Time, resources, and my education on how to do it” (Writing Prompt Interview 1, 12/19). In explanation of the time hindrance, she said that the 45-minute class period, too frequent interruptions to the

daily schedule, and the time needed to plan lessons and create mathematically rich tasks were serious deterrents to her changing her style of teaching. Joyce observed that she needed at least two 45-minute class periods to teach a fully reform-oriented lesson, but she believed that she could not afford to spend more than one class period teaching a single skill from her list of state mathematics standards.

For the resources hindrance, Joyce said she needed lessons and tasks that were appropriate to use in her classroom. Her current sources for lesson ideas and instructional tasks were the materials she received through Teaching Algebra, the challenge section in her textbook, and a variety of websites. An advantage for Joyce of using the challenge problems in her textbook was her being able to quickly determine whether the task she found was for the mathematical skill she needed to teach in a particular lesson. Joyce did, however, need to adapt the challenge problems that she used from her textbook. She described them as “very straightforward . . . but still better than just the problems” (Initial Interview, 11/13) in the main sections of her textbook. This hindrance was related to the previous one: Joyce pointed out that if she had the time to design her own lessons and instructional tasks, she would not need to be given these additional resources.

Joyce named her own inexperience as hindering her altering her teaching methods. Before she could more frequently teach lessons using goals of the SMP, Joyce wanted more and longer training and practice using reform-oriented teaching methods. She described how much she learned from her training sessions, especially from Teaching Algebra, but she wanted more of the same type of training:

I think a semester class would be good—a semester’s worth of real studying and learning of it, like you did when you were in college. I think that’s what it would

take. . . . I think in order to do something well, you have to be fully trained. A weekend or a day is not going to do that. (Writing Prompt Interview 1, 12/19)

In addition to more formal training, Joyce wanted time to practice and apply what she had learned. She commented that “you learn as you go. That’s true with anything” (Writing Prompt Interview 1, 12/19), and she wanted the opportunity to keep learning about the CCSSM as she used the standards. With her current level of training, Joyce felt confident to teach review lessons, but not to teach new skills in a reform-oriented fashion. “I still don’t feel confident enough in what I am doing to have the individual skills. I haven’t seen enough to know how I would teach each little part” (Writing Prompt Interview 1, 12/19). Because she was taught in very traditional classrooms and had not reached that same comfort level with her new teaching methods, Joyce acknowledged that when she was under pressure, it was easy for her to revert to a more familiar style of teaching.

State requirements. A third group of obstacles to her utilizing reform-oriented instructional methods that Joyce described was her state’s EOC exam and how the scores on this exam were used. The primary reason Joyce was concerned about the amount of material she taught during the school year was her desire for her students to perform well on the state’s end-of-year Algebra I test. Joyce perceived that her success and worth as a teacher was measured by her students’ performance on the Algebra I EOC exam. Her students’ Algebra I scores would factor into her overall teacher evaluation score, and school-wide Algebra I scores would factor into overall evaluation scores for each teacher in the school. She recognized that her “entire school is counting on our scores” (Writing Prompt Interview 2, 2/04). Joyce believed that, in general, students learned more thoroughly and were better able to make mathematical connections when they had

learned from an educator using less traditional teaching methods, but she recognized that those qualities were not measured on the multiple-choice EOC assessment. She thought the policy makers for her state were out of touch with an actual classroom, and she defended her decision to cover as many skills as she could in a school year:

[State policy makers] are doing lip service. I think [the policy makers] probably think they have really bought into it, but maybe they're too far removed from the classroom to realize that they are just doing lip service to it. The teachers are still accountable to the [State Performance Indicators] and the EOC and our merit is still based on that. As long as my merit is based on the EOC score, that is where my focus is going to be, and you'd be crazy not to feel that way. (Writing Prompt Interview 2, 2/04)

State's commitment. The final group of obstacles involved Joyce's perception of her state's commitment to their recently adopted standards. From experiences in previous years, Joyce questioned whether her state's legislators would continue to support the Common Core. She had adjusted for curriculum changes and assessment changes in the past and believed the implementation of the Common Core was merely another new curriculum that her state had adopted. "I hope I'm wrong, but I don't believe the state is really invested in Common Core. I think it will be a modified form of what we have always done, and they will call it Common Core" (Writing Prompt Interview 1, 12/19). In our final interview together, Joyce again voiced these same concerns:

We won't still be doing this [in a few years]. We all know better than that. This is just a phase. It's going to last a couple of years and then we'll do something else. So, we're just hanging on until it changes . . . [I] may be jaded, but, okay. We're

going to do Common Core, so I'll do what the state thinks Common Core is, to the best of my ability, until the next thing comes along. (Final Interview, 3/05)

Joyce believed the CCSSM was better for her students and wanted its adoption to succeed, but she did not predict its continuing to receive legislative support. She admitted that her preparation time was too valuable to spend on developing lessons and strategies that she would not continue to use in her classroom practice, and her classroom practice was determined by the style of and material on her students' end-of-year assessment.

Summary of Joyce's Case

Joyce had been teaching longer than the other two participants in this study. Throughout that time, she had become accustomed to the responsibilities that accompany teaching a class that gives an EOC exam. Also in this time, the content she taught had been revised more than once as a result of state curriculum changes. Because she had a firm schedule in mind of what skills she needed to have taught by certain dates, she was the first of the three participants to leave behind any attempt at using the SMP. She also would not allow herself to become invested in the CCSSM until she saw what decisions her state legislature would make regarding its continued support. Although she learned from traditional mathematics teachers, Joyce thought of herself as a very nontraditional teacher. Her students worked in groups and occasionally had projects, and she endeavored to use direct instruction less frequently in her classroom. She did not, however, use reform-oriented methods to teach skills with which her students were not already familiar, and she believed these methods were better suited to students who were more academically advanced than other students. She encouraged mathematical dialogue

in her classroom, and she was content with her students not getting the opportunity to defend their own strategies and critique the reasoning of their peers.

Kathy's Case

Kathy grew up in another state and attended parochial schools for eight years. She attended public school beginning in the eighth grade and moved to King County's state during her eleventh-grade year. Kathy had two children, one in elementary school and one preschool-aged. The following sections comprise Kathy's individual case, which are organized according to the same seven categories of responses as Joyce's case. First is Kathy's background as a student and her path to teaching.

Background as a Student and Path to Teaching

Kathy could not recall throughout elementary school, high school, or college having had a mathematics teacher she thought of as teaching creatively. Reflecting on whether her instructors were more traditional or more reform-oriented, Kathy said:

Kathy: Traditional, very traditional.

AKG: Give me some examples. Just pick a class and describe what it was like.

Kathy: Well, math. The teacher was in the front of the room, lecturing, telling us how to do it and then assigning the homework.

AKG: Can you remember ever in the whole time having somebody who was a little more creative, a little different?

Kathy: I'm trying to think back. I don't remember one who was creative at all.

Kathy talked a while about a school she attended and its strict policies about behavior, and then we continued our conversation about teaching styles:

AKG: Can you think, through the years, as grade levels changed and the courses that you took changed, did that teaching style vary, even on through college?

Kathy: Oh, no, definitely not in college. No, I don't think it ever changed. It was always that the teacher taught you how to do it, and here are your problems for homework. (Initial Interview, 11/14)

When I asked her why, given her very traditional mathematics background, she liked the subject so much, Kathy responded excitedly, "Because you started with something, and you came out with something different! It was just so interesting and everything built on each other. It's fun!" (Initial Interview, 11/14)

Kathy said she always wanted to be a teacher, but she followed an indirect path to becoming one. Because, when she began college, she was encouraged to choose a career that was more financially profitable than teaching, she decided to major in psychology and minor in education. While she was attending college, Kathy worked for a learning center franchise and also for a university tutoring service. She enjoyed the process of teaching, and, after graduation, she continued working for the learning center and also began working for her state's child services agency. After the birth of her second child, Kathy applied for a teaching position in several surrounding school districts and continued her work with the child services agency. After one year had passed, a teaching position became available, and she began teaching with an alternative license for King County High School. Kathy taught for the learning center for a total of six years, a school district other than King County's for one semester, and the year of this study was her second year teaching in King County's school district.

Teaching Style in Previous Years

Although Kathy had relatively few years of teaching experience, she had established a teaching style, which is described in this section. In her first year at King County High School, Kathy taught Algebra II. She described her teaching style that year as traditional, or as she had been taught. “I taught in [a different school system] for a semester, and that was in the traditional style. And last year when I taught Algebra II” (Initial Interview, 11/14) she continued using traditional methods. That year, when she taught Algebra II, she worked problems on the board, explained them to her students, answered any questions they had, and assigned the students their homework. During the second semester of that school year plus the following summer and fall, Kathy participated in Teaching Algebra. She credited her involvement in that professional development with causing her to think of mathematics education and her practice in a new way. Her second year teaching at King County High School, which was the year of this study, was Kathy’s first experience teaching Algebra I and her first opportunity to apply her new thinking to her classroom practice.

Training and Experience with Reform-Oriented Methods

Another category of Kathy’s responses was how she perceived her training for and experience with reform-oriented teaching methods. In preparation for the implementation of the CCSSM, Kathy participated in Teaching Algebra and also in the training that was provided by her state’s department of education. With the Participant Beliefs Survey, Kathy classified herself as between familiar and very familiar with the CCSSM at the beginning of the school year, and when I asked what contributed to her familiarity, she replied:

I had a class at [a nearby university] in the spring . . . which was taught using Common Core. Also, I attended training over the summer for four days, which [King County High School] sent me to. Also, I participated in [Teaching Algebra] for two days in the spring and five days over the summer. (Beliefs Survey, 11/01)

Although she felt familiar with the CCSSM, she believed she was only moderately prepared to teach using a method aligned with the goals of the CCSSM and blamed her lack of preparation on what she described as “a lack of materials” (Beliefs Survey, 11/01). On the same survey, Kathy classified her feelings at the beginning of the school year as between positive and very positive about transitioning from her previous state’s mathematics standards to the CCSSM. She credited the same three sources (i.e., university course, Teaching Algebra, and state training) for her positive attitude toward the upcoming changes in her school and classroom. An additional source of training and support for Kathy was an assistant principal who served as the Instructional Coordinator at King County High School. She described how he “completely supports us [and was responsible for] two days of training within our school before this school year started” (Beliefs Survey, 11/01).

Beliefs Regarding Mathematics and Reform-Oriented Methods

Kathy’s beliefs regarding mathematics and reform-oriented methods of teaching mathematics emerged as a fourth category of her responses to writing prompts and survey and interview questions. In one of her responses to the multiple-choice Discourse Survey, Kathy said she believed mathematics was mostly problem solving. When I asked her to elaborate, her response was similar to her earlier description of why she liked mathematics:

It's like a mystery. I sometimes [say it is] like a mystery or a mystery novel. You know, you're trying to figure out the answer. It's fun getting to the answer, like it's fun reading the book and getting to the end. (Final Interview, 3/05)

She responded that mathematics was not like cooking, and explained that in cooking there was a recipe, or formula, to follow, and adhering to a formula did not align with her view of mathematics.

In order to engage her students in the sense of mystery she saw in mathematics, Kathy began most lessons by assigning her students some type of activity, before she described the lesson to them or shared with them any key information. "I do a journal first, or a group activity, so they are exploring the new thing first. Then, I go into the lesson" (Final Interview, 3/05). Besides engaging her students in the lesson and giving them the opportunity to explore, another advantage Kathy found in asking her students to respond to a journal prompt was the students had an opportunity to realize "that they do know more than they think they do" (Initial Interview, 11/14) about the mathematics in the new lesson.

Another belief about mathematics held by Kathy was that mathematical conversations, especially those driven by student inquiry, were a key part of any mathematics lesson. She saw her role as engaging in these conversations with her students and asking questions that "encourage further student exploration and, if necessary, change direction of a lesson" (Discourse Survey, 11/01). Kathy valued student input and, on the Discourse Survey, selected the teacher and the students together over either one individually or the curriculum as the most important source of mathematical ideas in the classroom. Both times I observed Kathy while she was teaching, what I saw

in her classroom corresponded with her selections on the Discourse Survey about mathematical conversations. Her students were discussing with each other the problem they had been assigned, possible strategies for solving it, and how to implement their chosen strategy.

I asked Kathy about differences in her algebra classes, and she noted that in her standard Algebra I classes she had to ask more probing questions than she would in an honors Algebra I class, but her students eventually followed her lead. I asked her if teaching mathematics classes using the goals of the SMP would eliminate the need for ability-grouped classes:

Kathy: If I take my lowest student and my highest student then put them in the classroom to discuss any skill for Common Core, I don't think it would benefit that lower-level child at all. I think the higher-level child would go off on a tangent, understanding completely, but the lower one would say they understand, but if asked to explain it, they would probably try to say it exactly like the advanced student because they aren't really sure what they are talking about. So, I don't think it would benefit them in that way.

AKG: So, you are saying the lower-level student would be overlooked and left behind? Do you think the upper-level student would just go on as always? Because, some people say both ends are hurt and only the middle is okay when they are grouped all together.

Kathy: But my advanced students go into more. They even look at it differently than my lower-level students. They can see, for example, in solving for y , this has a slope of this. The lower-level students have no idea what to do, no clue at all.

The higher level is already thinking since both the slopes are the same, I know it's parallel lines. They are moving on. The lower-level student doesn't even know where to start. They don't know how to solve for y , even though you may have taught it for days and days. (Writing Prompt Interview 2, 2/04)

Her above response illustrated Kathy's belief that all of her students could benefit from learning in a reform-oriented classroom, but they would benefit more from also being in ability-grouped classes.

Kathy believed that students' presenting their work to their classmates and explaining the validity of their solutions was an important part of a mathematics lesson. She revealed on the Discourse Survey that she saw this time as an opportunity for the students to reinforce their own learning and for her to use any misconceptions that surfaced for further instruction. Kathy's classroom practice did not always reflect her stated beliefs about her students' presenting and defending their work and critiquing the work of others. This portion of the lesson typically came at the end of a class period, and sometimes there was not enough time remaining for the explanation and critique phase.

In addition to students' presenting their work, I wanted to know what other parts of a mathematics lesson Kathy believed were important. With Writing Prompt 8, I asked Kathy to consider these five possible parts of a mathematics lesson: teacher explanation, student exploration of lesson (both individually and as a group), student explanation of work, teacher questioning students, and students questioning other students. I requested that Kathy rank the parts in order, from most important to least important, and to explain her ranking. Her response follows:

#1 Student exploration of lesson (both individually and as a group)

#2 Students questioning other students

#3 Students explanation of work (meaning their work after exploration and questioning)

#4 Teacher questioning students

#5 Teacher explanation

This is exactly how I work a task. I was brainwashed to think this way during [Teaching Algebra] and the core curriculum training the school system sent me on over the summer. (Writing Prompt 8, 1/25)

Kathy was so thoroughly convinced of the principles she learned through Teaching Algebra that, in several interviews and written responses, she laughingly referred to herself as having been brainwashed during the project.

Another belief Kathy held was that by learning from a teacher utilizing reform-oriented instructional techniques, students would have a deeper understanding of the material. “Lecture does not go in depth to where the students can discover the transfer to other subjects and other situations. They will see the connections with Common Core” (Writing Prompt 10, 1/25). I asked Kathy to describe the consequences if she opted to disregard the objectives and teaching style she believed were needed for the end-of-year state test, and she focused instead on teaching with the goals of the CCSSM in mind. She believed that her students would know well the mathematics they had been taught, but she did not think they should be required to test on concepts they had not learned. She explained:

The students would not complete the material needed for the EOC. They would be able to go more in depth into each topic. Maybe it should be based on how far the students went in the material as to what to test them over. There would be multiple types of tests based on different sections covered. If the students would only study through polynomials, they would be given a test over the material through polynomials. Why is this not applied to testing? (Writing Prompt 6, 1/25)

Although Kathy believed students who had been taught mathematics using reform-oriented methods could make connections well and transfer their learning, she did not believe they would perform well on an assessment limited to multiple-choice items that have a procedural focus. As she said, “I do believe that students that learn in a reform-oriented classroom have a better understanding of the material. I do not know however if they would be able to score higher on a multiple choice test” (Writing Prompt 5, 1/10).

Description of Reform-Oriented Classroom

Through my analysis of Kathy’s responses, a fifth category that emerged was her description of a reform-oriented classroom. According to Kathy, a reform-oriented classroom could be recognized by the students’ engagement in the mathematics and the teacher’s acting as a guide for the students’ discovery. Her description of a reform-oriented teacher or classroom, in a perfect world, is below:

Kathy: All the students are engaged and trying to discover math, discover different tasks [and] different real-world problems using the knowledge that they have. What can they figure out? How can they do this? Doing the Lego problem, they had a lot of fun.

AKG: So, in this perfect world class, what is the teacher doing?

Kathy: Being a guide. That is what I try. There are some things that I don't feel as if I have time to let them discover and I actually have to teach them how to do it. With that it is direct instruction.

AKG: But, when you do that, you feel like it is because of a time issue and not because of the students?

Kathy: Yes. It is because of time, because I have so much to get in their brains before the end of the school year.

AKG: As the perfect-world lesson progresses, what are the students doing?

Kathy: "Ohhhhh!" I love that part. I love when I hear them say that. I don't even tell them to be quiet. I love that they are getting it. It's wonderful when I hear the light bulbs going off. That is what keeps me here: the "Ahhhh, I figured it out!"

AKG: So, right then, you know they've gotten it. How do they share what they know?

Kathy: I ask them if everyone in the group knows how to do it and see if they can help the ones that don't. (Initial Interview, 11/14)

In Writing Prompt 3, Kathy said that ideally she would teach about three times per week using the reform-oriented methods she described above, but issues such as the amount of time required to use these methods and the need for available mathematically rich tasks prevented her from doing so.

Another criterion for a reform-oriented lesson is, in Kathy's words, its being "more student-directed rather than teacher-directed" (Interview 1, 11/21). Her students' "engagement [in the lesson] and them taking responsibility for their own learning"

(Interview 1, 11/21) also made Kathy feel like she was using reform-oriented teaching methods as she envisioned. About a recent lesson, Kathy said, “I did not feel like a reform-oriented teacher during the lesson because I felt as if I was talking more than my students. I was not asking thought-provoking questions” (Writing Prompt 4, 12/05).

Attempts to Change Teaching Style

Kathy’s attempts to change her teaching style from that of previous years was another category in her individual case description. Kathy labeled her teaching style at the beginning of the academic year in this study as more student-centered than it had been in the past. She described her current classroom as “What are you given? What do you need to have? The style was more like ‘Let’s discover this’ rather than ‘This is how it is. Here’s your homework’ ” (Initial Interview, 11/14). She was “enjoying [teaching] more this year too. I really am because [the students] are in charge of their learning. They want to know how to do it. They are interested in it” (Initial Interview, 11/14). When reflecting on a recent lesson, Kathy said that she felt good when her students became excited about solving the problem on which they were working. “When the light bulb goes off and I see it in the students’ eyes, I remember exactly why I teach” (Writing Prompt 1, 11/17). Looking forward, Kathy said she thought the next year would be even better and called the current year “a rough draft” (Initial Interview, 11/14).

In the first two weeks of November, Kathy taught five or six lessons that she considered reform-oriented, or more student-centered than teacher-centered. Her students knew what she expected them to do, but they were unhappy with her guiding them rather than giving them the answers. Kathy described one of those lessons:

Kathy: Well, I gave them word problems and they had to determine what went on the x and what went on the y . They had to determine the points. They had to try it. They had to do it. I didn't tell them how to do it. All I did was to give them the prompt and they had to do the rest.

AKG: How did they respond to the lesson? Did they seem to know what you expected them to do?

Kathy: Yes. They knew what I expected them to do but they didn't like that I wasn't giving them answers. (Interview 1, 11/21)

Kathy struggled with her students' confusion that she did not answer their questions in the same manner their previous mathematics teachers did:

And [they say], "But, you're our teacher, why will you not teach us?" And, I feel bad, like I'm cheating them. One girl asked, "Are you going to teach this to us?" So, they feel like they're going home without their algebra teacher teaching them, and they feel like they're having to learn it all on their own. That is why I'm struggling. (Final Interview, 3/05)

To help her gauge her attempt to modify her teaching style, I asked Kathy to reflect on how well her students learned the mathematics that she intended them to learn in a recent lesson. She "wouldn't say all of them did. I would say, for the most part yes, but not all of them. I just can't get all of them" (Interview 1, 11/21). Although all the students did not learn what she had hoped they would, she did notice that they were all engaged in the lesson. She described how, "Even the ones that [usually] struggle or act up during class were actually discussing the problem. That is what I wanted" (Interview 1, 11/21).

One part of her change in teaching style on which Kathy thought she needed to work was her ability to pose questions that were more open-ended than the ones she had been asking:

If I could do something over, it would be to [ask] questions [that are not so] leading. This is something else that I did not practice enough on over the summer in either of my Common Core trainings. Just to help students get the ball rolling in the right direction without leading them more to the answer. I want to have questions that are more thought-provoking to the student. (Writing Prompt 2.1, 11/20)

Another area in which Kathy wanted to improve was how much she talked in class compared to how much her students talked. After one lesson, I asked her what she would do differently if she could teach the lesson again. Her response is below:

I probably would have had more discussion rather than me standing up there answering things. Of course, that would have taken more time, and we probably wouldn't have gotten through as many of them. You know, we've talked about time being a factor that hurts Common Core. (Post Observation Interview, 12/02)

Kathy recognized her questioning skills and student discussion time as areas for improvement in her attempt to change her teaching style. Another area she thought needed changing was one she recognized as beyond her control. Kathy felt frustrated when her concern about the number of lessons she needed to teach before school dismissed for the Christmas holidays forced her to teach lessons that were less student-centered than was typical for her. "There are certain lessons that I want to finish before Christmas break. I feel as if I am rushing sometimes when I am doing teacher-directed

learning rather than student-directed” (Writing Prompt 4, 12/05). Kathy recognized that, of the three participants in this study, she was “the furthest one behind, but I do all these [math] tasks and math journals. That is why I am further behind. The others don’t do as many [math] tasks as I do” (Initial Interview, 11/14). A recurring theme with Kathy was the amount of time required to teach a lesson using what she considered reform-oriented methods, and she often lamented, “Time is always a factor” (Writing Prompt 4, 12/05). I asked Kathy how time was a factor in a particular lesson she taught:

AKG: Was there time for [the students] to explain their ideas and critique each other? Were you able to get to all of it?

Kathy: No. I couldn’t get to it all in one class period. . . . Just like I said in my writing prompt, if I had longer time, I could have them think about “Which one of these values is going to go first in your [ordered pair]? Which one is going to come second?” I don’t have that time when I have three other hands up and only five minutes left. (Interview 1, 11/21)

As much as she loved teaching discovery lessons, Kathy acknowledged that when time constraints prohibited these lessons, she used more conventional instructional methods instead. She indicated that, by early March, she was no longer using reform-oriented methods in her classroom. “I can’t do any more [math] tasks like that [one] I did [when you observed]. There is no time to do any more. It is strictly teaching” (Final Interview, 3/05). Thinking back to the beginning of the school year, Kathy said:

We wanted to do lots of the stuff that we had learned. Then, we realized that we were going to get far behind if we kept doing it like that. We had to push and get

into [more] material so we kind of slacked off. (Writing Prompt Interview 1, 12/19)

When describing Kathy's instructional practices, Joyce and Michael recognized that, although they all began the year attempting to follow the recommendations in the CCSSM, Kathy, as Joyce said, "tried harder to stick with it" (Final Interview, 3/05) than the other two did. Not only did Kathy believe her new strategies were better for her students, but she also enjoyed her teaching more as well. She reflected that the mathematically rich tasks "were fun, when we could do them" (Final Interview, 3/05). In comparing her goals over the course of the school year, Kathy talked about being "brainwashed over the summer for Common Core. We went into it full force" (Final Interview, 3/05) and then, because of time constraints, being "back to how we were thinking last year" (Final Interview, 3/05) for the second semester. When anticipating the next school year and wondering what curriculum standards they would have, Kathy said, "Whatever [the state] tell[s] us we have to do, we just do it" (Final Interview, 3/05).

Obstacles to Change

The final category that emerged through my analysis of her data was the assortment of obstacles Kathy perceived to her transitioning to using reform-oriented teaching methods. At the beginning of the school year, and for the first months of school, Kathy was enthusiastic about using teaching methods that were on target with the goals for instruction described in the CCSSM. She enjoyed using these methods in her teaching, and she appreciated her students' enthusiasm for learning. As the year progressed, Kathy became frustrated and reverted to using teaching methods that were more traditional than those she had used at the beginning of the year. Through her

writings and interviews, Kathy revealed three obstacles to her transitioning to a more reform-oriented teaching style: difficulty in locating mathematically rich tasks to use in class, instructional time needed to teach the lessons plus instructional time lost school wide, and adjustments needed to be made by the students. In the following paragraphs, I will elaborate on each of the obstacles Kathy disclosed to her teaching using more reform-oriented methods.

Mathematically rich tasks. One obstacle to Kathy's transitioning to using reform-oriented teaching methods was the problem she had finding suitable tasks to use in class. She noted that finding mathematically rich tasks to correspond with the skill she wanted to teach was "the most difficult thing" (Initial Interview, 11/14) about teaching using reform-oriented methods. When I asked Kathy where she found the instructional tasks she used in class, she replied, "Sometimes I am making them up. I get some from the books I got from the [Teaching Algebra] we went through, and some I get online" (Initial Interview, 11/14). At the beginning of the school year, Kathy believed she was not as prepared as she should have been to teach according to the goals of the SMP, and she attributed her need for preparation to her "lack of materials" (Beliefs Survey, 11/01). Later, I asked Kathy what prevented her from using reform-oriented methods as often as she would like, and one of the items she listed was "learning tasks [that are ready] to be used are lacking. More resources available to all teachers would help" (Writing Prompt 3, 11/25).

Instructional time. A second obstacle Kathy found involved instructional time. Kathy named the length of the class period and the amount of time to teach a lesson well as significant obstacles to her teaching in a reform-oriented manner. She did not like

having to stop a lesson and continue it the following day and explained, “So much is lost when the student leaves the classroom and forgets about the topic” (Writing Prompt 3, 11/25). If her school adopted a schedule with extended block classes, then the problem of unfinished lessons could be eliminated:

Time is always a factor. It’s such a shame that we are limited to a short amount of time with these children and expect them to understand all seven classes they went to in that day. I am an advocate of block scheduling, especially with Common Core implemented. (Writing Prompt 2.1, 11/20)

Similar to, but more serious than, the problem of class time, according to Kathy, was the amount of time spent school wide on testing and preparing to test. She exclaimed, “If they would stop testing these kids all the time and let us teach!” (Final Interview, 3/05). When discussing the full implementation of the Common Core in the following school year, Kathy said she could be excited about the possible changes, if she knew the amount of time spent testing would be reduced. In the final interview with me, Kathy, speaking for all three participants, apologized that their frustration level led to their collective venting about testing and loss of instructional time and planning time. “So we’re a little frustrated. You’re getting to hear all of it, and I’m sorry” (Final Interview, 3/05).

Student adjustments. A third obstacle Kathy found in her attempted change in her teaching methods involved the adjustment difficulties she anticipated for her students. Kathy considered the scheduling of her state’s transition to using the CCSSM as flawed. She explained how, if the implementation had progressed with the students through

elementary school, middle school, and high school, then the students would be comfortable learning in this way:

They should have started this in first grade. First graders are doing it, second graders are doing it, and that's fine. We should have waited until we got those kids who got it all the way through their years before we started this and not just throw it up in the middle. It's like we're telling them, "You've been learning like this all your life but, now you've got to think." They don't know how to do it because they've never had to do it before. Whereas, the kids who are learning it, now, in elementary school, will know what they're doing when they get to us, if we're still doing this. (Final Interview, 3/05)

Summary of Kathy's Case

Kathy continued working at her version of reform-oriented teaching longer than did the other two participants in this study. She laughingly claimed that she was brainwashed by what she had learned through Teaching Algebra, but her students' excitement in the classroom was important to her. She believed that teaching using methods aligned with the goals of the SMP was a better way for her students to learn, and she continued attempting to use these methods throughout most of the first semester of the academic year. Kathy was frustrated by her unproductive searches for mathematically rich tasks, but recognized that she could eventually create or acquire the materials she needed. More daunting was Kathy's anxiety about the number of skills she needed to teach before her students took the EOC and the multiple-choice style of that test. She believed her students would perform well on the test items that addressed skills she had taught during the school year, but she worried about the items she would not get to teach

if she continued using more time-consuming teaching methods. Ultimately, her concern for her students' performance on the state's exit exam caused her to abandon her attempts to change her practice.

Michael's Case

Michael had lived in King County his entire life, and he graduated from King County High School. He attended college at a nearby university and had returned to his alma mater to begin his teaching career. Michael was active and athletic, and, to help alleviate the stress accompanying his new career, he had recently begun an exercise regimen. Michael's case is presented in the following sections. With one exception, I used the same categories of responses for Michael's case that I did for Joyce's and Kathy's. In Michael's case, a category for a description of his previous teaching style was not appropriate. For him, the category that emerged instead was one for his observations as a first-year teacher.

Background as a Student and Path to Teaching

In order to learn more about Michael, I asked him whether his mathematics instructors were more traditional or more reform-oriented, and he described his educational background:

For the most part, it has been traditional. That is the way I have seen most of the teachers do it and that is what I am used to. . . . It was mainly lectures. Give a problem, and then the student tried it. . . . From what I can remember, all of my math classes were done relatively the same way. (Initial Interview, 11/13)

He described how, as a student, he was not concerned about the process that lay behind his solutions. “I just wanted the right answer and I didn’t care how I got it. If I didn’t have to think about it, I just wanted the answer” (Initial Interview, 11/13).

In college, Michael was in two education classes that he described as more unusual than the others, but “the math classes were mainly traditional” (Initial Interview, 11/13). In one course, which was offered through the education department, Michael was supposed to design a mathematics lesson that used debate as a teaching tool. He explained how, at the time, this was a struggle for him, because he believed mathematics had to be right or wrong and left no room for debate:

My area was math so I would sit there and figure out how to debate using math.

Now, with this Common Core, I see that I could have done it easier. But then, I was having trouble figuring it out because [in math] it is either right or wrong.

(Initial Interview, 11/13)

Michael followed a more traditional path to teaching than Joyce and Kathy did. He completed a bachelor’s degree, majoring in mathematics and concentrating on mathematics education, and a minor in secondary education. Soon after he graduated, Michael began teaching at King County High School. The academic year of this study was Michael’s first teaching experience.

Observations from a First-Year Teacher

Michael’s first year of teaching began about three months before this study began. Although he could not compare his current teaching style to that in previous years, Michael was able to give insight into attitudes and perceptions of a beginning teacher. He observed that teaching was more stressful than he had anticipated, but he was “taking it

day-by-day and trying to survive” (Initial Interview, 11/13). After teaching for a few months, Michael realized:

How much I really don’t know about teaching, how much is really involved in the actual teaching. I am not going to base this first year on whether I like it or not, because it is so brand new. I am literally learning everything from scratch. . . .

Right now it is dealing with the frustration of not knowing what to do, not feeling independent enough to be able to do things on my own, because I don’t know what to do. . . . So, it is more stressful than what I want. (Initial Interview, 11/13)

Michael recognized not only the frustrations, but also the positive aspects he found in his teaching practice. He described his work with a student whose parents required him to receive tutoring from Michael after school:

He is starting to do worksheets, [math] tasks, and things like that on his own.

Now, he is actually surpassing one of the smartest students in class and answering questions. So, I can just see the smile on his face. Yeah, there are a few moments when I see the “aha” and the “Oh, that’s how you do it” and things like that. That is what keeps me going. (Initial Interview, 11/13)

Learning possible behaviors and characteristics of his students was one piece of Michael’s adjustment to his new teaching career. He recognized that he was an authority figure for his students, but he did not anticipate how that would translate to their learning process: “I am noticing that when the teacher says something, [the students] assume it is true, and they stop thinking” (Initial Interview, 11/13). As Michael worked on his question-posing techniques throughout the year, he realized that his students’ attitudes toward his position as their teacher were a factor to consider. He observed that “there is

already this new person, that is an authoritative person, [who] makes them nervous, and they feel because it's a teacher, he's going to expect only the right answers" (Writing Prompt Interview 2, 2/04). At this time, Michael worked at appearing neutral and avoided seeming to have all the answers. He did not want to hamper his students' desire to discover.

Training and Experience with Reform-Oriented Methods

Michael was hired by King County Schools early in the summer, and his predecessor at King County High School had participated in the spring sessions of Teaching Algebra. In his place, Michael became a participant and was able to complete the professional development project, but he did not attend the state-provided training in preparation for the implementation of the CCSSM. At the time of the enrollment for the state training, Michael was not yet a school system employee and therefore not eligible to enroll. Michael considered Teaching Algebra his training ground for reform-oriented teaching methods. On the Beliefs Survey, Michael classified himself as between familiar and very familiar, at the beginning of the school year, with the CCSSM, and he attributed his level of familiarity to his participation in Teaching Algebra. Although he felt familiar with the CCSSM, he felt only moderately prepared because he wanted better access to mathematically rich tasks and "it's still so new to me" (Beliefs Survey, 11/02). A recurring theme in Michael's responses was his frustration with finding tasks he believed were appropriate to use in his classroom. In later sections, I will elaborate on how he determined whether a task was appropriate for him to use to teach Algebra I. Michael described himself as very positive about transitioning from his current state standards to the CCSSM. When I asked what contributed to his positive attitude, he said, "The

professional development [Teaching Algebra] during the summer! It got me excited about it through experiencing it firsthand” (Beliefs Survey, 11/02). In the following section, I will describe some of the beliefs Michael had about his new career and newly discovered teaching method.

Beliefs Regarding Teaching Mathematics and Reform-Oriented Methods

Michael recognized there were benefits to students when they learned mathematics from teachers using reform-oriented teaching methods and, ideally, he “would be able to get to two reformed lessons in a week” (Writing Prompt 3, 12/02). He believed that students who learned from a teacher who applied the targets for instruction of the CCSSM were better able to make connections between their mathematical knowledge and their learning in other classes:

I think the Common Core would help them in going to other subjects. . . . I know the lecture students can only grasp so much information just by someone talking to them. Many people are hands-on and if they can get it done themselves, they will retain it longer and will be able to use it in different ways. (Writing Prompt Interview 2, 2/04)

Michael especially appreciated how using questioning techniques that were more open supported students. After teaching a lesson in which he worked at leading his students with questions, Michael noted, “It was difficult, but I think a great tool . . . to give students power and confidence in solving problems, rather than just telling them what to do” (Writing Prompt 1, 11/16).

Michael continued to work on his questioning techniques throughout the year, and, after one lesson, he said he felt like a reform-oriented teacher because his students were doing most of the work and he was asking questions:

I think the main thing from [Teaching Algebra] that I'm still using is to try not to say what a student can . . . say. I try not to, but it gets hard, because I'm not used to them waiting. . . . I want to jump in and save [them]. I have to force myself to sit there and just wait and get the other students to wait and let them work through it. Finally they see it. (Writing Prompt Interview 2, 2/04)

In contrast to his feeling good about how he posed questions to his students, Michael said he did not feel like a reform-oriented teacher when he reverted to doing most of the talking in class. Michael valued students' mathematical questioning as well as that of the teacher. In his responses to the Discourse Survey, Michael described mathematical conversations as students talking with other students while the teacher posed questions, and he revealed that students should, with the teacher's facilitation, question each other about their reasoning. Michael valued questioning, but did not consider it the most important part of a lesson.

Michael described his thoughts about needing good questioning skills, and with Writing Prompt 8, I asked Michael to rank questioning along with these possible parts of a mathematics lesson: teacher explanation, student exploration of lesson (both individually and as a group), student explanation of work, teacher questioning students, and students questioning other students. I also asked him to explain how he determined his rankings. His placement of each part and his explanation for that placement are below:

I had a lot of trouble with this one. They are all super important. I know it's mainly about the students, and the teacher is just there to throw out the idea then the students explore that idea and extend it. We are just there kind of like as the bait and they come up and grab it. That's all we're doing is laying the foundation. Of course, in order for them to do that, if they are learning a new idea, the teacher has to have a good explanation.

#1: Teacher explanation. The teacher has to explain it accurately and well enough so they can take it. The teacher shouldn't just give them the shortcut but explain why. Sometimes, in some classes, it is really hard to do because they don't know what that means.

#2: Student explanation of the work. They would be engaged in math conversation and that is very important. The more engaged they are, the easier it will be to talk math. It also lets the teacher know if the student understands the concept.

#3: Teacher questioning students. To be an effective questioner, that helps the teacher get more out of that student and make the student think more instead of just going over the surface. Trying to extend stuff and just asking questions forces them to think. If they're not prompted or they're given no question then they just study a whole sheet of answers.

#4: Students questioning other students. That was hard. I had kind of a tie between the teacher and the students. I do know that if students talk to each other, they can get more out of it than what a teacher can if the teacher was questioning.

The students have their own lingos and different ways of explaining that can make it even easier.

#5: Student exploration of the lesson. I feel like if they have got all the rest of that stuff that is going to set them up with a perfect foundation to explore. Now that they have some knowledge and they've talked about it a little bit, they have gotten a better grasp of it. If they go into an exploration lesson, they will be able to work their way more confidently. (Writing Prompt Interview 2, 2/04)

Although he talked about the importance of posing good questions, the above passage revealed that Michael valued teacher and student explanations above questioning.

The importance Michael placed on a teacher's explaining the mathematics for the students, which he ranked first in the list in the previous paragraph, was reflected in other comments he made about the teacher's control of the lesson. In the Discourse Survey, he said that students learned mathematics best when they were engaged in mathematical investigations in which the teacher designed the questions. Michael believed that students were the most important source of mathematical ideas, but that teachers must monitor and direct those ideas. According to Michael, the teacher was also responsible for teaching the mathematics the students needed before they could engage in a mathematical investigation. He explained, "I like to [teach a] traditional lesson to figure out what the kids know, and then . . . I can give them a task" (Writing Prompt Interview 1, 12/19).

His need to teach a lesson before his students worked with a skill was reflected in some of Michael's other responses. In the Discourse Survey, he shared that when planning, he considered group activities for his students that would be used after he had communicated key information. Reform-oriented lessons, according to Michael, guided

students to a new way of looking at their existing knowledge, but were not necessarily used for new learning. Michael said that the lessons need to revolve around mathematics with which the students “feel strong . . . and can do well” (Interview 1, 11/21). He had trouble finding suitable mathematically rich tasks because he wanted them to correspond with his textbook and also to use mathematics that the students already understood. He described finding a task that corresponded “with the actual lessons and material that they are going over. That [math task] is not so bad, but when I find one [that is] including something that I haven’t [taught], yet, I really can’t [use] it” (Writing Prompt Interview 1, 12/19). When I asked about the students who did not remember the mathematics to which they had been exposed, Michael responded that with reform-oriented lessons these students had a “huge opportunity to be able to, at least, get the chance to grasp it” (Interview 1, 11/21) in the new lesson. Michael believed that a good time to teach using reform-oriented methods was when some of his classes had gotten ahead of the others. Describing upcoming lesson plans, Michael said:

I am using a task for students that are ahead, and I have to get some other classes caught up. So, with the people that are ahead, I am going to use that day as a math task for those and then catch the other students up. (Initial Interview, 11/13)

When he described a recent lesson, Michael explained why he did not teach the same lesson in all of his classes. “Well, I wasn’t able to [for two classes] because this was one of those lessons that allowed me to help get [those classes] caught up.” (Interview 1, 11/21)

One belief that Michael shared with me about mathematics and reform-oriented methods of teaching mathematics related to the importance of students’ discussing and

defending their work. Michael appreciated mathematical arguments and students' justifying their choices. He compared mathematics to a lawyer's courtroom argument and said the students "have to justify [their choices] and their decision is based on weighed evidence" (Final Interview, 3/05). He believed it was important for students to learn to present their solutions and explain the reasoning behind their mathematical choices. One benefit of this process, according to Michael, was to reveal any misconceptions that existed and use them for further instruction. Although Michael did not continue his efforts to utilize methods aligned with SMP goals beyond the first semester, when he taught what he considered a Common Core lesson, he explained that his students presented their work, defended their choices, and critiqued the work presented by other students.

Description of Reform-Oriented Classroom

From his responses, Michael revealed some of his beliefs, which are in the previous section, about reform-oriented teaching methods, and he also revealed his perception of a reform-oriented classroom, which I will share in this section. When I asked him to describe a reform-oriented classroom, Michael said the teacher would first lay a foundation for the mathematics being taught, and then would ask probing questions, getting the students to answer their own questions:

What I imagine is the teacher would just ask questions. That is what I have been trying to do. I have to tell them the foundation first, but then, after they have seen it, it is just asking questions, probing them, to get them to answer their own questions. They are just given a task and they know the drills, then they just sit there and try. There is this stuff that they have seen before, kind of like how we

did it in our [Teaching Algebra], and then just working together to come up with an answer and being able to justify with mathematical reasoning. (Initial Interview, 11/13)

Michael added that what he described was an ideal situation, not what he observed in his own practice.

Sharing his image of a dream class in a reform-oriented classroom, Michael described one in which the students worked independently within their groups and did not get frustrated when they struggled with the mathematics:

The students would be sitting in their groups, waiting quietly for the teacher to walk in. I'm assuming they have already been introduced to this topic [through some type of] discovery lecture where they get the information, but they have already seen this stuff. When they are given the problem everything has been laid out, instruction wise, for what they need so, obviously, the procedures are understood. I am assuming they are going to sit there and work together [and be] open to [seeing] different views from other students. [They will] try it out first, and then ask questions later. Then they would be able to not get frustrated when they are being asked a question or when they ask, "How do I do this?" So, I am assuming it is more than being able to be independent. (Initial Interview, 11/13)

Michael again expressed his belief that students needed to work independently and think for themselves in a reform-oriented classroom:

I feel like a reform teacher when I am getting the students to do most of the work on the board, or verbally in class, when I ask questions. I remember reading that article about to not say what a student can say. This has made my questioning as a

teacher a lot better, and I know the students are gaining more from answering more questions. (Writing Prompt 4, 12/05)

In this section, Michael described his image of how reform-oriented teaching methods would look in a classroom. In the next section, I will share his experiences as he attempted to use reform-oriented methods in his own classroom.

Attempts to Change Teaching Style

Michael began the school year eager to teach in a manner closely aligned with the goals for practice described in the CCSSM. He expected that he and his fellow Algebra I teachers would teach the same classes and would be able to share ideas and plans with each other. Soon he observed the three teachers were “not as uniformed as I thought we would be but, the thing is, we are all at three different places and we have three different types of students” (Initial Interview, 11/13). Michael recognized that the pressures of teaching, combined with those specific to a first-year teacher, caused him to search for the familiar and comfortable in his practice. “I teach like [my teachers] did because that is how I learned, and it is very hard to break what I have learned. I am [however] trying my best to use the Common Core [practices]” (Initial Interview, 11/13). Michael thought of himself as orderly and structured, but realized:

It is possible that I am changing my procedures on a weekly basis. . . . I hate it. I am trying to get used to it. I am able to be flexible, if I am given enough time to change things. (Initial Interview, 11/13)

Although Michael was not comfortable with what he felt was an almost constant change in his practice, he recognized that he did want to improve his practice. He noticed that as he planned, he was “thinking about doing it the right way and [figuring] out how

to do what I'm doing right now but with a math task" (Interview 1, 11/21). After one lesson, I asked Michael to rate himself, using a 1 to 5 scale, as a reform-oriented teacher:

On that lesson? I would not score myself high. I would give myself a 3 just because it is still new. I still feel like I [need] to say more. . . . I think most of my teaching is going from table to table, asking those questions. I guess it's more individual, tailor-made instructions for each student while everyone else can still be working. (Interview 1, 11/21)

After the lesson on which he rated himself a 3, Michael said, "I enjoyed it, and I think the kids enjoyed it. I am trying to get more with Common Core and get [the students] to do most of the work" (Interview 1, 11/21). Michael was pleased with his students' enjoying class and also with their behaviors in class, which is shared in the following paragraph.

His students' attitudes toward his attempts to change his teaching style encouraged Michael. He explained, "They really liked the independence. This week, I have had students, hands-down, say they wanted more" (Interview 1, 11/21). Michael was pleased also with his students' work in class:

Normally, I have students who will raise their hand almost immediately when a word problem is on the worksheet. This time, with the help of their teammates, the students worked together and tried to work out the problem to their best ability. (Writing Prompt 1, 11/16)

Michael described how a student, who was typically disruptive, was engaged in the lesson and took charge of her group:

I had a few people that were struggling who stepped up and actually became the leader in one of their groups. I had one young lady stand up and just start taking

charge of that group, because they were starting to get talkative. With her, it doesn't matter if there is another teacher in there, the principal or anybody. She will act up if she wants to act up but she [wanted] to do that lesson. (Interview 1, 11/21)

Michael was pleased with his students' behavior, but he was also pleased with some of his own teaching behavior and proud of how his questioning skills developed throughout the year. After one lesson, Michael regretted not giving his students clearer instructions. He explained that several students were not sure what the assigned problem was asking them to do. Rather than giving them explicit instructions, he asked the students questions and helped them figure out what was being asked. Reflecting on one lesson, Michael felt good about the probing questions he asked his students during the lesson:

I tried in every encounter with my students to ask them a question when they asked me about a problem. I really focused on the student, who just said "I don't know how to do this," or just pointed at the problem and expected my great telepathic powers to shine. I really tried to lead them to what really was their misunderstanding and finally to their success in the problem, without really telling them anything. I only asked questions. (Writing Prompt 1, 11/16)

Although he was proud of his improved questioning skills, Michael recognized that he lacked the confidence he needed as a teacher to let some events unfold on their own. During one lesson, he realized that he was dissatisfied with the random assignment of students into groups:

I could control some of the placements. . . . I could hold all the red [UNO] cards for the smart students and have them spread out so that every group will have a high-performing student. I think that will balance out the groups and make the environment more of a positive learning place. (Writing Prompt 2.1, 11/20)

Michael also wanted more structure for the students who were presenting their solutions in class, and thought a guide and some practice would help:

What I wish I had done was to have an extra [PowerPoint] slide where it showed the presenters what they actually had to present. While other people were presenting, they could be looking up and preparing . . . I had a few people walk up and ask what they needed to say, so it was unclear. That was the only thing that I wish I would have put up there because that probably would have made it better. (Interview 1, 11/21)

For several months, Michael attempted to change his teaching style, but, by February, he was no longer using reform-oriented techniques in his classroom. He explained that he was beginning to prepare his students for the Algebra I EOC exam and needed to use more traditional teaching methods. After he observed Joyce's teaching, Michael adopted some of her teaching procedures that allowed him to work from the area of his desk and move around the room only when the students had problems. He was excited that this technique made him feel more in control of the events in his class. He also had a system whereby his students were able to respond quickly to questions regarding mathematical procedures. "That's what I'm doing right now and that seems to be working phenomenally, because they are spitting the information right back to me" (Final Interview, 3/05). Michael was excited about learning these procedural techniques

and commented, “My ideas on what I am seeing in the class are constantly changing for me. . . . I realize some of these things that I want to do are kind of like a fairy tale or Utopia thing” (Final Interview, 3/05). He had not, however, given up on using instructional methods that were aligned with Common Core:

Towards the end of the year, with me being a new teacher, I just tried to survive. I’m just now trying to figure out how to confidently teach, and I’m slowly working into doing some more in that [Common Core] style. . . . I’m just not effective enough as a Common Core teacher yet. (Final Interview, 3/05)

At the beginning of the school year, Michael attempted to teach in a reform-oriented fashion, but he “had so many disciplinary problems that I had to change my seating because the kids were just talking the whole time” (Final Interview, 3/05). At the beginning of the second semester, Michael voiced his agreement with Joyce when she said the goal was “to get through the checklist” (Final Interview, 3/05) of skills that would be on the state Algebra I EOC exam.

Obstacles to Change

Michael’s obstacles to his teaching using practices aligned with the goals of the CCSSM could be grouped primarily into differences he perceived between Common Core standards and practices and his current state requirements, concerns associated with his students, and his need for resources and training. In the following paragraphs are Michael’s explanations of each of these groups of obstacles.

Conflict in standards. Michael called the relationship between Common Core goals and his state’s high-stakes testing a “huge conflict” (Final Interview, 3/05). When

discussing teaching in a manner aligned with Common Core goals and the demands of the state test his students would take at the end of the year, Michael said:

I wish we just tried one thing and would stick with it. . . . Because, now we are being stretched in 900 different ways. I am a very structured person and I don't like to be going two different ways at once. I am either gung-ho on this way or gung-ho on that way. I don't ride fences in situations. (Initial Interview, 11/13)

Not only did Michael believe he needed to fulfill two very different sorts of requirements, but, as a first-year teacher, he was apprehensive about his students' taking an assessment with which he was unfamiliar:

I just have the pressures of having to get through this section, having to get through this EOC and then, all of a sudden, I need to be doing this Common Core. And as a new teacher, trying to figure it out [is stressful]. (Initial Interview, 11/13)

I asked Michael what would happen if he did not think about EOC demands and focused instead on teaching with Common Core goals for instruction in mind. He replied, "I am just worried that not all concepts will be addressed and I will miss something to teach them that will be on the EOC" (Writing Prompt 6, 1/28). Michael recognized that teaching his students through a mathematically rich task was more time-consuming than using more traditional methods. He observed that investing the time in using a mathematical task "has to be worth it in the end because of the EOC" (Writing Prompt Interview 1, 12/19).

Toward the end of the first semester, I asked Michael what were factors that prevented him from teaching the two reform-oriented lessons per week that he wanted to

teach. The first obstacle he named was the “EOC test—I have to get to a certain point by the test day. I fear that I will not get through enough for them to pass” (Writing Prompt 3, 12/02). Michael recognized that his main teaching focus had become his students’ performance on their state exit exam, and he was not happy about this shift. “Right now, I want to make sure [my students] know the stuff that will be on the EOC, even though that sounds like the person I didn’t want to be, with the test, test, test” (Writing Prompt Interview 2, 2/04).

Student concerns. A second group of obstacles to Michael’s teaching using reform-oriented methods concerned his students. Michael believed that in order to be successful, his students needed to make various modifications, and their need to change prevented Michael from teaching reform-oriented lessons as often as he would like. His students were comfortable with the traditional methods in which they had previously learned mathematics, and they were not comfortable with more reform-oriented methods. Michael observed their behavior when his students were confronted with a mathematically rich task:

With the way that students have been trained now, if it hasn’t been shown to them before, they are going to look at it and, a few of the students that do care—and I’m saying probably about 4 or 5 in each class—will actually try. But, if it doesn’t make sense right off the bat to them, no one else is going to want to try. So, I think they are looking at the leaders in the classroom to see if they can do it, and if they can’t, then [the others] aren’t even going to worry about it. (Writing Prompt Interview 1, 12/19)

In addition to his students' comfort with traditional teaching methods, Michael also noted that what he considered his students' hectic nature combined with their short attention spans presented a problem:

I've got to get the information to the students as best I can before they lose the focus. These days, with this generation, these kids want things so fast, and their attention span has shortened dramatically from when I was in school. They are texting constantly, social media is there and constantly updating. They [want] stuff now, and if they have to sit, stop, and think, it completely messes them up and they get bored really easily. I have to keep moving, change things around, get people up, and have them do stuff. Just to sit down and do exploration method is something I would love to do if my environment allowed me to, but it's not, so I have to readjust. As a teacher, that's what I have to do. (Final Interview, 3/05)

Michael believed that a majority of his students

aren't going to get a thing out of it because they honestly just don't care. Now, if we had a classroom full of students who are the best of the best, then, yes, Common Core would be perfect because it would push them to the next level and make them think more than they have normally done. This Common Core, one-size-fits-all, is not going to work with this group. (Final Interview, 3/05)

From their behavior in his classroom, Michael determined that his students had short attention spans and did not value learning algebra. He also believed that these characteristics impeded his students' learning mathematics with reform-oriented teaching methods.

Resources and training. Another obstacle to Michael's using reform-oriented teaching methods was the need he felt for resources and additional training. Michael did not mention needing time to create mathematically rich tasks like his colleagues did; instead, he said he needed readily available tasks that were aligned with his curriculum, and he needed training on how to use them effectively. A recurring topic for Michael was his wanting tasks that corresponded specifically with his mathematics book, or he wanted "more structure with Common Core. I want it to be aligned with the curriculum in my class" (Writing Prompt 6, 1/28). While he was trying to decide when he would attempt to teach another reform-oriented lesson, Michael explained what would determine the topic for that lesson:

I know I at least want to get through solving systems, and then I might try to do maybe one for . . . something they have seen and feel strong in and can do well in. . . . I'm just afraid to use the [math tasks] that are far away from the book.

(Interview 1, 11/21)

Michael explained that what he desperately needed was a book of mathematically rich tasks that were labeled to coordinate with his textbook and standards:

If we can get something that is aligning with our standards and along with most of the textbooks [it would be wonderful]. I'm not saying that it has to be a textbook, but kind of structure it to where we can . . . just look up stuff, pick a topic, pick a subject and, boom, it's right there. (Writing Prompt Interview 1, 12/19)

In addition to wanting tasks and lessons that coordinated with his curriculum, Michael also wanted to see the lesson taught by another teacher. He did not want to teach

a lesson unless another teacher had taught that lesson successfully and had made suggestions about it:

If I haven't seen something done, or if I don't know how to do it myself, then I am going to be clueless until I have seen something. I am one of those people that needs to look at it, and then I am able to kind of replicate and then start making it all my own, after I have seen it work. (Writing Prompt Interview 1, 12/19)

He added that fear of the unknown combined with a feeling that time would be wasted on a lesson that did not work deterred him from teaching new lessons. Michael was apprehensive about trying to create lessons without a guide:

It's so new I don't really know how to do it confidently and comfortably. I know we have to start somewhere and can't keep using that excuse, but, with the way I think, I have to have some type of foundation, some type of skeleton to fill in and then I'd be set for it. . . . I don't mind not having a good skeleton, if it's something that I can improve on. Having something would be better than nothing. Right now, I have no clue where to start or what to get. (Writing Prompt Interview 2, 2/04)

When I asked Michael about advantages to the student of learning in a reform-oriented classroom, Michael reiterated his need for more training and the pressures he felt regarding the state's end-of-year Algebra I test. When discussing the possible curriculum changes for the following school year, Michael said, "If we're going to go full-fledged Common Core, I need more stuff" (Final Interview, 3/05).

Summary of Michael's Case

Michael's responses to the Discourse Survey and during subsequent interviews were in contrast to his practice. I was unsure if his answers were what he thought I wanted to hear, or were they his actual beliefs, which were then confronted by the reality of the classroom. In Interview 1, which was our second extended conversation, Michael seemed to be contradicting himself throughout the entire interview. He excitedly described a reform-oriented lesson that he considered a success, and told me how his students and an observing administrator thought the lesson was great. In the same interview, he also described the traditional lesson he had taught that day and how well he thought the students learned and responded. Like many other first-year teachers, Michael had not yet established his position as a teacher and, by the end of the study, was still confused and frustrated by what he thought of as opposing ideologies. Michael believed that reform-oriented teaching methods were better for the students, but he could not reconcile using those methods with preparing for the Algebra I EOC exam.

Cross-Case Comparison

In order to address the three research questions in this study, I examined the interview transcripts, writings, and survey responses from the three participants. As I examined these, I looked for similarities and differences among the participants that would help explain their beliefs and perceptions relative to the three guiding questions. In contrast to the individual cases, which revealed the participants' perceptions about reform-oriented teaching and the CCSSM, the cross-case comparison revealed the participants' beliefs about themselves during their attempted transition from using

traditional teaching methods. The following paragraphs use the participants' words to examine each of the three research questions.

First Research Question

The first research question used to guide this dissertation study was: How do Algebra I teachers who are attempting to transition from using traditional instructional methods perceive their abilities to teach using reform-oriented instructional methods. Through the Participant Beliefs Survey, the three participants revealed that at the beginning of the school year they each had some measure of confidence in their abilities to teach Algebra I using reform-oriented methods. With 1 representing the most positive response and 5 representing the least positive response, Joyce rated herself a 3 on both familiarity with and preparedness for the Common Core, and both Kathy and Michael rated themselves with a 2 on familiarity and a 3 on preparedness. At the beginning of the school year, all three of these participants believed that they had the abilities and they attempted to teach using practices aligned with the goals of the CCSSM. Michael described, and Joyce and Kathy agreed, that all three of them had "started off [the year] doing the same style" (Final Interview, 3/05), which to him meant using the techniques they had learned through their participation in Teaching Algebra during the summer. This section examines each participant's perceptions of her or his own ability to teach Algebra I using reform-oriented instructional methods.

Joyce. All three participants perceived they were capable of teaching using reform-oriented methods. They believed, however, that their capabilities existed to varying degrees and came with assorted restrictions. Joyce believed she had the ability to occasionally teach using reform-oriented instructional methods, but she opted not to

practice those methods. In addition, her belief about her ability was restricted to specific types of lessons. Early in the school year, Joyce made a decision that this was not the year for her to transform her teaching style. In a conversation with all three participants, Kathy reported that less than two weeks into the year, Joyce “began saying we had to get moving” (Final Interview, 3/05) if they were going to teach the skills their students needed before EOC exams. As the one possessing the most teaching experience of the three, Joyce was their de facto leader. Joyce believed that she had the creative ability to use problems and assessment items from her textbook resources and “modify those to make them task-like” (Initial Interview, 11/13). She was hesitant, though, about her ability to use those tasks more than occasionally:

But, as far as doing that style of teaching, every day, no, no, I don’t feel like I can.

I don’t feel like I have . . . we had an awesome training with [Teaching Algebra] and it helps, but I still don’t feel like I am trained enough, that I’m knowledgeable enough to be doing it every day and be doing a good job with it. (Initial Interview, 11/13)

Not only did Joyce restrict her ability to use reform-oriented instructional methods to occasional lessons, but she also limited her ability to those lessons which taught general mathematical skills. Joyce believed she had the ability to teach broad topics using reform-oriented methods, but she did not think she had “seen enough to know how I would teach each little part” (Writing Prompt Interview 1, 12/19). In our final conversation together, Joyce implied that she believed she had the ability to use the goals for her teaching practice that were described in the CCSSM, but she did not put forth the effort that Kathy did. “I think you’ve tried harder to stick to it than we did. I

really do” (Final Interview, 3/05). In the same interview, Joyce implied that it was her choice, not her lack of ability, that prevented her from using reform-oriented teaching methods:

I think in a perfect world, investigation is the way to go because it’s going to stick with them, but we can’t do that. It’s not realistic. . . . But there are some things in which it is just not worth it to do exploration. It’s not worth it to do every single thing with exploration. Sometimes, I don’t think it is profitable to do exploration.
(Final Interview, 3/05)

Kathy. Of the three, Kathy attempted to teach longer than her colleagues did using methods aligned with the goals of the SMP. She believed strongly enough in the effectiveness of these methods and felt confident enough in her own abilities to continue her efforts after the other two participants had reverted to using more traditional teaching methods. From the beginning, Kathy’s eagerness to practice what she had experienced through Teaching Algebra and her state training was evident in her words and in her voice. She laughingly referred more than once to her being “brainwashed” (Final Interview, 03/05; Writing Prompt Interview 1, 12/19) for the Common Core and talked about wanting “to do lots of the stuff that we had learned” (Writing Prompt Interview 1, 12/19). Kathy believed she had the ability to teach using methods aligned with Common Core goals for practice, and she did so two or more times per week throughout the first semester of school and through the first few weeks of the second semester. In mid-November, Kathy was confident enough in her ability that she used her new teaching style to plan and teach a reform-oriented lesson for her formal classroom evaluation by one of the administrators of her school. Because of Kathy’s attitude toward the SMP and

her belief in her ability to teach using these practices, she kept attempting to use reform-oriented teaching methods in her classroom until mid-January. However, when she realized how many skills her students needed for their EOC exam that she had not yet taught, Kathy returned to using more traditional teaching methods in her classroom.

Michael. Like his colleagues, Michael believed he had the ability to teach Algebra I using reform-oriented teaching methods and, at the beginning of the school year, intended to implement those methods throughout the year. He also taught a reform-oriented lesson during his formal evaluation by a school administrator, and he was encouraged by the positive feedback he received from his evaluator. Michael maintained his belief that he was able to teach in this style, but, throughout our interviews, he continued to report issues that were preventing him from achieving his goal. Michael reported that his mental picture of an Algebra I classroom was not an accurate one. He explained that if his students were more invested in their learning and cooperative about working with others in class, then he could use more exploration and investigation in his lessons. Besides students' attitudes, finding appropriate mathematical tasks and planning for lessons were additional issues preventing Michael from teaching using more reform-oriented methods. He believed that if he had mathematically rich tasks that correlated with his textbook, then he had the ability to teach in a manner aligned with Common Core goals. He was "afraid to use the ones that are far away from the book" (Interview 1, 11/21) and did not consider writing the tasks himself. Michael believed he had the ability to revise a lesson he had taught to make it more aligned with Common Core goals:

I'm trying to figure out how I can do that with another lesson. I am one of those people who, even though I feel better after getting that out of the way, now I'm

thinking about doing it the right way and figuring out how to do what I'm doing right now but with a math task. (Interview 1, 11/21)

Michael believed he had the ability to revise lessons and teach using reform-oriented methods, but "it just takes a lot of preparation, and I'm just not sure if I can do that every day" (Interview 1, 11/21). In early February, Michael reported that he needed to prepare his students for their upcoming Algebra I EOC exam. "I still haven't done another math task, because now it is starting to get into the EOC. I'm getting nervous and I'm trying to figure out what I need to do" (Writing Prompt Interview 2, 2/04). When questioned, Michael implied that without the EOC looming ahead, he would attempt to achieve the goals for instruction described in the SMP.

Summary of first research question. Each of the three participants believed, to varying degrees, they had the ability to teach Algebra I using reform-oriented teaching methods. Kathy believed she could, she was eager to try, and she continued her efforts the longest of the three participants. Like Kathy, Michael believed he could teach using reform-oriented instructional methods, but he reported several issues that prevented his demonstrating and practicing his ability. Joyce believed, with reservations, that she could use reform-oriented teaching methods, but she decided that, because of the EOC exam, she needed to use more traditional teaching methods and move her students quickly through the skills she needed to teach.

Second Research Question

The second research question guiding this study was: What are the criteria teachers attempting to transition from teaching with traditional methods utilize to determine their success as reform-oriented teachers. The three participants each used

different criteria to measure their own success, and they judged themselves to be at varying levels of success as reform-oriented teachers. In a group conversation at the end of the study, I asked how they would order themselves in how closely aligned they were to the goals of the CCSSM at the beginning of the school year. Michael responded, “I think we started off doing the same style,” and Kathy added, “We were all pretty much doing the same thing” (Final Interview, 3/05). They portrayed this shared teaching style at the beginning of the year as an attempt to replicate what they had learned through their participation in Teaching Algebra, and this was supported by their responses to the Participants Beliefs Survey (Kathy, 11/01; Michael, 11/02). The following paragraphs examine the participants’ perceptions of successful reform-oriented teachers. The first section describes criteria for success that were common to the three participants. This section is followed by a description of each participant’s individual perception of success.

Common characteristics. Three characteristics of successful reform-oriented teachers were shared by all three participants: an observed transformation in the students’ classroom behaviors or attitudes, an improvement in the teacher’s questioning skills, and the opportunity for students to share their work with their classmates. The following paragraphs provide examples of each of these characteristics.

When I asked each of the participants about themselves as reform-oriented teachers, all three described student-focused traits. Joyce described feeling like a reform-oriented teacher when her students were engaged in discovering something they had not previously realized. She explained that, in previous years, she “would go down the checklist” (Writing Prompt Interview 1, 12/19) and tell her students what to do at each step. This year, she instead encouraged her students to discover for themselves what they

could do in a given situation. Kathy depicted her students' excitement about learning:

“When the students saw how to work the problem, they gave statements such as, ‘Oh! I get it!’ or ‘I see it now!’ [and I saw] the light bulbs go off” (Writing Prompt 1, 11/17).

Michael was excited that his students relied more on their peers than they relied on him:

“This time, with the help of their teammates, the students worked together and tried to work out the problem to the best of their ability” (Writing Prompt 1, 11/16).

An improvement in questioning skills was another common characteristic the three participants used in describing their own success as reform-oriented teachers. Joyce noted her “questioning and teaching style have completely changed from last year to this year because of the training” (Initial Interview, 11/13). Kathy struggled with her questioning skills, but she reported that she was working to improve:

I would limit my questions to not be as leading . . . to help students get the ball rolling in the right direction without leading them more to the answer. I want to have questions that are more thought-provoking to the student. (Writing Prompt 2.1, 11/20)

In one interview, Michael said he “felt really good about my probing questions. I tried in every encounter with my students to ask them a question, when they asked me about a problem” (Writing Prompt 1, 11/16). A few days later, when describing a recent lesson, Michael shared, “For this . . . task, I was able to ask better questions, and I never answered anyone directly” (Interview 1, 11/21).

A third goal described by the participants for a teacher using reform-oriented methods was the opportunity for students to present their work to their peers and critique the work of their classmates. With Writing Prompt 8 and the Discourse Beliefs Survey,

all three participants revealed that they valued this portion of a reform-oriented mathematics lesson, and, with other interviews and writings, all three recognized that this characteristic was missing from their own classrooms. When I asked Joyce what she would change if she taught a recent lesson again, she replied, “What I would have done is let them present their results. I would have let them work and produce something together, but with the [time] restraints of the class, we didn’t get to take it there” (Interview 1, 11/21). Similarly, Kathy described how, following one lesson, she felt like a reform-oriented teacher, except the students were not able to explain their ideas and critique each other because they “couldn’t get to it all in one class period” (Interview 1, 11/21). When I asked Michael about that portion of his lesson, he explained, “It does take two days just to get through all the presentations” (Interview 1, 11/21). The following sections depict characteristics of successful reform-oriented teachers described by each participant.

Joyce. At the beginning of the school year, Joyce had a goal in mind and believed herself to be moderately successful as a reform-oriented teacher. Her participation in Teaching Algebra “shows me what it could be. Now, I am definitely not there. Maybe, for five or six lessons this year I have been there” (Initial Interview, 11/13). In a later interview, when I asked Joyce if she considered herself to be in the reform-oriented spectrum, she responded, “Well, I’m on the way, but I’m not there or even close to there. . . . My feet are in the water and I’m trying it out” (Interview 1, 11/21). By the second week of school, Joyce was worried about the amount of material she was teaching compared to previous years. As the school year progressed, her concern about the amount of class time needed to teach using reform-oriented methods decreased her attempts to

teach using these practices. In early December, she described a lesson she taught that morning:

If I rated it from one to ten, I would rate this at about a six. I thought they did pretty well, but I was frustrated with the time constraints. I just wish we could have gone further with it. . . . I mean, I could stretch it into two days, but I can't afford to do that. (Post Observation Interview, 12/02)

In a later interview, Joyce described a different lesson:

I felt like I was a little bit reform oriented in that we didn't learn a procedure. I felt like I was being traditional in that we had a list of things to do in two days and we checked them off. (Writing Prompt Interview 1, 12/19)

Joyce acknowledged that she had made the decision to table her attempts to use teaching methods aligned with the goals of the SMP. "I am not even thinking about Common Core right now, honestly. I have traditional lessons. We are in the grind toward EOC" (Writing Prompt Interview 2, 2/04). In our final conversation together, Joyce said, "I've just gone under the panic of how much we have to get done in the amount of time left and I feel I don't have time for this" (Final Interview, 3/05). During the time she was attempting to teach using reform-oriented methods, Joyce felt somewhat successful. After she decided her students would perform better on the EOC exam if she used more traditional teaching methods, she deemed herself to be unsuccessful, by choice, as a reform-oriented teacher.

Kathy. Overall, Kathy considered herself successful in her attempts to teach using reform-oriented methods. From the beginning of the school year, she tried "to do [at least] one per week" (Initial Interview, 11/14) and continued her effort into the second semester. Given the amount of time she taught using reform-oriented methods, Kathy had

the opportunity to hone her teaching, and she felt successful using methods aligned with Common Core goals. Each time I asked her about her criteria for determining success, her responses were student-centered. In one instance, she had put her students “in charge of their learning” (Initial Interview, 11/14). Another lesson “actually worked. They were having to put their minds together. Even the ones that struggle or act up during class were actually discussing the problem. That is what I wanted” (Interview 1, 11/21). The occasions Kathy did not feel successful as a reform-oriented teacher were the times she “felt as if I was talking more than my students” (Writing Prompt 4, 12/05). When reflecting on what she would change in a recent lesson, Kathy said:

I probably would have had more discussion rather than me standing up there answering things. Of course, that would have taken more time, and we probably wouldn't have gotten through as many of them. You know, we've talked about time being a factor that hurts Common Core. (Post Observation Interview, 12/02)

Early in the second semester, Kathy's concern about the time she required to teach reform-oriented lessons caused her to begin teaching more traditional lessons and cover more material that her students would need for their Algebra I state exam. Until that point, she perceived she was successful as a reform-oriented teacher.

Michael. Michael recognized that teaching in a manner aligned with the CCSSM goals was difficult for him. He was a beginning teacher, and he wanted the comfort of teaching in a style with which he was more familiar. Referring to his own mathematics teachers, he said, “I teach like they did because that is how I learned and it is very hard to break what I have learned, but I am trying my best to use the Common Core” (Initial Interview, 11/13). Later, in the same interview, I asked Michael how his transition to

using reform-oriented methods was progressing. He replied, “I just have the pressures of having to get through this section, having to get through this EOC, and then, all of a sudden, I need to be doing this Common Core” (Initial Interview, 11/13). After receiving positive feedback after his formal evaluation, Michael believed more strongly in his success as a reform-oriented teacher. He favorably compared the evaluated lesson he taught to one he taught earlier in the semester. “I felt like I was really more comfortable than I was [with a] math task at the very beginning of the year” (Interview 1, 11/21). Using that lesson, I asked Michael to rate himself on his teaching with the goals of the CCSSM in mind, and he said:

I would not score myself high. I would give myself a 3 just because it is still new. I still feel like I have to say more, but then again, I think most of my teaching is going from table to table, asking those questions. I guess it’s more individual, tailor-made instructions for each student while everyone else can still be working. (Interview 1, 11/21)

After talking to his evaluating administrator, Michael’s perception of his success was strengthened. “After I had my evaluation and post-conference, I saw that I am doing a good job. I know, with that math task, I was able to get kids to think in a different way” (Interview 1, 11/21). As the year progressed, Michael’s feelings of success became less positive:

I feel like a reform teacher when I am getting the students to do most of the work on the board or verbally in class when I ask questions. . . . I did not feel like a reform-oriented teacher when I am not planning more Common Core type

lessons. I tend to go back to me teaching, but the students work together. (Writing Prompt 4, 12/05)

Michael recognized that he was becoming more traditional in his teaching methods, and rationalized his decision by saying traditional lessons are “just what [the students] are used to and what I am used to, so I feel like I am just slowly going back” (Writing Prompt Interview 1, 12/19). In early February, Michael reported that he had not taught using a mathematically rich task since the first semester because “it is starting to get into the EOC. I’m getting nervous and I’m trying to figure out what I need to do” (Writing Prompt Interview 2, 2/04). In our last group conversation, Michael explained that he was using traditional teaching methods because “I’m just not effective enough as a Common Core teacher, yet” (Final Interview, 3/05).

Summary of second research question. The participants in this study had three shared criteria to judge their success as they attempted to transition from using traditional teaching methods. In their evaluation of success, all three included student behaviors, their own questioning skills, and students’ presentation of work. They varied, however, in their ratings of their own success as reform-oriented teachers. Joyce believed she was moderately successful using teaching practices that were described in the CCSSM, while she was attempting to transition to that style. In deference to the EOC exam, she elected to discontinue her efforts, and, therefore, was, by choice, unsuccessful as a reform-oriented teacher. Because Kathy attempted to use reform-oriented methods longer, she was more practiced and felt more successful than her colleagues did. Her new style, however, was derailed by her concerns about the impending EOC exam her students would take. Michael considered his transition to using reform-oriented teaching methods

as a work in progress, and he believed he could eventually be successful. At the time of this study, he was dealing with the pressures felt by a first-year teacher and felt more successful using the traditional teaching style with which he was familiar.

Third Research Question

The final research question for this study was: What obstacles do teachers face as they attempt to transition from teaching with traditional methods to teaching with more reform-oriented methods. Although there was some variation in how severely these obstacles deterred each participant, the four obstacles, with one exception, which will be explained in a later section, were common to Joyce, Kathy, and Michael: time required to teach reform-oriented lessons, especially with concerns about preparing students for their EOC exam; materials, specifically mathematically-rich tasks, needed to teach mathematics using reform-oriented methods; problems related to the students' attitudes or abilities; and additional training or experience needed by the participants. This section examines how the participants described each of these obstacles.

Time requirement. All three participants mentioned several times the difficulty they had with teaching reform-oriented lessons, given the time constraints they were facing. Each class period at King County High School lasted 45 minutes, which meant, as Kathy explained, "Most of the lessons have to be two days" (Writing Prompt 3, 11/25), a problem voiced also by Joyce and Michael. None of the participants wanted to spend more than one day on a topic, and they discussed the pressure they felt to finish teaching each of the tested standards before the Algebra I EOC exam, which would be administered in April. As Michael said, "I have to get to a certain point by the test day. I fear that I will not get through enough for them to pass" (Writing Prompt 3, 12/02).

Kathy echoed the sentiment: “Time is always a factor. There are certain lessons that I want to finish before Christmas break. I feel as if I am rushing sometimes when I am doing teacher-directed learning rather than student-directed” (Writing Prompt 4, 12/05). In explaining why all three participants were using more traditional teaching methods, Kathy said, “We realized that we were going to get far behind, if we kept [trying to teach reform-oriented lessons]. We had to push and get into the material, so we kind of slacked off” (Writing Prompt Interview 1, 12/19).

Materials. A second obstacle common to all three participants was the need for materials, especially mathematically rich tasks, to use in the classroom. For Joyce, the need for materials was created by the shortage of time:

I mean, it takes too long to write your own task. You know, I can’t do it [with the amount of time I have]. I can’t write a task, and there is nothing there like “Ten Great Tasks for Systems of Equations” or whatever. There just aren’t any resources. (Writing Prompt Interview 1, 12/19)

When I asked Kathy what obstacles were hindering her using, as often as she would like, mathematical practices described as goals in the CCSSM, the first item she listed was the need for mathematically rich tasks. Michael was more exact about the tasks he lacked than Joyce and Kathy were. He specified needing “resources where it actually goes along with our curriculum” (Writing Prompt Interview 1, 12/19). Later, he elaborated even more: “I would love [math tasks] to be tailored to our curriculum and going with problems aligned with our textbooks that we are teaching our students” (Writing Prompt 5, 1/15). In a group conversation, Michael stated, as Joyce and Kathy nodded their

agreement, “If we’re going to go full-fledged Common Core [next year], I need more stuff” (Final Interview, 3/05).

Student concerns. Concerns related to students formed the third obstacle faced by all three of the participants as they attempted to transition from using traditional teaching methods. Joyce and Michael were troubled by their students’ attitudes, and Kathy was apprehensive about their adjustment to a different teaching style. Joyce explained that students in Algebra I “don’t care if this is an investigation. They just want to know what they are supposed to do, so it’s hard to fight against that mentality” (Final Interview, 3/05). Michael described his frustration:

I have half of the class actually doing the exploration, and the other half is completely wasting time. . . . Exploration method is something I would love to do, if my environment allowed me to, but it’s not, so I have to readjust. As a teacher, that’s what I have to do. (Final Interview, 3/05)

Kathy was dissatisfied with the timeline followed in her state for the implementation of the CCSSM. She believed the students would have adapted more easily to their new way of learning if the mathematics standards had been implemented at increasingly higher grade levels each year rather than all of elementary school and middle school in the same year:

We should have waited until we got those kids who got it all the way through their years before we started this, and not just throw it up in the middle. It’s like we’re telling them, “You’ve been learning like this all your life but, now you’ve got to think.” They don’t know how to do it because they’ve never had to do it before. (Final Interview, 3/05)

Kathy did not communicate that the attitude of her students' was an obstacle to her using reform-oriented teaching methods in her classroom.

Training or experience. The fourth obstacle, a need for more experience and training, was shared by Joyce and Michael, but not by Kathy. Joyce believed that ideally she would teach everything in a style aligned with the goals of the CCSSM. When I asked what was preventing this, one of the problems she listed was “my education on how to do it” (Writing Prompt Interview 1, 12/19). I asked Joyce if learning over time would be enough, and she replied:

Joyce: Well, yeah, you learn as you go. That's true with anything.

AKG: But my question is, do you think practice is all you need or do you think you need something else, as well?

Joyce: Oh, I think a semester class would be good—a semester's worth of real studying and learning of it, like you did when you were in college. I think that's what it would take. (Writing Prompt Interview 1, 12/19)

Rather than a training course, Michael wanted to see videos of another teacher implementing a mathematically rich task before he used the same task in his own classroom:

I guess it's just the fear of the unknown of what is going to happen. I want to know, for sure, that it has been proven, and then I have something to fall back on. You know, if it fails, I can say, “It worked here and so I guess that is why it doesn't work here.” (Writing Prompt Interview 1, 12/19)

Joyce and Michael did not practice reform-oriented methods in their own classrooms to the extent that Kathy did, and she did not voice a concern about needing more experience or training.

Summary of third research question. Through each type of response that they shared with me, the three participants revealed obstacles to their transitioning from teaching with traditional methods to teaching with reform-oriented ones. These obstacles could be grouped into four categories: amount of time required, materials needed, student-related problems, and training or experience needed. All three participants shared the first three obstacles, and Joyce and Michael shared the fourth one.

Summary of Cross-Case Comparison

The participants' responses in their interviews, surveys, and writings were used to address the three guiding research questions for this dissertation study. All three participants generally believed they had the ability to teach Algebra I using reform-oriented teaching methods. They believed, however, that they possessed these abilities to varying degrees. All three participants shared three criteria to use when measuring their success as reform-oriented mathematics teachers. The participants also believed they each exhibited, to differing extents, success as a reform-oriented teacher. When examining obstacles to using less traditional teaching methods, all three participants named time constraints, lack of materials, and issues with students. Two participants also named a need for more experience and training.

Summary of the Chapter

The goal of this study was to develop a description of the three participants as they attempted to transition from using primarily traditional teaching methods to more

reform-oriented instructional methods. In this chapter, I presented the individual case description for each participant as well as the cross-case comparison among the three participants. To develop these descriptions, I carefully and repeatedly examined the participants' responses to survey questions and writing prompts as well as their interview transcripts. From this examination, a picture of the participants, both individually and comparatively, emerged.

The framework for the participant's individual case descriptions developed from their own responses to the research instruments mentioned above. These descriptions included the participants' educational backgrounds, their beliefs regarding their own abilities and successes in transitioning, their attempts to transition throughout the course of the study, and the obstacles they recognized to their transitioning to using reform-oriented teaching methods.

The three research questions guiding this study formed the framework for the cross-case comparison among the three participants. All three participants believed they had the ability to teach using reform-oriented methods, yet all three, using their own criteria, judged themselves unsuccessful in their attempts to do so. The three participants recognized the same three obstacles to their successful transition, and two of the participants recognized a fourth obstacle.

The descriptions revealed that although they believed that using reform-oriented teaching methods was better for their students, and their state required them to begin using the goals for practice described in the CCSSM, the participants in this study were not successful in altering their practice. In the next chapter is a discussion of the results of these findings and the implications on mathematics education.

CHAPTER FIVE: DISCUSSION

Introduction

Mathematics education in the United States has been through a series of reform efforts (Klein, 2003; Lambdin & Walcott, 2007), with the most recent being the adoption of the CCSSM (CCSSI, 2010). The CCSSM incorporated the recommendations of recent suggestions from NCTM (2000a) and the NRC (2001), and methods that attempt to realize the goals expressed in these are termed reform-oriented instructional methods. In states that adopted the CCSSM, mathematics teachers not already implementing the newer approaches to teaching began attempts to transition from using traditional instructional methods to reform-oriented ones (Hobbs, 2012; Strauss, 2011; Wilkerson, 2011). The dissimilarity between the two teaching methods boded difficulty, however, for some teachers attempting the transition in their classroom practice (Bostic & Matney, 2013; Davis et al., 2013).

In this chapter, I will revisit the purpose and goals of my research, the methodology I used in this study, and the individual and combined cases of the participants. Following that review, I will discuss the results of this study and examine implications for mathematics education. Finally, I will suggest areas for further research inspired by this study.

Research Purpose

The purpose of my study was to describe, through a study of three Algebra I teachers, the beliefs and perceptions of mathematics teachers who attempted to change their style of teaching from using traditional instructional methods to reform-oriented methods. Determining whether the participants were successful in their attempts to

change their style of teaching was outside the scope of this study. Rather, my purpose was to determine their thoughts during the transition process. One of my goals in conducting this case study research was to gain insight into how mathematics teachers, who attempted the transition described above, perceived their abilities to teach using reform-oriented instructional methods. Related to this goal, my second goal was to discover what criteria teachers utilized, when attempting to transition from teaching with traditional methods, to determine their success as reform-oriented teachers. My final goal was to develop an understanding of the perceived obstacles teachers faced as they attempted to transition from using traditional instructional methods. The following section is a review of the methodology I used to achieve my goals for this research.

Review of Methodology

To examine teachers as they attempted to shift from using traditional instructional methods to reform-oriented ones, I employed a qualitative case study methodology. To better understand the beliefs and perceptions of the participants, I utilized surveys, interviews, and written reflections as my instruments for collecting data. Throughout the data collection process, I repeatedly read each piece of data, searching for emerging themes and ideas to revisit with the participants. When I recognized I was gleaning no new information from my analysis of the data, I used what I had ascertained to construct a case report for each of the three participants plus a report comparing and contrasting the three participants. The following section is a discussion of what I learned from my three participants about teachers attempting to alter their methods of instruction.

Review of Results

The results in this study were the case reports presented in Chapter Four. The next few paragraphs are a review of the individual cases and the cross-case comparison. Included in this review is a description of how my review of literature about teachers in transition correlated with my findings about the participants' period of attempted transition.

Joyce's Results

Joyce was in her fifth year of teaching mathematics and acknowledged she was jaded about school reform. After past impending reforms that either did not materialize or underwent substantial changes before adoption, Joyce avoided committing to the CCSSM until her state finalized its plans. Joyce's hesitation echoed that of other teachers represented in the literature who justified avoiding mandated reforms by referring to previous failed reform efforts (Terhart, 2013; Zimmerman, 2006). She anticipated the full implementation of the CCSSM being postponed and the standards themselves undergoing rewrites before they were finalized as the state standards. Similar to her hesitancy about the standards adopted by her state, Joyce was also concerned about the state exam her students would take. Because of Joyce's experience with the state exam for Algebra I, she had a timeline in mind of the skills that should be taught by certain points in the year. She was determined for her current students to be successful on end-of-course tests as her students had been in previous years, and she referred to her skills timeline when she made classroom decisions.

Joyce had been a student in traditional classrooms, but she considered herself a nontraditional teacher. Her students worked regularly in groups and were given group

assignments to reinforce or review previous learning, but Joyce utilized traditional instructional methods when she introduced new learning. In addition, Joyce believed that reform-oriented lessons were appropriate only for her high-performing students, an opinion shared by other teachers in the literature (Desmione et al., 2005). She encouraged dialogue among her students, but they seldom defended their work or critiqued the work of their classmates. Joyce stated that she valued both traditional instructional methods and reform-oriented methods, and she maintained that each had a purpose in mathematics education.

Joyce believed she needed to use traditional methods for her students to score well on their EOC exams. She briefly attempted using reform-oriented methods, but abandoned them in favor of teaching more material in the amount of time remaining before state exams.

Kathy's Results

Kathy was a second year mathematics teacher, and she was teaching Algebra I for the first time. She had been a student in traditional mathematics classrooms, but she aspired to use reform-oriented teaching methods in her own classroom. She jokingly described herself as having been brainwashed by Teaching Algebra and spoke more enthusiastically about implementing reform-oriented teaching methods than did the other two participants. Not only was Kathy more enthusiastic than her colleagues were about changing her style of teaching, but she also continued using reform-oriented methods after Joyce and Michael had reverted to using traditional methods. Kathy's positive attitude about her change in practice corresponded with a report about the constructive role teachers' beliefs played in classroom reform (Handal & Herrington, 2003). Sources

of her enthusiasm included the excitement her students demonstrated toward their mathematics activities and her belief that her students were more successful mathematically with her new method of teaching. Despite her enthusiasm, Kathy was frustrated by her efforts to locate or create appropriate mathematical tasks for her students and by the amount of time she believed she needed to teach a reform-oriented lesson.

Kathy believed her students knew and understood the skills she had taught using reform-oriented methods, but she recognized there was not enough time before the administration of the state exam for her to teach the remainder of the Algebra I curriculum and utilize those methods. Although Kathy continued her efforts to change her practice after the other two participants had ceased their attempts, she eventually reverted to using traditional instructional methods in order to prepare her students for their standardized state exam.

Michael's Results

Michael was a first-year teacher at the time of this study and was still establishing himself as an educator. He was comfortable following Joyce's lead in instructional matters, and he emulated her classroom style. He described learning in traditional mathematics classrooms and explained that, as a student, he wanted an example he could follow when he completed his own assignments. Michael professed his desire to use reform-oriented instructional methods, but he claimed he needed to examine videos of other teachers and imitate what he observed in those lessons. Michael appeared to value traditional teaching methods as well as reform-oriented ones. After teaching a reform-oriented lesson, he excitedly described what he and his students had done during the

lesson and the approval demonstrated by his students and his supervisor. In the same conversation, Michael described a recent traditional lesson and was pleased with how much his students learned during that lesson.

Michael, like teachers in a 2014 study by Le Fevre, was frustrated by the disconnect he perceived between his state's assessment demands and the goals of the CCSSM, and he struggled with the unknowns that existed at that time regarding curriculum and assessment. His desire to prepare his students for their EOC exam outweighed his desire to use reform-oriented teaching methods, and, when Joyce reverted to using traditional methods, Michael began to use the traditional instructional methods he had observed as a student. Michael recognized that it was simpler for him to teach using the method by which he was taught, a perception shared by other teachers in the literature (Coburn, 2003; Gwyn-Paquette & Tochon, 2003; Nesmith, 2008).

A recurring theme in the individual case reports was the participants' concern about their students' EOC scores, which has been documented in the literature (Handal & Herrington, 2003; Le Fevre, 2014; Mayer, 1988; Nesmith, 2008). The participants in this study were concerned about how EOC scores reflected on their students, themselves, and their school. The following section is a description of other comparisons among the three participants in this study.

Group Results

My three goals in this study provided a framework for the cross-case comparison among the three participants. In this section, I describe how the participants' responses provided information related to each of these goals. With the third goal, I also provide a connection between the participants' responses and the literature reviewed previously.

Teachers' abilities. With my first goal, I sought insight into teachers' perceptions about their abilities to implement reform-oriented teaching strategies. All three of the participants believed they had been trained well through Teaching Algebra, and also believed, to varying degrees, they had the ability to alter their teaching strategies. Kathy believed she could change her style of teaching and was eager to enact her plans. Michael also believed he could adopt reform-oriented instructional methods, but he perceived obstacles in his path. Joyce believed, with reservations, that she possessed the ability to change her style of teaching, and decided to stop her efforts in anticipation of her students' EOC exam. Kathy attempted to utilize reform-oriented instructional methods longer than the other participants, but eventually all three elected to teach in a traditional fashion.

Criteria for success. My second goal in this study was to understand teachers' criteria for determining success using reform-oriented instructional methods. The three measures shared by all three of the participants focused on students' attitudes and behavior, the participants' own questioning skills, and students' presentation of work. With the first criterion, the three participants felt successful as reform-oriented teachers when their students were engaged in the lesson, excited about learning, and worked well with their peers. For the next measure, the participants described their increased skill in asking thoughtful questions as evidence of their reform-oriented teaching skills. The final criterion for success as reform-oriented teachers was providing students with the opportunity to present their work to their classmates in order to critique and defend their solutions. Using their criteria, Joyce deemed herself moderately successful as a reform-oriented teacher, until she elected to halt her attempt. Kathy judged herself successful

during the time she was still implementing reform-oriented methods. Michael considered himself a work in progress, but believed he would eventually be successful as a reform-oriented teacher.

Obstacles to success. To determine what obstacles teachers perceived in their attempts to implement reform-oriented teaching methods was my final goal in this study. The participants listed three common obstacles to their successful transition from using traditional instructional methods, and two participants added a fourth obstacle: time constraints, lack of resources, student concerns, and insufficient training and experience. For each of these obstacles, I provide a connection to my previous review of literature regarding barriers faced by teachers in a period of transition.

Time constraints. In citing time constraints as an obstacle, the participants described the time needed for planning for teaching a reform-oriented lesson as part of the problem, and the time required to teach the lesson as another issue. In three studies, teachers were found to offer concerns about time as barriers to adapting their teaching in response to reform efforts (Charalambous & Phillipou, 2010; Terhart, 2013; Timperley & Robinson, 2001). Like the participants in my study, the teachers in these studies explained that their existing daily duties did not allow time to learn how to write meaningful instructional tasks and design lessons around them. In addition, both the participants in the current study and the teachers in the studies reported pressure to cover their curriculum and believed they could not afford the extended time they perceived they needed to teach a reform-oriented lesson (Charalambous & Phillipou, 2010).

Lack of resources. A second obstacle described by the participants and in the literature was a lack of the resources they believed they needed in order to change their

instructional practice. Some studies cited a general need for materials (Charalambous & Phillipou, 2010; Handal & Herrington, 2003), but teachers in other studies believed they needed a textbook aligned with their curriculum (Le Fevre, 2014; Nesmith, 2008). Joyce and Kathy wanted meaningful instructional tasks available to use when they planned their lessons, and Michael wanted a textbook aligned with his current curriculum that contained meaningful tasks, along with explanations for using them.

Student concerns. Another set of obstacles shared by the participants related to student preparedness for and behavior in a reform-oriented classroom environment. Joyce explained that her students wanted to know the correct answer for an assignment and did not want to discover the solution on their own. Similarly, Goldsmith and Schifter (1997) and Hiebert and Gruows (2007) described teachers who needed to provide a safety net against their students' productive struggle to learn mathematics. Michael was concerned that his students' general behavior would not allow him to use exploration as a teaching tool, a barrier also reported by Le Fevre (2014). Kathy did not consider her students' behavior to be an obstacle, but she was concerned about their navigating what she considered the abrupt change from traditional classrooms to reform-oriented ones. Similarly, Timperley and Robinson (2001) reported teachers who shared Kathy's concerns about what they perceived as an abrupt shift between two teaching styles.

Need for training and experience. Their need for more training and experience was the final obstacle discussed by the participants. Joyce and Michael made positive comments about the training they had received through Teaching Algebra, but they realized they needed ongoing professional development that included more training and opportunities for them to practice what they had learned. Kathy did not list a need for

training and experience as a barrier to her changing her teaching practice. Corresponding with the participants' thoughts, teachers in two studies reported they did not possess the knowledge they needed in order to implement the changes they were expected to make (Charalambous & Philippou, 2010; Handal & Herrington, 2003). Other authors explained that utilizing reform-oriented teaching methods required a different skill set than the one needed to use traditional instructional methods (Goldsmith & Schifter, 1997; Gwyn-Paquette & Tochon, 2003; Handal & Herrington, 2003).

Summary of Results

I achieved my purpose for this study: through an examination of Algebra I teachers attempting to change their teaching practice, I described the beliefs and perceptions the teachers held during their period of transition. The results of this study, however, must inform a wider audience. The following section is a discussion of these results, and after that is a description of the implications for mathematics education.

Discussion of Results

After completing the five-day summer workshop with Teaching Algebra, all three participants were eager to use the reform-oriented teaching methods about which they had learned. A primary motivation for them to change their style of teaching was the impending implementation of the CCSSM. An additional motivation, revealed through their responses during this study, was their belief that students gained a deeper understanding of the mathematics when teachers used reform-oriented instructional methods. Through the Participant Beliefs Survey and initial interviews, the participants indicated they were motivated, understood how, and were prepared to use the new

teaching methods, yet all three eventually abandoned their efforts to achieve the goals of the SMP. What follows is a discussion of this discrepancy.

Motivated to Change

The participants in this study were motivated to change their practice by their state's upcoming implementation of the CCSSM, but then realized the state EOC exams did not reflect the goals of the new standards. The mismatch the participants perceived between the CCSSM and the EOC seemed to remove their motivation for changing their teaching practice. The perceived disconnect between recommended practice and assessment demands as a barrier to reform has been documented in research literature (Le Fevre, 2014). There is not enough evidence in this study, however, to determine whether the cause of the participants' ceasing their reform efforts was their confusion over the conflicting curricula or their concern over their students' test scores.

Concern for Students' Test Scores

Apprehension about their students' scores was a prevailing issue for these participants. They recognized that the scores on EOC exams reflected on the students, their teachers, and their school. An additional concern, for these participants, was that Algebra I EOC exam scores factored into individual teacher evaluations for the entire school. Stigler and Hiebert (1999) explained that, during a transition period, test scores should not be expected to immediately increase. For measurable improvement in teaching, they described reform as a gradual, ongoing process: "Any changes will come in small steps, not in dramatic leaps" (Stigler & Hiebert, 1999, p. 132). Given the high stakes of the EOC exam, these participants believed they could not afford to gamble on a reform that did not promise an immediate improvement in exam scores.

Perceptions about Reform-Oriented Lessons

Related to their concern about test scores was the participants' uneasiness about the number of skills they could teach using reform-oriented instructional methods. They described needing two days to teach one lesson, and they believed that only one skill could be taught with each lesson. They perceived that if they continued using reform-oriented teaching methods, they could complete only half of their assigned curriculum in the amount of time they had previously taught all of the required skills for their subject. The participants' inability to design a mathematics lesson teaching more than one skill was similar to their uncertainty about teaching new skills. After attempting to use reform-oriented methods, Joyce and Michael struggled with how they could use mathematical tasks to teach new skills rather than to simply review previously learned ones. The participants' perceptions about reform-oriented mathematics lessons belied their confidence in their knowledge of the CCSSM and revealed a naïve perspective of reform-oriented teaching methods.

Phases of Transition

Reflecting on the four stages of teachers in transition discussed previously: (i.e., resisting change, talking about changing, mimicking change, and changing practice) (Andreasen et al., 2007), the participants in this study did not follow a linear progression during their attempted transition. Based on my findings, I propose a model as depicted in Figure 1.

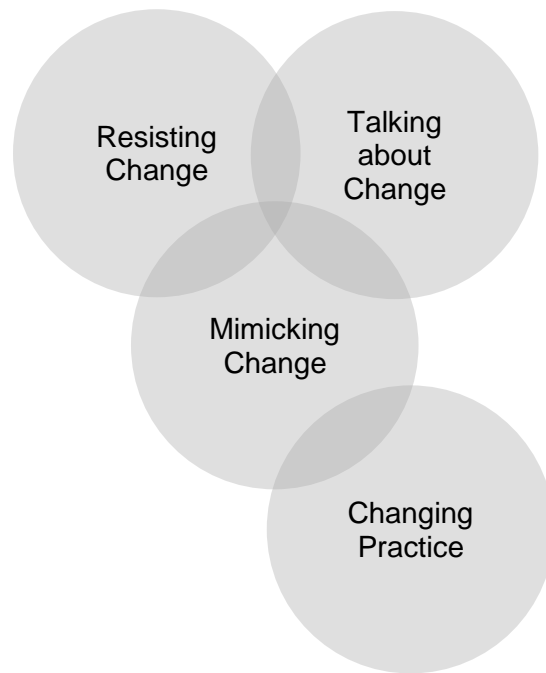


Figure 1. Teachers in Transition Model. Based on Andreasen et al., 2007.

The participants in this study appeared to move seamlessly between the phases of resisting change and talking about change. Within a single conversation, a participant's comments might begin by indicating resistance to change and then a few moments later indicate a willingness to talk about change. In addition, at times the participants' words and actions provided evidence of mimicking change. Therefore, rather than moving through the stages in a linear fashion, the participants provided evidence of moving among these three stages. To this end, I have created Figure 1 such that these three stages can be seen as overlapping.

Although these participants did not move beyond the mimicking change phase, I hypothesize that as teachers move toward the stage of changing practice they will provide evidence of alternating between mimicking change and changing practice. This

alternating is, once again, represented by the overlapping of these two stages in the figure. Furthermore, I hypothesize that when teachers begin to move between the phases of mimicking change and changing their practice, they will not return to the first two phases of resisting change and talking about change. As a result, the changing practice stage as represented in Figure 1 does not overlap with the first two stages. This progression among phases is an important idea for those providing support for teachers during a period of transition.

Participants' Understanding

The previous topics of discussion revealed an overarching theme of the participants' lack of understanding of reform-oriented teaching methods. Although they believed they knew how to implement their new teaching style, their beliefs and behaviors implied they needed assistance in understanding the ideology behind the methods. Stigler and Hiebert (1999) reported that teachers needed to share with each other what they have learned and discovered about teaching, suggesting that schools should be "places where teachers can learn" (Stigler & Hiebert, 1999, p. 142). Teachers' ongoing training in the form of professional development is one of the implications for mathematics education described in the following section.

Implications for Mathematics Education

Results of this study inform the field of mathematics education regarding how teachers can be supported in their efforts to transform their style of teaching in order to achieve the goals for instruction described in the CCSSM. With the widespread adoption of the CCSSM, many mathematics teachers across the United States need to alter their teaching practice in order to achieve the goals described in the SMP (Bostic & Matney,

2013; Davis et al., 2013). This study described mathematics teachers who expressed not only their intention to transition from using traditional instructional methods to reform-oriented methods, but also their enthusiasm about doing so. They believed they were well-informed about their prospective teaching style and also believed they were capable of implementing it, but they abandoned their goals because of perceived obstacles in their path.

The participants in this study began the school year enthusiastic about the goals of the CCSSM and eager to implement reform-oriented teaching methods. As the school year progressed, they began losing their eagerness to change their instructional methods. With a means of rekindling their earlier enthusiasm, teachers would not abandon their efforts to achieve the goals of the CCSSM. For these participants, their original enthusiasm was sparked during their involvement in Teaching Algebra. To reignite that spark, they needed a similar professional development program that continued throughout the school year.

The above model for teachers in transition (See Figure 1) suggests several implications for mathematics education, all of which relate to supporting teachers through professional development. Andreasen and her colleagues (2007) suggested that teachers in transition need professional development to move from one phase in the sequence to the next. Targeting the phase at which teachers would be best supported by professional development would help ensure the productivity of the education and support the teachers received. The participants in this study needed training to move from talking about change to mimicking change, and I posit they would need different training to move from mimicking change to actually changing their practice. A professional development

program designed around teachers' transitional phases, with both homogeneous and heterogeneous breakout groups in reference to their transitional phases, would strengthen the educational value of the professional development received by the teachers. Furthermore, the above model suggests that mathematics educators providing professional development should be aware of teachers' potential tendencies to alternate among the stages and the influence of this circumstance on teachers' professional development experiences.

Addressing three of the groups of obstacles (i.e. time constraints, lack of resources, and concerns about students) could be accomplished by addressing the fourth obstacle: a need for training and experience. With ongoing professional development and support from an effective professional learning community (PLC), teachers would develop a deeper understanding of the reforms being implemented. Training and support would better prepare teachers to use reform-oriented instructional methods, but they would not alleviate the anxieties these participants felt about their students' test scores and how those scores were used in teacher evaluations. Concerns about teacher evaluations and the use of test scores are administrative issues rather than teacher issues. The findings from this study could better inform administrators about the causes for teachers' losing their motivation when attempting to implement reform-oriented teaching methods.

The results of this study provide insight into how teachers who are in a similar period of transition in their practice can be educated and supported to continue their pursuit of educational reform. In the next section are ideas for future research inspired by this study.

Future Research

To contribute to the body of knowledge about teachers aspiring to achieve the goals described in the CCSSM, further research is needed. This study examined Algebra I teachers who were attempting to change their teaching practices in anticipation of the full implementation of the CCSSM. Since the time of this study, more states have fully implemented these standards and are administering assessments aligned with the goals described in the CCSSM. Additional research is needed to uncover the beliefs and perceptions of mathematics teachers who are operating with fully adopted standards based on the CCSSM.

Studies with teachers who are supported by ongoing professional development programs and effective PLCs would also contribute to the body of knowledge about teachers who are attempting to change their practice in response to reform efforts. In this current study, the teachers were determined to change their practice, but they were not supported by professional development or by fellow teachers.

Returning to the Teachers in Transition Model depicted in Figure 1, the participants in this study moved effortlessly between resisting change and talking about change, with occasional periods of mimicking change. To reinforce my finding that teachers move among the first three phases before attempting to actually change their practice, further research is needed to examine the beliefs and behaviors of teachers during a similar period of transition. Patterns of behavior similar to those found in this study would reinforce the implications described previously for mathematics educators providing professional development for teachers attempting to transition from using traditional instructional methods.

From the findings in this study, I hypothesized that as teachers progress to mimicking change they will begin alternating between that phase and actually changing their practice. I also hypothesized that once teachers begin alternating between mimicking change and actually changing their practice, they will not return to the first two phases depicted in the transition model (See Figure 1). Being aware of this behavior would aid in the planning of professional development for teachers during a period of transition in their practice, especially those who are at the mimicking change phase and contemplating changing their practice. Given the potential implications for mathematics educators, further research is needed to examine my premise.

Each of these suggestions for research would inform the field of mathematics education about how to provide the training and support needed by mathematics teachers during a time of transition. These suggestions would help uncover the assistance needed by teachers to ensure they progress from merely talking about or mimicking change to actually changing their practice.

Summary of the Chapter

Aspiring to goals described by NCTM (2000a), the NRC (2001), and the CCSSM (2010), mathematics teachers across the United States are attempting to leave behind their traditional teaching methods and join the other teachers who use reform-oriented instructional methods (Cogan et al., 2013; Daggett et al., 2010; Gewertz, 2013). In previous years, teachers have struggled with making changes to their practice (Charalambous & Philippou, 2010; Handal & Herrington, 2003; Zimmerman, 2006), and in some cases the barriers they encountered caused them to abandon their attempts to reform (Battista, 1994; Zimmerman, 2006). The distinct differences between traditional

teaching methods and the goals for instruction in the CCSSM (Bostic & Matney, 2013; Daggett et al., 2010; Davis et al., 2013) could discourage teachers from making the recommended changes to their practice. This study described three mathematics teachers who found the obstacles insurmountable.

For the goals described in the CCSSM to be reality for all mathematics students in the United States, teachers must be supported in their roles as both fledgling and established reform-oriented teachers. If teachers receive ongoing training, professional development, and encouragement, then it is conceivable they will persevere in their efforts to modify and strengthen their teaching practices. The ultimate goal for teachers and for the CCSSM is to develop mathematically proficient students prepared for careers or for further education.

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APPENDICES

APPENDIX A

Participant Background Survey

Please answer each of the following as completely as possible. Feel free to include any additional information.

- How long have you been teaching?

- Has all of your teaching experience been with [King] County High School? If not, please elaborate.

- Did you have a different career prior to your becoming a teacher? If so, please elaborate.

- If you had a different career prior to your becoming a teacher, what prompted your change in career? Did your becoming a teacher require additional education? If so, what courses did you take or what degree did you earn?

- List all of your college education. Please include universities, dates, degrees earned, and majors.

APPENDIX B

Participant Beliefs Survey

Think back to how you felt *when this school year began*. Please answer each of the following questions based on your feelings at that time.

(Note: Common Core refers to the Common Core State Standards for Mathematics.)

- On a scale of 1 to 6, how *positive* were you about transitioning from your previous state standards to Common Core?

Very positive

1

2

3

4

Not at all positive

5

What contributed to how positive you were?

- On a scale of 1 to 6, how *familiar* were you with Common Core?

Very familiar

1

2

3

4

Not at all familiar

5

What contributed to how familiar you were?

- On a scale of 1 to 6, how *prepared* did you feel to teach using a method aligned with Common Core?

Most prepared

1

2

3

4

Least prepared

5

What contributed to how prepared you were?

- On a scale of 1 to 6, how much *support* did you feel you had from your school administration in your transition to Common Core?

Lots of support

1

2

3

4

Very little support

5

Please give examples of your support or lack of support from school administrators.

APPENDIX C

Survey of Teacher Mathematical and Discourse Beliefs

For each question, choose the one choice that most often describes your beliefs.

1. I believe when introducing a new concept it is most important to teach mathematics lessons that:
 - a. Focus on one idea at a time, emphasizing both reasoning and computational accuracy together.
 - b. Combine a variety of ideas and their connections using a problem solving approach.
 - c. Combine at least two ideas and the connections between them.
 - d. Focus on one idea at a time, emphasizing computational accuracy before reasoning.
2. I believe the most important role of the mathematics teacher is to:
 - a. Convey information to students and evaluate student performance.
 - b. Explain reasoning for mathematical processes to students, assist students in clarifying their mathematical understanding and assess their mathematical knowledge.
 - c. Provide information to students, question them about their knowledge, and seek to understand their thinking.
 - d. Pose problems that engage students in exploring mathematical ideas and assess their mathematical understanding.
3. I believe that students learn mathematics best by:
 - a. Paying attention to the teacher and practicing problems.
 - b. Exploring student-generated mathematical problems found in their environment.
 - c. Taking notes during lessons and asking questions when they don't understand.
 - d. Participating in mathematical investigations in which the teacher designs the questions.
4. I believe that it is important for mathematical conversations to most often be in the form of:
 - a. Teacher and student discussion driven by student inquiry.
 - b. Teacher and student discussion with the teacher initiating questions.
 - c. The teacher initiating questions to determine whether or not students have correct answers.
 - d. Students talking with other students while the teacher facilitates questioning.
5. I believe it is important to learn math because it:
 - a. Provides structure.
 - b. Promotes logical reasoning.
 - c. Is beautiful and creative.
 - d. Is useful.
6. I believe that mathematics:
 - a. Is invented.
 - b. Is already all known.
 - c. Exists independent of human thought and is discovered.
 - d. Is constructed as a product of social interaction.

For each question, choose the one choice that most often describes your beliefs.

7. When I prepare lessons I believe it is most important to consider the following:
 - a. Activities or investigations that will assist my students in developing their own understanding about the key mathematical ideas.
 - b. Opportunities for group activity to be used after I convey key information.
 - c. Explanations I want to give in a class discussion along with questions I want to ask students during the lesson.
 - d. Key information I want to convey in a lesson along with student practice problems.

8. In order to teach students how to factor quadratic polynomials, I believe it is most important to:
 - a. Present students with the procedure for factoring and then have them practice individually factoring polynomials.
 - b. Use manipulatives to demonstrate using an area model for factoring polynomials with the whole class and then have students work in groups to practice factoring polynomials.
 - c. Provide student groups with manipulatives and facilitate groups in creating a model for factoring.
 - d. Present students with the procedure for factoring and then have them work in groups to practice factoring polynomials.

9. I believe mathematics is mostly:
 - a. Problem solving.
 - b. Proving existing ideas.
 - c. Computation and manipulation.
 - d. Creating new ideas.

10. I believe mathematics is most like:
 - a. A lawyer's courtroom argument.
 - b. A painting.
 - c. Cooking.
 - d. A 1000-piece jigsaw puzzle.

11. I believe that the most important source of mathematical ideas in the classroom is:
 - a. The teacher and the students.
 - b. The curriculum.
 - c. The teacher.
 - d. The students.

For each question, choose the one choice that most often describes your beliefs.

12. I believe:

- a. Learning is a mostly individual process that is aided by discussion with the teacher.
- b. Learning is an individual process accomplished by the learner alone.
- c. Learning is a process of social construction that takes place through discourse with a variety of others.
- d. Learning is a process that is accomplished through discussion with other learners and a teacher.

13. I believe that the body of mathematical knowledge is:

- a. Fixed with interconnecting structures.
- b. Fixed and predictable.
- c. Surprising, expanding and driven by new problems.
- d. Surprising and investigated through solving of existing problems.

14. I believe that:

- a. There are multiple ways to learn a mathematical topic.
- b. There is a best way to learn a mathematical topic but it may be represented in more than one way.
- c. Mathematics is learned through problem-solving in which multiple pathways to solutions are possible.
- d. There is a best way to learn a mathematical topic.

15. I believe that students learn the process of completing the square best by:

- a. Working in groups to complete several completing the square problems and discussing the solutions with the group.
- b. Repeating the steps of completing the square and explaining them to a classmate.
- c. Memorizing the steps of completing the square and practicing them.
- d. Working with a group using manipulatives to derive the process and then generalize it.

16. I believe that eliciting students' mathematical thinking in classrooms should be accomplished by:

- a. The teacher asking students to explain why their answer is valid.
- b. The teacher asking questions of students to check to see if students have the correct answers.
- c. Students questioning each other about their reasoning with teacher facilitation.
- d. The teacher asking students to explain how they solved a problem.

For each question, choose the one choice that most often describes your beliefs.

17. I believe it is most important to ask questions during classes:
- a. To assess whether or not students are paying attention.
 - b. To encourage further student exploration and, if necessary, change direction of a lesson.
 - c. To evaluate student knowledge.
 - d. To better understand my students' thinking.
18. I believe it is most important for students to learn to:
- a. Generate and explore their own mathematical questions.
 - b. Explain reasoning for processes and explore connections between problems.
 - c. Solve problems and explain reasoning for processes.
 - d. Solve specific problems accurately.
19. I believe it is most important during lessons to:
- a. Allow students to present solutions only after I have checked them for correctness.
 - b. Allow students to present different methods of a solution than I have presented.
 - c. Allow students to present solutions and use any misconceptions that surface to propel instruction.
 - d. Have the teacher present all solutions so that students are not confused by multiple or incorrect solutions.
20. In order to teach solving linear equations, I believe it is most important to:
- a. Show several examples of solving linear equations with questions asked to check for student understanding incorporated into the demonstration.
 - b. Show several examples of solving linear equations and then have students practice solving individually.
 - c. Explain the reasoning that creates the rules for solving equations while demonstrating solutions of linear equations.
 - d. Engage students in conversation that leads to the development of multiple ways to solve linear equations.

APPENDIX D

IRB Approval

October 25, 2013

Angeline Gaddy
Department of Mathematical Sciences
akg3c@mtmail.mtsu.edu



Protocol Title: The Transition of Algebra I Teachers from a Traditional Style of Instruction to a Reform-Orientated Style of Instruction: A Multiple Case Study

Protocol Number: 14-099

Dear Ms. Gaddy:

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above. The MTSU IRB or its representative has determined that the study poses minimal risk to participants and qualifies for an expedited review under the 45 CFR 46.110 Category 2, 4, and 7.

Approval is granted for one (1) year from the date of this letter for 3 participants.

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. **If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance, MTSU Box 134 before they begin to work on the project.** Any change to the protocol must be submitted to the IRB before implementing this change.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918.

You will need to submit an end-of-project form to the Office of Compliance upon completion of your research located on the IRB website. Complete research means that you have finished collecting and analyzing data. **Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date.** Please allow time for review and requested revisions. Your study expires **October 25, 2014.**

Also, all research materials must be retained by the PI or faculty advisor (if the PI is a student) for at least three (3) years after study completion in the faculty advisor's office. Should you have any questions or need additional information, please do not hesitate to contact me or the Research Compliance Office.

Sincerely,

Beverly J. Boulware

Research Compliance, IRB Committee
Middle Tennessee State University

APPENDIX E

Writing Prompts

Think about a lesson you taught recently. With that lesson and your teaching for Common Core goals in mind, reflect on and respond thoroughly to the following writing prompt. Thanks!

I felt **good** during the lesson when . . .

Think about a lesson you taught recently. With that lesson and your teaching for Common Core goals in mind, reflect on and respond thoroughly to the following writing prompt. Thanks!

If I could **do something over**, it would be . . .

Think about a lesson you taught recently. With that lesson and your teaching for Common Core goals in mind, reflect on and respond thoroughly to the following writing prompt. Thanks!

I am eager to **tell/ask** other teachers about . . .

I am thinking of a reform-oriented lesson as one in which **all** of these aspects are present: mathematically rich task, students leading learning, students presenting and defending their ideas to the class, students critiquing other students' work.

In a "perfect world," how many times per week would a teacher have a fully reform-oriented lesson?

Think of the factors—under your control or not—that prevent you from teaching reformed lessons that often. List some of those factors, in order from most important to least important. For each of the factors that you list, describe could be done to eliminate that factor. Again, the remedy may or may not be under your control.

Think about a lesson you taught recently. With that lesson and your teaching for Common Core goals in mind, reflect on and respond thoroughly to the following writing prompt. Thanks!

I did/did not feel like a **reform-oriented** teacher during the lesson because . . .

Researchers have found that mathematics students who learned in a reform-oriented classroom scored as well or better on multiple choice tests, such as EOC, than their peers who learned in a traditional classroom. What do you think about these findings? Do you question the research or findings? Or do you think the results seem reasonable? Explain your thoughts.

What would be the consequence if you chose to ignore EOC and teach in a more Common Core style?

If you were given the opportunity, and your class would not get behind, do you think you would benefit from observing other Algebra I teachers in your school? From another school? Would you be reluctant to be observed by other Algebra I teachers in your school? From another school? Please explain your thinking.

Look at these possible parts of a math lesson. Rank them in order of importance, and explain your ranking.

- teacher explanation
 - student exploration of lesson (both individually and as a group)
 - student explanation of work
 - teacher questioning students
 - students questioning other students
-

Do you favor ability-grouped math classes? Why or why not? Do you think lessons taught in a Common Core style eliminate the need (real or perceived) for ability-grouped classes? Why or why not?

Do you think the way students learn mathematics (lecture vs. Common Core-type tasks) affects their ability to transfer what they learned to other subjects and other situations? Explain your thinking.

APPENDIX F

Initial Interview Protocol

Think about your own mathematics education, both K-12 and college.

- Do you remember your instructors as primarily traditional or reform-oriented? Did they give lectures or use discovery-type activities? Can you give me some examples?
- How did the teaching styles vary with different courses and grade levels? Can you tell me more about that?
- When you think about your own mathematics teachers, do you think you teach in the same manner they did? Can you give me some examples of you do/do not teach similarly to your own teachers?
- How do you describe a reform-oriented teacher? What does the classroom look and sound like? What does a typical mathematics lesson look like?
- What changes have you noticed in your own practice so far this school year?

Make notes of questions from Teacher Background Survey and Teacher Beliefs Survey.

APPENDIX G

Participant Interview Protocol

- How many lessons have you taught this week that you consider reform-oriented? What made them reform-oriented?
- Tell me about one (or more) of the lessons (mathematical content, activities/problems used, etc.)
- How did the students respond to the lesson? Did they seem to know what was expected of them? Can you elaborate on that?
- How well did the students seem to understand the mathematics in the lesson? Could you talk a little more about that?
- When it was over, did you give yourself a mental thumbs up? Tell me more about that.
- Did you feel like you were well-prepared for the lesson? What are some things that made you feel prepared?
- Did working with other teachers help you feel prepared? Tell me more about that.
- If/when you teach the lesson again, what will you do differently? Why do you want to change_____?
- Would you call yourself a successful reform-oriented teacher after this lesson? What made you consider yourself successful (or not)?
- What criteria are you using to measure your success? Can you give me an example?

APPENDIX H

Final Interview Protocol

All three participants

From conversations with each other and what you know about each other's practice, how would you order the three of you in how closely aligned you are now to Common Core practices?

Discourse Handout

(#3) I believe students learn best by:

- a. Paying attention to the teacher and practicing problems. **(Kathy)**
- b. Exploring student-generated mathematical problems found in their environment.
- c. Taking notes during lessons and asking questions when they don't understand.
- d. Participating in mathematical investigations in which the teacher designs the questions. **(Joyce & Michael)**

In "rank the parts," interview question, Michael placed teacher explanation first, and Joyce and Kathy placed student exploration. How does that correspond to how you answered the survey question?

(#7) When I prepare lessons, I believe it is most important to consider the following:

- a. Activities or investigations that will assist my students in developing their own understanding about the key mathematical ideas. **(Joyce)**
- b. Opportunities for group activity to be used after I convey key information. **(Kathy & Michael)**
- c. Explanations I want to give in a class discussion along with questions I want to ask students during the lesson.
- d. Key information I want to convey in a lesson along with student practice problems.

Why did you choose the option that you chose?

(#10) I believe mathematics is most like:

- a. A lawyer's courtroom argument. (**Michael**)
- b. A painting.
- c. Cooking. (**Kathy**)
- d. A 1000-piece jigsaw puzzle. (**Joyce**)

Tell me more about these comparisons.

(#14) I believe that:

- a. There are multiple ways to learn a mathematical topic. (**Joyce, Kathy, & Michael**)
- b. There is a best way to learn a mathematical topic but it may be represented in more than one way.
- c. Mathematics is learned through problem-solving in which multiple pathways to solutions are possible.
- d. There is a best way to learn a mathematical topic.

What are some of the multiple ways?

Beginning this fall, assume EOC is gone, none of the old SPIs are left, and TN follows the CCSSM recommendation for Algebra I. (**Handouts from CCSSI**) What will be different about how you teach? What will you do differently to prepare for next year? [In an early interview, Kathy called this year a "rough draft."]

Compare and contrast your classroom practice goals at the beginning of the first semester this school year and the beginning of the second semester. These aren't necessarily official, written goals, but the goals you had in mind for your own practice.