

# Linking Teacher Learning to Pupil Learning: A Longitudinal Investigation of How Experiences Shape Teaching Practices in Mathematics

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BOSTON COLLEGE  
Lynch School of Education

Department of Teacher Education, Special Education, and Curriculum and Instruction

LINKING TEACHER LEARNING TO PUPIL LEARNING:  
A LONGITUDINAL INVESTIGATION OF HOW EXPERIENCES SHAPE  
TEACHING PRACTICES IN MATHEMATICS

Dissertation

by

CINDY JONG

submitted in partial fulfillment of the requirements  
for the degree of  
Doctor of Philosophy

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Linking Teacher Learning to Pupil Learning: A Longitudinal Investigation of  
How Experiences Shape Teaching Practices in Mathematics

By Cindy Jong

Lillie Richardson Albert, Ph.D., Chair

Abstract

Mathematics education is constantly at the forefront of public and academic debates during this era of increased accountability. Questions concerning teacher preparation and teaching practices that connect to pupil learning are central to these discussions. However, very few studies have examined relationships among these factors and most are confined to a short time period; thus, this dissertation studies such relationships over a two-year period. Informed by a sociocultural perspective, this study examines how preservice elementary teachers' past K-12 schooling and teacher education experiences influences their attitudes and perceptions about mathematics education over time. It also explores how teaching practices are shaped by these experiences, and are ultimately linked to pupil learning.

A mixed-method design of survey and qualitative case-study research methods was employed to collect and analyze data over a two-year period. During the first year of this study, pre- and post-surveys using Likert-scale items were administered to all preservice teachers (n=75) enrolled in an elementary mathematics methods course. For a two-year period, the experiences of two participants were explored through longitudinal interviews, observations, and an examination of artifacts (i.e., teacher lesson plans, assessments, and pupil work) to develop in-depth case studies.

Findings indicate that prior schooling experiences influenced teachers' initial attitudes and perceptions about mathematics. Nevertheless, over a short period, positive changes in teachers' attitudes and confidence to teach mathematics suggest that experiences in the mathematics methods course were conducive to building on teachers' prior knowledge. Survey and case-study findings also indicate that preservice teachers planned to teach mathematics with a reformed approach, which emphasizes a conceptual understanding of mathematics. However, it was challenging for case-study participants to implement a reformed approach as first-year teachers, especially if they had limited teaching models to reinforce this method. Findings also suggest that school context, classroom management, and mathematical content knowledge all influence teaching practices and pupil learning opportunities. Implications for teacher education, school reform, and future research are discussed.

## DEDICATION

To my sister and best friend, Vanessa Dalkhaa, for her love and support.

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## Chapter 1

### INTRODUCTION

#### Statement of the Problem

The National Council of Teachers of Mathematics (NCTM, 2000) states that “Effective teaching requires knowing and understanding mathematics, students as learners, and...a variety of pedagogical and assessment strategies” (p. 17). Today, mathematics teachers at all grade levels are expected to have a great deal of pedagogical skill and content knowledge. Most classrooms have pupils who possess a range of learning abilities, which places increased demands on teachers (Donovan & Bransford, 2005). Additionally, traditional methods for teaching mathematics are shifting to more reformed practices that have shown increases in pupil achievement (Klein, Hamilton, McCaffrey, Stecher, Robyn, & Burroughs, 2000; Ziegler & Yan, 2001). With reformed teaching, the teacher acts as a facilitator while pupils learn mathematics in a more hands-on and socially constructed manner to gain a conceptual understanding of the content (Dossey, 1992). This contrasts with traditional methods, where the teacher dispenses knowledge by presenting mathematical procedures and rules to be memorized and practiced by pupils (Romberg, 1992).

Teaching mathematics in a reformed practice can be challenging for teachers, because in most cases, they are learning to teach in a way that is completely different from the way in which they were taught mathematics (Ball, 1989; Lortie, 1975). Studies have found that first-year teachers, in particular, have difficulty teaching in a reformed manner (Ball, 1989; Hart, 2001). Although they may have been trained to adopt a reformed

practice during their preservice years, the school context of their first year plays an influential role on beginning teachers (Warfield, Wood, & Lehman, 2005). Amongst the myriad new responsibilities and challenges, first year teachers usually lack support and operate on a survival mode (Wideen, Mayer-Smith, & Moon, 1998). With increasing demands for change in mathematics education, it is important to note the ways in which teacher education programs are preparing preservice teachers (PTs) (Robinson & Adkins, 2002), how they transition into their first years of teaching, and what their pupils learn as a result of their classroom practices.

#### Purpose of Study

In light of the teaching and learning challenges in mathematics education, the purpose of this study was to investigate teacher experiences from the preservice period through the first year of teaching. Acknowledging that teaching is a multi-layered continual learning process, various experiences and contexts were examined to shed light on their influence on teaching practices over time. Furthermore, with teacher accountability on the rise, this study analyzed multiple artifacts (i.e., teacher tasks, pupil work) to connect teaching practices to pupil learning.

The goals of this study were to examine how preservice elementary teachers' past K-12 schooling and teacher education experiences influenced their attitudes and perceptions about the teaching and learning of mathematics. The investigation focused on how beliefs and teaching practices evolved over time. Another goal was to follow PTs into their first year of teaching to continue examining the characteristics of their teaching practices and how their past experiences and school contexts shaped both their



mathematical pedagogy and perceptions. In addition, the extent to which teaching practices reflected reformed mathematics pedagogy and how practices influenced pupils' mathematical learning were characterized.

To meet the goals of this study, a mixed-method approach of survey and qualitative case-study research methods was used to collect and analyze data over a two-year period. The National Research Council (2002) argues that research designs can be strengthened significantly by using multiple methods that integrate “quantitative estimates of population characteristics and qualitative studies of localized context” (p. 108). To thoroughly investigate the problem, surveys, as well as interview and observation protocols, were constructed to closely investigate the research questions posed in this study. During the first year of this study, pre- and post-surveys using Likert-scale items were administered to all preservice teachers (n=75) enrolled in an elementary mathematics methods course. For a two-year period, the experiences of two participants were explored through longitudinal interviews, observations, and an examination of artifacts (i.e., teacher lesson plans, assessments, and pupil work) to develop in-depth case studies.

### Research Questions

A constructivist perspective holds that, “We construct our understanding through our experiences, and the character of our experience is influenced profoundly by our cognitive lenses” (Confrey, 1990, p. 108). This view relies on growing evidence from cognitive science research indicating that one's prior knowledge and beliefs strongly affect the ways in which one makes sense of new ideas (Donovan & Bransford, 2005;

Nunez, 2000; Schoenfeld, 1983). Although pupils are often the focus of this research, Ball (1989) argues that mathematics teacher education could be improved by adopting a similar perspective on teacher learning. Based on the premise that teacher beliefs and experiences shape their practice, the goals of this study were to understand both the relationship among these elements and their influence on pupil learning.

Specifically, this study examined the following questions:

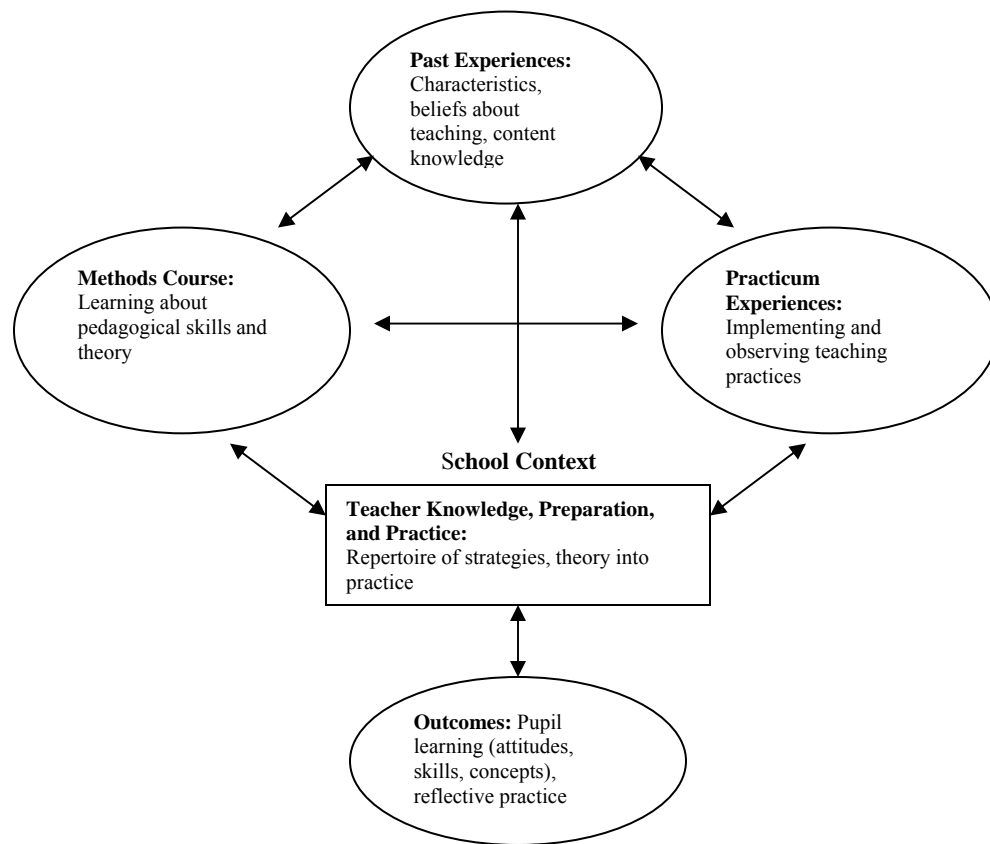
1. How do preservice elementary teachers' past schooling and teacher education experiences (i.e., mathematics methods course and field experiences) influence attitudes and perceptions about the teaching and learning of mathematics?
2. How are preservice elementary teachers' mathematics teaching practices influenced by prior schooling and teacher education experiences?
3. What are characteristics of the mathematics teaching practices of first year teachers? How do prior experiences and current school contexts shape perceptions and pedagogical practices in mathematics? To what extent do practices reflect reformed mathematics pedagogy?
4. How do first year teachers' pedagogical practices influence pupils' mathematical learning?

### Conceptual Framework

To provide structure for this study, a conceptual framework informed by literature on learning to teach highlighted the main components of the ongoing process (Grossman, 1990; Wideen, Mayer-Smith, & Moon, 1998). Teaching is a highly complex activity that occurs within multiple contexts, and theories about teaching are “remarkably

underdeveloped” (Cochran-Smith & Lytle, 1998; Clift & Brady, 2005; Oakes et al., 2002, p. 228); therefore, much research about how various experiences influence this complex process is needed. A longitudinal study was the ideal opportunity to take a comprehensive approach, beginning with preservice teachers’ entry into the teacher education program; in particular, teachers were followed throughout their elementary mathematics methods course and practicum experiences, and continuing through their first year of teaching. This design captured multiple perspectives within varying contexts of this dynamic process.

The conceptual framework presented in Figure 1.1 guided various aspects of this study. It consisted of four components: past experiences, teacher education (i.e., methods courses and practicum experiences), teacher knowledge and practice, and outcomes (i.e., pupil learning). This study examined these interactive elements, how they shaped mathematics teaching practices, and how they influenced pupils’ learning (see Figure 1.1). This conceptual framework was a simplified version of the Boston College Teachers for a New Era Evidence Team’s conceptual framework (see Appendix A), which was informed by the literature on learning to teach.



*Figure 1.1.* Conceptual Framework.

The preservice teachers' past experiences take account of their entering characteristics, attitudes, and assumptions about the teaching and learning of mathematics. Additionally, past K-12 schooling experiences include the development of their mathematical content knowledge. The next two elements of the conceptual framework are part of the teacher education program. Methods courses expose PTs to various theories of learning and help teachers develop a repertoire of pedagogical strategies. Preservice teachers majoring in elementary education in the teacher education program are required to take teaching methods courses in reading, writing, social studies, science, and mathematics. However, this study focused solely on the mathematics

methods course, because it was the most relevant to the research questions. Finally, the purpose of the practicum is to provide PTs with teaching experience as they implement acquired strategies; they gain a greater sense of teacher responsibilities in the classroom, interacting with pupils, and collaborating with an experienced cooperating teacher (Feiman-Nemser & Remillard, 1995). It is assumed that each of the three components will contribute to teachers' knowledge base, preparation, and practice in a dynamic and interactive way. Additionally, the school context is placed above the teacher practice box because it is considered to have a major influence on teacher learning and practice (Hart, 2001; Skott, 2001).

Next, the framework shows that practicing teachers (both preservice and in-service) have several outcomes, including pupils learning various concepts and skills, and the teacher reflecting on his/her practice. In this study, the outcomes were considered through observed teaching practices and an examination of teacher tasks and pupil work. Finally, the arrows in the framework were placed to show the connections among the components and their influences on teacher preparation and practice. Each component is extremely complex within itself and its interactions with the other elements. Hence, a mixed-method approach was optimal for investigating the process of learning to teach and how changes in beliefs and practice occur.

The conceptual framework for this study was developed and informed by literature on learning to teach (Grossman, 1990; Wideen, Mayer-Smith, & Moon, 1998). Several underlying assumptions of this framework viewed the combination of past experiences, teacher education programs (including the methods course and practicum

experiences), and school contexts as key components that inform teaching practices. The arrows in Figure 1.1 reveal existing relationships among the factors explored in the study. Operating under sociocultural theory, this research assumed that learning is a co-constructed process that occurs and is influenced by multiple contexts (Geertz, 1973; Vygotsky, 1978). A key assumption of teaching is that teacher practices operate under a set of value-laden cultural ideas (Gee, 1996). Additionally, the various components of the conceptual framework help to shape these values and subsequent teaching practices.

#### Importance of Study

Mathematics education is constantly at the forefront of public and academic debates due to the *No Child Left Behind Act* (NCLB) that requires greater accountability, higher standards, and increased mathematics achievement for all pupils. Highly publicized results from the National Assessment of Educational Progress (NAEP) have made mathematics an integral part of educational discourse in the United States, while the Trends in International Mathematics and Science Study (TIMSS) have opened discussions at a global level (Hiebert, 2003). As a result, stakeholders are raising critical questions about the teaching and learning of mathematics at local, national, and international levels (Ferrini-Mundy & Schmidt, 2005). These larger debates are not exclusive to the role of teachers and pupil learning. In fact, teachers and pupils are often central to these broader discussions (Schoenfeld, 2004), and it is essential that teaching practices and their outcomes are continually examined.

Traditionally, studies have examined teacher beliefs, attitudes, and experiences through surveys (Zeichner & Conklin, 2005). Existing studies focusing on teaching

practices have been widely limited to observations ranging from a few months to one year. Rarely has there been longitudinal research that follows PTs from program inception into their first year of teaching. Even scarcer is research concerning the connections made between teacher perceptions, teacher practice, and pupil learning (Lubienski, 2005). In contrast, this study examined these factors in depth.

Specifically, this dissertation used survey data (n= 75) to capture preservice elementary teachers' beliefs and perceptions of the teaching and learning of mathematics. In addition, this study examined the experiences and teaching practices of two participants with differing characteristics over a two-year period, from their preservice teacher education into the first year of teaching. The mixed-method approach of this study provided a more complete picture of the teaching and learning process in elementary school mathematics. It examined not only what teachers said, but what they did in the classroom. Darling-Hammond (2006) recommended the use of multiple research methods to assess the influence of teacher education. Furthermore, this study extended teaching practices a step further by connecting them to pupil learning.

This study was a component of the Qualitative Case Studies Project (QCS), a larger study conducted by Boston College's Teachers for a New Era (TNE) Evidence Team. TNE is a high-profile Carnegie Corporation initiative that focuses on improving pupils' learning by reforming and improving university-based teacher education programs in the United States (See Appendix A to read more about the QCS Project). Few studies of teacher learning and education are longitudinal, and even fewer link teachers' learning with pupils' learning (Lubienski 2005; Wilson, Floden, & Ferrini-Mundy, 2001). However,

this study sought to broaden the understanding of learning beyond test scores by capturing the complexity of teachers' and pupils' learning within differing contexts. The goal was to bring new insight to the field of mathematics teacher education during this era of increased accountability.

### Definition of Terms

For the purpose of this study, four key terms are defined for clarity and understanding of the research perspective: reformed mathematics, traditional mathematics, curriculum, and sociocultural theory. Current reform movements in mathematics, supported by the National Council of Teachers of Mathematics (NCTM, 2000), emphasize a conceptual understanding of mathematics that connects prior knowledge to new experiences through active inquiry-based learning that is socially constructed. That is, pupils should understand and be able to explain the mathematical processes behind the procedures they are learning. No one would necessarily argue against pupils learning mathematics with understanding. However, the means for achieving this goal have been controversial. In this study, the term *reformed mathematics* is consistent with the practices advocated by the NCTM *Principles and Standards for School Mathematics* (2000). For the purpose of this dissertation, the term also relates to the seminal work of Hiebert and Carpenter (1992), who discuss learning and teaching mathematics with understanding. They argue that both conceptual and procedural knowledge are valuable and must be connected. The term *reformed mathematics* refers to their work on *learning and teaching with understanding* (1992). Reformed mathematics adopts an internal view of mathematics, which presents the teaching and learning of



mathematics as a process of human activity. In practice, the emphasis is on pupils “doing” mathematics by investigating problems and making conjectures as they develop a personalized understanding of the concepts (Dossey, 1992; Romberg & Kaput, 1999). Thus, the role of the teacher is to create meaningful tasks that engage pupils with mathematical ideas and encourage pupils to explain their solutions strategies so that they may internalize the concepts.

In contrast, *traditional mathematics* embodies mathematics as a static collection of facts, rules, and procedures to be passively learned by practice, memorization, and drill (Romberg, 1992). That is not to say that there is no place for this type of activity in schools. However, when pupils are constantly practicing procedures without making connections to different representations, their knowledge can be limited. Traditional mathematics is consistent with the external idea of mathematics. In practice, the emphasis is on pupils mastering the established mathematical content in a sequential order (Dossey, 1992; Romberg & Kaput, 1999). Since mathematics is seen as an established body of concepts and skills available in the curriculum, there is no perceived need to discover mathematics. As a result, the role of the teacher is to present these concepts, while pupils are expected to practice the procedures and memorize facts until they are mastered. Once a concept is mastered, the teacher and pupils can move on to the next idea. One of the fundamental differences in reformed and traditional mathematics is the role of the teacher. A teacher who adopts a reformed view is more of a facilitator and co-creator of knowledge, while one with a traditional view acts as a dispenser of knowledge in the classroom. Nevertheless, teachers can have characteristics from both perspectives. As the

case studies in this dissertation demonstrate, teaching practices can fall along a spectrum from a reformed to traditional pedagogy, rather than being strictly characterized into one category. However, defining the two approaches to teaching and learning mathematics facilitates a common language for discussion.

In this study, the term *curriculum* refers to textbooks, teaching materials, or instructional guides. Participants in this dissertation were exposed to a variety of curricula, including *Everyday Mathematics; Investigations in Number, Data, and Space (Investigations); Scott Foresman; and Harcourt Math*. To clarify the classification of these curricula, NSF-funded curricula are considered “reformed” because they are based on NCTM *Standards*. Reformed curricula include *Everyday Math* and *Investigations in Number, Data, and Space*. These curricula consist of lessons that have more problem-solving activities and worksheets that focus on a conceptual understanding of mathematics. Curricula that are not sponsored by the NSF, such as *Scott Foresman* and *Harcourt Math*, are considered to be more “traditional” in nature. They tend to rely on a structured teacher presentation followed by worksheets that are generally focused on the practice of procedures. Similarly, Stein, Remillard, and Smith (2007) categorize the reformed curricula mentioned above as “standards-based” because they were made with the NCTM *Standards* in mind. They categorize the traditional curricula as “conventional” because they were commercially developed textbooks with earlier editions that were not influenced by reform documents published by NCTM and NSF.

*Sociocultural theory* views learning as an ongoing process that develops as an individual interacts with the environment (Goos, 2005; Vygotsky, 1978). The

environment includes social interactions with others and the contextual influence of the experiences. This study adopts a sociocultural lens to gain insight about the process of learning to teach elementary school mathematics. It acknowledges that the complex process of teaching is non-linear and constantly evolving. When applied to teaching, this means acknowledging that classroom practices are rooted in cultural ideas, ideals, and beliefs about teaching, learning, school, and society.

In addition to the four key aforementioned terms, there are words I use throughout this dissertation to consistently discuss participants of this study, the pupil they teach, and aspects of the teacher education program. For example, the term *pupil* is used to refer to the K-8 grade students taught by participating teachers in this study. I use this term to differentiate between participants' pupils and their own K-8 prior schooling experiences as students. The term *field experience* refers to classroom experiences provided by teacher education programs for preservice teachers including both practicum and student teaching. The *practicum* is a part-time classroom experience while *student teaching* is a full-time culminating classroom teaching experience that usually takes place during the final semester of teacher education programs.

### Overview of the Dissertation

This dissertation consists of six chapters. Chapter One presented an overview of this study. It framed the problem and presented the research questions investigated. It explained the purpose of this investigation and its rationale. Chapter Two, the Literature Review, provides an overview of sociocultural theory, which served as the lens for examining the process of learning to teach mathematics. The review includes literature on

learning to teach elementary mathematics, the role of mathematics reform, and pupil learning in mathematics. Chapter Three describes the mixed-methods used in this research. It includes the quantitative and qualitative data collection and analysis procedures.

Chapters Four and Five report the results of the data analysis for this study. Chapter Four reports findings from survey results focusing on preservice teachers' attitudes and perceptions. Chapter Five presents two longitudinal case studies to demonstrate how multiple experiences influenced teacher perceptions and practice. The chapter also provides an analysis of the assessment tasks and pupil work from the two case studies that connected their classroom practices to pupil learning. Chapter Six summarizes and discusses findings of the study. It provides implications for teacher education and acknowledges limitations of the study. Finally, Chapter Six concludes with recommendations for future research.

## Chapter 2

### REVIEW OF THE LITERATURE

This study was informed by three main bodies of literature: sociocultural theory, current reforms in mathematics education, and learning to teach mathematics. In the first section, a description of sociocultural theory is presented as the lens for this study. The section also includes a review of major conceptual arguments and a sample of empirical studies that have applied sociocultural theory to investigate issues related to the teaching and learning of mathematics. The second section presents an overview of current reforms in mathematics education. It provides an historical perspective on the reform movement and addresses its influence on both curriculum and teaching practices. The third section is a description and analysis of literature on learning to teach mathematics. It includes influential conceptual studies on learning to teach, mathematics teacher education, followed by empirical studies specifically on learning to teach elementary mathematics. Taken together, these three bodies of literature provide a theoretical and historical context for the study. The literature addresses the problem of preparing elementary teachers to teach mathematics in a reformed way. The final section summarizes the findings of the review and locates the research questions of this study within the context of the related literature.

#### Sociocultural Theory

Sociocultural theory views learning as a continuous multi-level process that takes place as the individual interacts with the environment through a cultural lens (Geertz, 1973; Vygotsky, 1978). An environment includes social interactions with others, objects

and tools that one uses, and the contextual influence of the experiences. Vygotsky emphasized learning through social interactions, whether peer to peer or teacher to pupil. Although learning can occur for all interacting members, in most cases, an individual with a more advanced understanding of the concept being taught guides another. Emphasis is on the cultural lens because one does not passively learn or accept all of the external influences, but interacts with experiences encountered. Geertz (1973) defines culture as a set of values, beliefs, and symbols through which individuals view and act on the environment. In other words, these values create the lens through which a person perceives his/her environment. A key assumption is that all social practices are based on a set of cultural ideas, values, and beliefs, rather than being neutral or free from bias (Gee, 1996). When applied to teaching, schooling, and teacher education, this means acknowledging that these practices are rooted in cultural ideas, ideals, and beliefs about teachers, learners, schooling, and society. Therefore, a fundamental part of understanding how preservice elementary teachers learn to teach is uncovering the beliefs and value systems they develop over time and examining how these beliefs and value systems affect their experiences and are shaped by university and school contexts. This study adopted a sociocultural lens to gain insights about the process of learning to teach elementary school mathematics.

In teacher education, sociocultural theory considers the knowledge and experiences preservice teachers bring with them. With this perspective, university professors, supervisors, and cooperating teachers at local schools would be aware of preservice teachers' entering characteristics and provide experiences that build upon or

challenge their existing knowledge with new opportunities to learn. Goos (2005) used a sociocultural framework in her research with preservice and beginning teachers to examine how pedagogical identities develop. She claimed that it is the responsibility of teacher educators to engage preservice teachers in worthwhile and authentic activities that help them to bridge their own personal factors with contextual factors to adopt and practice the desired pedagogy.

Pape, Bell, and Yetkin (2003) acknowledged that skills, dispositions, and knowledge are formed through social interactions. They suggested that “learning occurs as co-participation, and meaning is mutually negotiated between the novice and the community of practice through successively greater degrees of legitimate practice” (p. 181). In mathematics teacher education, engaging PTs in mathematical inquiry can foster a higher level of understanding of the content and pedagogy. Both studies found that discourse mediated the type of critical thinking that teachers should develop. Similarly, this theory is applicable to pupils’ learning of mathematics.

For instance, pupils who engage in justifying and communicating their mathematical thinking reinforce their own understanding of the concept and contribute to the learning community. According to Vygotsky (1994), language is a cultural tool that connects thought to the outside world. By communicating their reasoning, pupils internalize and construct mathematical knowledge by linking ideas with formal mathematical language (Steele, 2001). Sociocultural theory takes an asset-based perspective by viewing pupils’ backgrounds as resources (Moschovich, 2002). Rather than focusing on deficiencies or lack of experiences, a teacher recognizes the skills a

pupil has and builds upon that knowledge. This view of actively and socially learning mathematics is consistent with the current NCTM reforms.

Another idea espoused by sociocultural theory is *internalization*, which Vygotsky described as “the internal reconstruction of an external operation” (1978, p. 56). The process of internalization begins with socially constructed experiences and is realized when an individual is able to transform the interpersonal process into an intrapersonal one as a result of an extended series of developmental events. This idea is relevant for both teacher and pupil learning. Tharp and Gallimore (1988) argued that an internalization of higher order teaching skills should be developed in order for teachers to acquire effective teaching strategies. To achieve this, they argue that rethinking needs to occur by engaging in cognitively challenging tasks and discourse with the guidance of more capable instructors. Bonk and Kim (1998) build off the same idea by linking sociocultural theory to adult learning that values a learner-centered approach. They assert that learners should be actively involved in their own learning process and reach a stage of self-direction. The same claims can be made with pupils learning with the assistance of teachers, leading to independent learners.

By adopting sociocultural theory as a framework, this study operated under several assumptions. It explicitly viewed the process of learning to teach as being informed by values, prior knowledge, cultural ideas, and constantly evolving with continuous interactions within multiple contexts. Therefore, a major purpose of the study was to understand the ideas PTs possess when they begin the teacher education program and how the ideas shift, change, or expand as they encounter new ideas within different



contexts. It also considered the role of social interactions in the learning process and examined the influences that members of the teacher education community have on PTs. Additionally, sociocultural theory views the environment, or context, as an important aspect of learning. The study considered how various contexts affected participants' teaching practices. Finally, teachers' pedagogical stances towards the teaching and learning of mathematics were investigated through longitudinal interviews and classroom observations. These data were connected to the learning experiences they provided for their pupils and how that influenced the mathematical knowledge acquired by pupils. Taken together, sociocultural theory offered a more holistic perspective on the process of learning to teach mathematics.

#### Reforms in Mathematics Education

The National Council of Teachers of Mathematics (NCTM) is the world's largest mathematics education organization, with 100,000 members and 250 affiliates throughout the United States and Canada. Founded in 1920, NCTM has been a public voice in providing vision and leadership to ensure high quality mathematics education for all students. Its vision was built around the idea of classrooms where knowledgeable teachers create meaningful and challenging experiences for all students engaging in higher level mathematics. It includes curriculum that is "mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding" (NCTM, 2000, p. 3). In striving towards its mission, NCTM published several influential documents. In particular, its *Standards* have had a major impact on mathematics reform. By explicitly stating what the organization values and regards as a

quality mathematics education, it placed its standards out in the open for critique. From their earliest stage, the *Standards* have not existed without controversy. This section provides an historical overview of past and current reform efforts in mathematics education, and discusses the impact the *Standards* have had on both curriculum and teaching practices.

### *Historical Context*

During the end of World War II and for years to follow, public education in the United States was under close examination. The launch of Sputnik in 1957 created a sense of a national crisis with a perception that the United States was behind in the world of technology and military power (Lagemann, 2000; Senk & Thompson, 2003). In particular, discontent with high school mathematical preparation fomented change amongst mathematicians, and the *New Math* phenomenon was born. The *New Math* placed a great deal of emphasis on set theory with little attention to the application of mathematics and basic skills. Due to increased public criticisms about its ineffectiveness, the *New Math* was dead by the early 1970s. In reaction to the failure and dissatisfaction of the *New Math*, “the nation’s mathematics classrooms went ‘back to basics’—the theme of the 1970s...the curriculum returned to what it had been before...focused largely on skills and procedures” (Schoenfeld, 2004, p. 257-258). However, the “back to basics” movement had “little positive impact on improving the quality of mathematics education on students’ performance” (Burrill, 2001, p. 28).

As a response to the low mathematics performance of pupils in the U.S., the National Council of Teachers of Mathematics (NCTM, 1980) published *An Agenda for*

*Action.* This report made recommendations for instruction in mathematics to place a greater focus on problem solving rather than basic skills. Although this document did not have a monumental impact, it did influence publishers of textbooks to include problem-solving editions (Klein, 2003; Schoenfeld, 2004).

In 1983, the National Committee of Excellence in Education issued *A Nation at Risk*, an alarming report aimed as a wake up call for America, as it revealed the “steady decline in achievement scores.” This report stated:

Learning is the indispensable investment required for success in the ‘information age’ we are entering... The people of the United States need to know that individuals in our society who do not possess the levels of skills, literacy, and training essential to this new era will be effectively disenfranchised, not simply from the material reward that accompany competent performance, but also from the chance to participate fully in our national life (p. 7).

The report listed several “indicators of the risk,” including various literacy, mathematical, and technological deficiencies. It recommended that “schools, colleges, and universities adopt more rigorous and measurable standards, and higher expectations, for academic performance and student conduct” (p. 3). This document was clearly a milestone for the standards movement.

In 1987, *The Underachieving Curriculum*, another highly cited document, emerged with a focus similar to that of *A Nation at Risk*. It, too, called for mathematics reform after analyzing findings regarding the U.S. performance on the Second

International Mathematics Study (SIMS). Funded by the National Science Foundation (NSF) and the U.S. Department of Education, it recommended:

Clear standards for achievement must be established at each grade level in order to create an institutionalized climate of expectation to which students will respond. ... Professional development programs for mathematics teachers must be improved. Such programs would include ways to broaden the repertoire of teaching strategies that promote mathematics learning as an active rather than a passive enterprise (pp. 113-115).

This document extended the call for change in mathematics by suggesting national standards. However, it localized the need for improvement at the school level by focusing on teacher preparation and learning expectations for pupils.

In response to *A Nation at Risk* and *The Underachieving Curriculum*, NCTM published *Curriculum and Evaluation Standards for School Mathematics* in 1989, making it the first professional organization to create a set of content standards. Its goals were to encourage students to value mathematics, reason and communicate mathematically, become problem solvers, and gain confidence in their mathematical abilities. The NCTM *Standards* provided a list of suggested changes in mathematical content for the elementary, middle, and high school grades. It recommended that a broader range of content be taught across the grades with an emphasis on the understanding and application of mathematical concepts. The *Standards* advised that “increased attention” be given to thinking strategies for basic facts, a broader range of content across the grades, the use of calculators for complex computations, problem

solving strategies, and alternative forms of assessment. In contrast, it suggested that “decreased attention” be given to complex paper and pencil computations that are focused on isolated skills and reliance on standardized tests as the sole indicator of success. “The *Standards* challenged (or was seen as challenging) many of the assumptions underlying the traditional curriculum” (Schoenfeld, 2004, p. 267). While these recommendations were embraced by many, they also set the stage for significant criticism, which will be discussed later.

Ten years later, NCTM (2000) revised its original *Standards* document and published *Principles and Standards for School Mathematics* in continual pursuit of its vision. This was consistent with NCTM’s initial plan to revise the *Standards* every decade and remain current with research and educational reform. This document was also developed to respond to sharp criticisms launched against the 1989 standards regarding decreased emphasis on the teaching of computation and algorithms learned in rote form (Schoenfeld, 2004). The purpose of the 2000 *Standards* was to create a set of goals for PreK-12 mathematics education to influence curriculum frameworks, instructional materials, and assessment practices. *Standards* served as a resource for policymakers, teachers, and educational leaders to examine the quality of mathematics programs and how to best help students achieve (NCTM, 2000). *Principles* described important elements of a high-quality mathematics education, while *Standards* described the mathematical content and processes that students need to learn.

The *Standards* included both mathematical content and processes that students in grades preK-12 should be able to know and use. The content standards consisted of

number and operations, algebra, geometry, measurement, data analysis, and probability. Process standards included problem solving, reasoning and proof, communication, connections, and representation. The ten standards “describe[d] a connected body of mathematical understanding and competencies”...as they specif[ied] the “knowledge and skills that students should acquire from grades prekindergarten through grade 12” (NCTM, 2000, p. 29). The process standards were designed as the means for learning, exploring, and applying mathematical content knowledge. Content standards presented mathematical topics developmentally, sequenced across the grades. For example, although all ten standards applied to every grade level, a greater emphasis was placed on number and operations in the elementary grades, while algebra was emphasized in high school.

About this time, the *No Child Left Behind Act* (NCLB, 2001) was passed. It required greater accountability for schools and teachers while focusing on pupil achievement in reading/language arts and mathematics. Schools were required to show *adequate yearly progress* (AYP) in state standardized test scores. NCLB led to the current era of high stakes testing and accountability. Additionally, teachers had to meet the state criteria for being *highly qualified teachers* in their content areas. Although NCLB did not advocate a reformed pedagogy in mathematics, its testing focus placed more pressure on teachers to become proficient in teaching mathematics effectively, as determined by standardized tests, which differed in content and level of difficulty from state to state.

As we entered the 21<sup>st</sup> century, NCTM was not the only organization calling for reform. The National Research Council (NRC) published key documents that informed current reforms in mathematics education. In 2001, the NRC published *Adding It Up: Helping Children Learning Mathematics* to synthesize the literature on the teaching and learning of mathematics and to discuss public concerns of reform. NRC made recommendations on what and how mathematics should be taught in grades K-8. Similar to NCTM, their instructional recommendations included a conceptual understanding of mathematics through multiple representations, rather than learning a series of procedures. A few years later, the NRC (2005) focused on research in cognitive science and published *How Students Learn: Mathematics in the Classroom*. It emphasized the need to use pupils' prior knowledge to connect new conceptual and factual knowledge of mathematics. Applying cognitive science to the classroom was a way of addressing the limits of the NCTM Standards, which focused on teacher practice and mathematical content rather than children's thinking. More recently, NCTM released *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics: A Quest for Coherence* (NCTM, 2006). This document presented the most important mathematical topics to be mastered at each grade level. It emphasized key topics essential for preparing pupils for higher level mathematics, especially algebra. The United States' mathematics curricula are often criticized as being "a mile wide and an inch deep." Hence, the *Curriculum Focal Points* were one of the steps taken to address this critique. Taken together, these documents built upon and added to major perspectives advocated by the NCTM documents that set the foundation for reform in mathematics education. The

development, publication, and acceptance of the NCTM Standards by the wider community of policy makers, administrators, and teachers resulted in the development of standards in the areas of History, English, and Science.

### *Influence of Mathematics Reform on Curriculum and Teaching*

Shortly after NCTM published its first set of standards, the National Science Foundation (NSF) funded the development of several *Standards*-based reformed curricula at the elementary, middle, and high school levels (Lagemann, 2000; Senk & Thompson, 2003). For the purpose of this literature review, the term *curriculum* refers to textbooks or instructional guides. NCTM (2000) stated, “a curriculum is a strong determinant of what students have an opportunity to learn” (p. 14). They assert that an effective curriculum focuses on important mathematical topics that develop both conceptual understanding and procedural knowledge (NCTM, 2000). A curriculum plays an important role in mathematics education; its philosophy influences both content and pedagogy. Therefore, it is essential for “mathematics educators...to focus on the nature of mathematics in the development of ...curriculum ...as they strive to understand its impact on the learning and teaching of mathematics” (Dossey, 1992, p. 46).

The literature reviewed does not always define what is meant by reformed curricula or teaching practices on the one hand or traditional curricula and teaching practices on the other. Thus, a brief overview of the differing views of mathematics is presented here. Dossey’s (1992) literature review about the nature of mathematics revealed that “conceptions of mathematics fall along an externally-internally developed continuum” (p. 45). An external view treats mathematics as a static subject with an



established set of externally existing facts and principles. On the other side of the spectrum, an internal, or reformed view, considers mathematics as a dynamic field that is constantly evolving and as a personally constructed set of knowledge. Although there can be some overlap between both conceptions, they are described as dichotomized terms to highlight their distinct characteristics.

The external idea of mathematics is consistent with the traditional notion of teaching and learning mathematics. In practice, the emphasis is on students mastering the established mathematical content in a sequential order (Dossey, 1992; Romberg & Kaput, 1999). Since mathematics is seen as an established body of concepts and skills available in the curriculum, there is no perceived need to discover mathematics. Therefore, the role of the teacher is to present these concepts, while students are expected to practice the procedures and memorize facts until they are mastered. Once a concept is mastered, the teacher and students can move on to the next idea.

The internal view of mathematics presents the teaching and learning of mathematics as a process of human activity, consistent with a reformed pedagogy. In practice, the emphasis is on students “doing” mathematics by investigating problems and making conjectures as they develop a personalized understanding of the concepts (Dossey, 1992; Romberg & Kaput, 1999). Therefore, the role of the teacher is to create meaningful tasks that will engage pupils with mathematical ideas in which they learn multiple solution strategies assisting in the conceptualization of the mathematical content.

To clarify the meaning of *standards-based curricula*, this section refers to NSF-funded curricula, which espouses an internal and reformed view of mathematics. In

particular, the three elementary mathematics curricula sponsored by NSF include, *Everyday Math*, *Trailblazers*, and *Investigations in Number, Data, and Space*. Ball and Cohen (1996) asserted that curriculum materials can serve as agents of instructional improvement, but often play an uneven role in teaching practices due to the lack of consistency and preparation to enact the curriculum. In this section, empirical literature based on how reformed elementary mathematics curricula were implemented in practice are described and analyzed.

In 2000, the ARC Center (2003) carried out a large-scale study to examine student achievement among schools using reformed curricula in comparison to those using non-reformed curricula. The *ARC Center Tri-State Student Achievement Study* was funded by the NSF to specifically compare the use of *Everyday Math*, *Trailblazers*, and *Investigations* to non-reformed curricula (Senk & Thompson, 2003). A comparative design matching schools according to SES, reading levels, ethnicity, and level of English proficiency was implemented in Massachusetts, Illinois, and Washington State. The study included over 100,000 pupils, making comparison groups of approximately 50,000 pupils for users of reformed curricula and non-reformed curricula. Results showed that average mathematics scores of pupils in reformed schools were significantly higher than the scores of pupils in non-reformed schools. Every significant difference indicated that pupils using the NSF-funded curricula outperformed pupils using non-reformed curricula. In addition, findings were true regardless of SES and ethnicity. Contrary to criticisms about reformed teaching, students who learned mathematics with reformed curricula improved in both their basic computation skills and higher-level processes.

Another large-scale study funded by the NSF, known as the *Mosaic Study*, was conducted by the RAND Corporation to examine the relationship between reformed teaching practices and student achievement. Data collection and analysis for the first year consisted of teacher questionnaires and student multiple-choice and open-ended response assessments within two states, including four urban districts, 97 schools, and 324 mathematics teachers at both the elementary and middle school levels (Klein, Hamilton, McCaffrey, Stecher, Robyn, & Burroughs, 2000). Reports of the first-year findings, *Mosaic I*, found that achievement had a positive relationship with reformed practice (Klein, et al., 2000). Although this relationship was relatively weak, the positive trend was consistent across all sites. The NSF also found that students who received reformed instruction performed better on open-ended problems and the same on multiple-choice problems in comparison to students who did not have teachers who used reformed curricula. These results supported the findings reported by the ARC Center, which favored the use of reformed curricula.

RAND extended and continued *Mosaic I* into a longitudinal study. In 2006, findings from *Mosaic II* were published. This study included more measures of instructional practices, including vignette-based measures and teacher logs. Additional student achievement measures included problem solving (PS) and procedures (PR) subscales taken from the SAT-9 multiple choice problems. This study followed a group of pupils for a three-year period to measure the relationship after an extended experience with reformed mathematics curricula (Le, Stecher, Lockwood, Hamilton, Robyn, Williams, Ryan, Kerr, Martinez, & Klein, 2006). Similar to first-year findings, *Mosaic II*

showed a consistently positive but weak relationship between reformed teaching practices and student achievement. Some results indicated that this relationship was greater with longer exposure to sustained reformed practices. Another non-significant result indicated that reformed teaching related positively with the PS scale and negatively with the PR scale. As Le et al. stated, this is “a pattern that suggests that reformed teaching may enhance higher-order thinking skills, and that also raises questions about the apparent trade-off between PS and PR improvements” (2006, p. 64). This controversial finding adds to the critique that reformed curricula do not promote the learning of basic skills (Klein, 2003). However, the report also discussed the fact that teachers who considered their practice reformed were not always consistent with classroom observations, nor were they deemed to have reformed characteristics by NCTM and NSF standards. This study also speaks to the issues of curriculum implementation, teacher preparation, and professional development, and the need to further study their influence on teaching practices and pupil learning.

Senk and Thompson (2003) provided a review of the literature that examined *standards-based* or reformed school mathematics curricula. They presented an overview of studies on elementary, middle, and high school reformed curricula and specific studies on individual curriculum. In this same book, Putnam (2003) synthesized the literature on four reformed elementary mathematics curricula. He affirmed that a consistent finding across all studies showed that “students in these new curricula generally perform as well as other students on traditional measures of mathematics achievement, including computational skill, and they generally do better on formal and informal assessments of

conceptual understanding and ability to use mathematics to solve problems” (p. 161).

This supports the use of reformed curricula, which differs from the mixed findings of the *Mosaic II* study. Again, enacting curriculum is not a linear process (Doyle, 1993), and there are diverse views on what it means to teach reformed mathematics (Civil, 2006).

Remillard and Bryans (2004) studied the role that reformed curricula played in supporting teacher learning by examining the way in which eight teachers in the same public urban elementary school implemented the *Investigations* curriculum. They sought to understand teachers’ beliefs and perceptions about teaching mathematics. Remillard and Bryans examined their classroom practices through multiple interviews and observations over a two-year period. The participating teachers attended monthly study group meetings that involved discussions and explorations of mathematical content and pedagogy. Results of the data analyses yielded considerable variations among the teachers’ beliefs about the curriculum and its role in their practice. Results indicated that variations in curriculum enactment “created significantly different learning opportunities for students and for themselves” (p. 364). This study highlights the important influence of teachers’ beliefs about teaching mathematics and orientations towards the curriculum on how they implement curriculum. It is important for researchers to recognize that teachers who use the same curriculum can exhibit very different teaching practices.

Another study explored teacher learning by examining how two upper-elementary teachers used the *Investigations* curriculum materials (Collopy, 2003). The two participants in the study were veteran teachers in similar schools. Both used a traditional textbook to teach mathematics for several years prior to this study and had not attended

any seminars on teaching mathematics within the previous five years. Data were collected through multiple interviews and observations during the first year the teachers were required to implement the reformed curriculum. The extent of both teachers' training with *Investigations* consisted of a two-day workshop. Analysis of the data revealed completely contrasting experiences in the teachers' learning and how they enacted the curriculum. One teacher was confident in her mathematical knowledge and views on the teaching of mathematics and did not see a need for change; therefore, aside from superficial and brief uses of *Investigations*, her practice remained the same. The other teacher was not as confident in her mathematical abilities due to negative past experiences learning mathematics. This gave her the desire to adopt a more engaging way of teaching mathematics. Therefore, she took full advantage of the teacher support aspects of the curriculum and closely followed the lessons. Within a year, her teaching was transformed to reflect more characteristics of a reformed practice by focusing her instruction on conceptual understandings of mathematics (Collopy, 2003).

Implications of this study suggest that reformed curricula have the potential to change teaching practices. However, Collopy (2003) asserted that ongoing professional development that targets teachers' beliefs is necessary to foster change and sustain reformed teaching practices. Additionally, future studies should further examine the role of teacher and pupil background experiences, as well as the school context within curriculum implementation.

Drake and Sherin (2006) examined teacher narratives based on the "claim that teachers' sensemaking about a mathematics reform curriculum and about their own

mathematics teaching practices is situated in their identities as learners and teachers of mathematics” (p. 157). Two of twenty teachers from a larger study using the *Children’s Math Worlds* (CMW) curriculum over a three year period were selected for this study. The teachers in this study participated in several mathematics story interviews as a particular method of narrative inquiry and shorter pre- and post-observation interviews. They were each observed 13 times and participated in monthly professional development sessions about the curriculum. Based on the data analysis, models of curriculum implementation reflecting adaptation style were developed for both teachers. Teacher narratives were essential in understanding their interaction and implementation of the reformed curriculum. Findings showed that teachers’ early experiences in mathematics, their current understandings of mathematics, and what they learned from their families about teaching were three influential factors in the way they engaged with the curriculum and viewed their pupils as learners. Implications of this study suggest that reformed curricula should be designed to explicitly connect to the lives of teachers and help in reconstructing narratives to adopt reformed teaching practices. Suggestions for further research include the need to examine teacher narratives through multiple methods and to consider other contextual factors in curriculum adaptation, including the mathematics stories of pupils.

Hart (2001) examined first-year teachers’ levels of reformed practice by conducting a two-year study that followed eight preservice teachers from their year-long teacher certification program and into their first year of teaching at urban schools. Through pre- and post- surveys, she collected data that examined mathematics beliefs, teacher reflection

logs, and classroom observations. Hart found that although the beginning teachers struggled to maintain their reformed practices, they still tried to implement strategies they learned as preservice teachers. However, it was difficult to do so with contextual constraints such as traditional curricula that did not match their pedagogical philosophy. Additionally, several of the teachers' mathematical content knowledge was not sufficiently developed to give them the confidence necessary to understand and teach the content in a reformed manner. Implications for further research suggest that school context be considered in future studies of reformed teaching, and opportunities for teachers to gain a deeper understanding of mathematical content should be provided.

The studies described above examined the influence of mathematics reform on curriculum, teaching, and learning. These studies highlighted the connections among the three interrelated components. The first set of studies examined the impact that reformed curricula and teaching had on pupil mathematics achievement (ARC Center, 2003; Klein et al., 2000; Le et al., 2006; and Senk & Thompson, 2003). The findings generally showed a positive relationship between reformed teaching and pupil learning. Due to their larger scale, most of these studies relied on standardized tests and open-ended problems; rarely were teaching practices taken into consideration in these large scale studies. Meanwhile, observations were central to the research in this study; however, this dissertation analyzed multiple samples of pupils' mathematics work (i.e., assessments, worksheets, and word problems) over time to take a more authentic approach to examining pupil learning in mathematics. Several of the pupil work samples also connected to specific teacher practices over time.



Studies about reformed curricula implementation revealed that teachers using the same curriculum within the same school context still had different teaching practices leading to diverse learning opportunities for pupils (Collopy, 2003; Drake & Sherin, 2006; Hart, 2001; Remillard & Bryans, 2004). Enacting a reformed curriculum is clearly a non-linear multi-layered complex process. These studies call for further research of teacher learning experiences and the role of school context. For this reason, this study closely examined teachers' learning experiences over a two-year period and considered the role of both the teacher education program and school context. Additionally, it utilized a mixed-method approach to examine the teaching process and its influence on pupils' mathematical learning, rather than relying on one method of analysis. The study also focused on the transition from preservice preparation into the first-year of teaching, an area in which there has been very little research.

#### Learning to Teach Elementary School Mathematics

Learning to teach mathematics is a multifaceted process that begins when teachers are students and continues during their preparation programs and into their own classroom teaching (Wideen, Mayer-Smith, & Moon, 1998). Preservice teachers who enter teacher education programs are similar to pupils who enter the classroom with a wealth of knowledge, resources, experiences, and misconceptions (Ball, 1989). PTs are exposed to multiple views within varying contexts that can reshape their conceptions of teaching in preparation for their full-time teaching positions, which often require further adapting to a new school context (Ball & Cohen, 1999). In this section, major conceptual and empirical literature on learning to teach is summarized to provide a broad overview

of this complex process. Then, literature specifically focused on learning to teach elementary mathematics is described and analyzed to inform the design of this study and situate it within the existing literature.

Lortie's (1975) historical study about the socialization of teaching has functioned as a springboard to other studies examining the process of becoming a teacher. In his study, Lortie (1975) suggested that every teacher experiences an "apprenticeship of observation." This idea implies that beginning teachers' socialization into teaching starts when they are students; it perpetuates traditions at the expense of informed change. Lortie claimed that the thousands of hours spent as a pupil in school create a "latent culture" that surfaces when one becomes a teacher. As K-12 pupils, future teachers experience countless hours of mathematics lessons and teaching models; these experiences shape their ideas about the teaching and learning of mathematics (Ball, 1989). Additional research has shown that this apprenticeship of observation, or past schooling experiences, is very influential in shaping preservice teachers' ideas about teaching and learning (Ball & Cohen, 1999; Feiman-Nemser, 1983; Grossman, 1990; Wideen, et al., 1998).

Feiman-Nemser (1983) asserted that teacher educators often underestimate the insidious effects of past experiences on PTs. Additionally, she stated that a number of researchers have argued that teacher education does not have enough power to overcome the impact of early experiences. Ball and Cohen (1999) called for a reconstruction of teacher preparation. In order to achieve this, "Teacher education would have to become an agent of professional countersocialization," which is "no easy task" (Ball & Cohen, 1999, p. 6). Wideen et al. (1998) stated that the prevailing aim in teacher education is to

help preservice teachers learn to teach in ways that are essentially different from the way they have been taught and from what they have observed. However, Ball (1989) argued that it is not necessary to completely change teachers, but to work with them, because many do enter the program with appropriate ideas about teaching. Additionally, Grossman (1990, p. 16) found that four main factors are “sources of pedagogical content knowledge: apprenticeship of observation; subject matter knowledge; teacher education; and classroom experience.” Grossman (1990) also stated that methods courses may offer preservice teachers the opportunity to develop knowledge and strategies about the subject they will teach; however, teachers lacking formal teacher education are likely to rely primarily on their past experiences and disciplinary content knowledge. Meanwhile, Tabachnick and Zeichner (1984) argued that teacher education can provide direction to socialization through an interactive student teaching experience.

Much of the literature on teacher preparation has also focused on the student teaching experience and coursework. Wideen et al. (1998) studied the process of learning to teach by reviewing the literature from 1990 to 1996. They found that both teacher educators and preservice teachers face the dilemma of “bridging the cultures of the school and the university” (p. 156). PTs can be overwhelmed with the practical demands of student teaching and may attribute their frustration to an inadequate preparation in their coursework. Feiman-Nemser and Remillard (1995) also pointed to the dilemma that on one hand, research indicates that teacher education has a “limited impact” on PTs; yet research also reveals that “powerful and innovative teacher preparation can affect the way teachers think about teaching and learning, students, and subject matter” (p. 65). A

longitudinal study about learning to teach writing showed that beginning teachers utilize pedagogical and conceptual tools they acquire during teacher education to inform their classroom practice over time (Grossman, Valencia, Evans, Thompson, Martin, & Place, 2000). An important aspect of learning to teach identified by these studies and reviews was that school context mattered once PTs became first-year teachers.

Whether one is an elementary teacher who teaches all subject areas, or a secondary teacher focusing on history, mathematics, science, or English, the school context has a major influence on teacher classroom practices (Feiman-Nemser & Remillard, 1995; Wideen et al., 1998). This is especially true for first-year teachers and beginning teachers who are developing their practice during a stressful time. Beginning teachers are sometimes in a “survival” mode, which can make them more impressionable. They are so preoccupied with handling practical matters of the classroom that resisting pressures created by the school environment may not appear reasonable, even if they do not agree with the underlying philosophy. Fortunately, there is evidence that beginning teachers can develop a sense of agency within their respective school systems and maintain the practices learned during their teacher education programs (Grossman et al., 2000). School context can also serve as a support system that matches and enhances what was learned in a teacher education program, although this is a rare occurrence. However, the limited research about teachers’ transitions from preservice to the first-year does not closely describe school contexts or their influence on classroom practices.

More recently, Cochran-Smith and Zeichner (2005) edited *Studying Teacher Education: The Report of the AERA Panel on Research and Teacher Education*. This

report was an extensive collection of literature reviews on the most current issues pertaining to teacher education. The AERA Panel reviewed literature from 1995 to 2001 on teacher quality, teacher preparation, methods courses, field work, teaching for diverse populations, and teacher education programs. In this report, Clift and Brady (2005) reviewed the empirical research on methods courses and practicum experiences from 1995 and 2001. In their investigations about mathematics education, they noted several contributions and limitations to the research. These contributions can be summarized as follows: it is possible, but not simple, to change PTs' conceptions of learning mathematics; it is difficult to change the notion of the teacher as authority and provider of knowledge to teacher as facilitator and co-investigator with the pupils; desirable practice is more likely to occur when there is coherence between the methods course and field work, which creates a supportive environment; researchers are just starting to document progress about the changing perspectives of PTs. The limitations they found included the following: researchers' studies relied on their own preservice teachers; most studies focused on preservice elementary education teachers, while preservice middle and high school teachers were ignored; little information was provided about teaching specific secondary content areas such as algebra and geometry; mathematics studies provided less information on the demographics of participants and contexts; and there were very few existing longitudinal studies.

Ebby (2000) explored how PTs learn to teach mathematics differently by using case studies to illustrate how three preservice elementary teachers made sense of their methods course and field experiences during a one-year masters level teacher preparation

program. The methods course was specifically structured to help PTs learn to teach in a constructivist or reformed way by engaging in mathematical problem solving. One participant's experiences did not change her traditional view of mathematics; instead, her negative self perception as a mathematics learner was strengthened. Conversely, the other two participants' experiences showed that PTs were able to develop new perceptions about themselves and pupils as learners of mathematics. Both adopted a teaching role that focused on gaining mathematical understanding through a process of inquiry. The findings suggested that methods courses should shift from mastering practical skills to developing "habits of mind" such as "making sense of children's understanding and learning to take a reflective stance towards one's own teaching" (p. 93). This study highlighted the need for teacher education to expand beyond the preservice years to further develop these habits over time.

McGinnis, Kramer, Roth-McDuffis, and Watanabe (1998) conducted a longitudinal study that charted the attitudes and beliefs of the nature and teaching of mathematics and science. Preservice teachers (n=104) enrolled in the Maryland Collaborative for Teacher Preparation, an NSF-funded undergraduate program focused on preparing elementary/middle school level mathematics and science specialists, participated in this study. They completed the attitudinal and belief survey several times over a two-year period. Results showed statistically significant differences in a positive direction on all five sub-scales; PT beliefs about the nature and teaching of mathematics and science showed evidence of reform. Findings suggested that programs focused on reformed practice can change beliefs about teaching and learning mathematics.

Lubinski and Otto (2004) examined the influence of a mathematics content course designed to help K-8 PTs develop their mathematical knowledge and recognize what it means to teach and learn mathematics with understanding as expressed by the NCTM *Standards*. Data collection and analysis consisted of 1) pre- and post-opened ended questions about PTs' mathematics backgrounds, attitudes, and perceptions of the nature of mathematics, and 2) individual interviews with 16 of the 20 PTs in the course. Results showed that the course had an overall positive influence on attitudes, beliefs, and perceptions of mathematics. Additionally, several PTs realized that their prior ideas of mathematics were limited. This study revealed the potential for courses to change PTs' beliefs.

To study the influence that prior K-12 and college math and science content courses had on preservice elementary teachers, Ellsworth and Buss (2000) conducted a content analysis of 98 autobiographical stories. Particular attention was given to positive or negative experiences that had an effect on PTs' interest in or attitudes towards mathematics or science. Findings showed that the teacher effect was the most salient theme, suggesting that teachers had a powerful effect both positively and negatively. Similarly, family members' attitudes towards mathematics had an influence. PTs also stated that in order for understanding to be gained, content had to be relevant and connected to real life situations. On the other hand, PTs often had vivid memories of mathematics classes emphasizing memorization and repeated practice of skills. Those with negative experiences recalled moments of embarrassment or failure, while those with positive experiences did well on timed-tests or competitive games. Moreover,

participants expressed a constant frustration with the pace of mathematics and science courses that did not provide enough time to fully develop the understanding of concepts. This study revealed how autobiographical data can shed light on past experiences of educators and how mathematics teaching and courses can be improved to provide more positive experiences.

Similarly, Harkness, D'Ambrosio, and Morrone (2006) focused on giving voice to preservice teachers by examining their experiences in a mathematics methods course through mathematical autobiographies. The study examined why PTs were highly motivated in a methods course that focused on mastery goals through a social constructivist structure of engaging PTs in problem solving. Through a data analysis process of coding, the following recurring themes emerged as factors that contributed to a positive learning experience: struggling through complex problems, engaging in group work, constructing new mathematical meaning, changing self-efficacy and concepts about learning mathematics, and feeling support from instructors. The findings of this study suggested that the methods course should provide opportunities for PTs to engage in meaningful problem solving tasks to make sense of the mathematics and make connections to improve upon their future practices.

Vinson, Haynes, Brasher, Sloan, and Gresham (1997) compared PTs' mathematics anxiety before and after taking methods courses emphasizing the use of manipulative materials. Pre- and multiple post-survey results indicated no significant difference in the mathematics anxiety scale after the first quarter of classes in the fall; however, significant differences showing a reduction of mathematics anxiety was present



after the winter, spring, and summer quarter classes. Through informal discussions and interviews, researchers also learned that mathematics anxiety increased for some PTs who struggled to relearn and teach mathematics concepts with unfamiliar manipulatives. Implications of this study connected to previous literature suggested that reducing mathematics anxiety for teachers could improve their teaching practices and increase their pupils' achievement in mathematics. Almost ten years later, Bursal and Paznokas (2006) measured the relationship between elementary PTs' mathematics anxiety and their confidence to teach mathematics and science. Pre- and post-surveys about mathematics anxiety, science teaching self-efficacy, and mathematics teaching self-efficacy were administered during the beginning and end of two semester-long methods courses (n=65). Results indicated that those with a higher level of anxiety had lower confidence levels in their teaching and vice-versa. Participants were split into three categories: PTs who scored a low, moderate, or high level of anxiety. ANOVA and Tukey's HSD tests showed statistically significant differences in the confidence to teach levels among the three groups. Findings showed that more than half of PTs who scored high on the mathematics anxiety scale were not able to teach effectively, suggesting that teacher educators should structure methods courses to help support PTs and reduce their anxiety.

In 1993, Eisenhart, Borko, Underhill, Brown, Jones, and Agard were among the first to explore the complexities of learning to teach mathematics for understanding. Their study focused on the experiences of one PT in her final year of a teacher preparation program. They interviewed her on several occasions and observed her teaching three times, within three of her four distinct field placements. Results showed

that although the participant desired to teach for understanding, she thought that pupils should acquire both conceptual knowledge and procedural skills in mathematics. However, analyses of observations indicated that she rarely taught mathematics in a conceptual manner, which suggested a tension between her beliefs and practices with learning conceptual and procedural knowledge. Researchers learned that she had more confidence in her own procedural knowledge and was better prepared to teach arithmetic; therefore, her own limited understanding of mathematical concepts led to a limited practice. Additionally, cooperating teachers and field placements were classrooms where procedural knowledge was the focus of instruction, which did not reinforce ideas taught in the methods course. Findings suggested that teacher education focused on building conceptual mathematical knowledge and pedagogical skill should establish partnerships with schools sharing a reformed view of mathematics to strengthen PTs' experiences and preparation to teach for understanding.

Ten years later, MacNab and Payne (2003) conducted a similar study that examined the beliefs, attitudes, and practices of elementary teachers in Scotland. They analyzed a national survey taken by PTs in their final year of either a four or one-year teacher preparation program. Results indicated that overall, PTs had more positive attitudes towards mathematics but were not always enthusiastic about engaging in mathematical tasks. They also found that the majority of PTs viewed their own understanding of mathematics as "good" or "very good." PTs also had good intentions about using a variety of teaching strategies to teach mathematics. However, data also showed that Scottish PTs were "relatively unadventurous in their teaching...[and]

[thought] of mathematics teaching as unexciting and in relation to other curricular areas, difficult and worrying” (p. 66). In this study, there were no observations to capture PTs’ teaching practices; therefore, the researchers relied on a survey to examine their intended practices.

Rowland, Huckstep, and Thwaites (2005) explored elementary preservice teachers’ mathematical subject knowledge and practice thereof. The study took place in the UK and data consisted of videotaped lessons of twenty-four PTs in a one-year Postgraduate Certification in Education course. Coding of videotapes led to the development of a “knowledge quartet,” consisting of four types of knowledge: foundation, transformation, connection, and contingency. The *foundation* category was defined by the theoretical background and beliefs of mathematics, including the content knowledge and understanding of mathematics. The other three categories referred to ways in which knowledge was accessed and used to show preparation and inform teaching practices in the classroom. *Transformation* meant the ability to take one’s knowledge of mathematics and translate it in a manner accessible to students. *Connection* referred to making mathematics coherent by presenting content in a sequentially sound manner and drawing connections to other mathematical ideas and real world contexts. Lastly, *contingency* was defined as one’s ability to change instruction and take “contingent action” based on unplanned classroom occurrences by deviating from the lesson to respond to children’s ideas. Rowland et al. then presented one case study to provide an example of how the knowledge quartet plays out in the classroom. Implications suggested that teacher educators, mentors, and supervisors should be aware

of the types of knowledge used by PTs and how they could help PTs develop these qualities. Along the same lines, Hill and Ball (2004) examined teachers' mathematical knowledge and found that professional development providing teachers with opportunities to complete a great deal of mathematical analysis and reasoning could help significantly improve their mathematical knowledge for teaching, as shown on a pre- and post-large scale assessment. This knowledge has also been shown to have a highly positive relationship with student learning (Hill, Rowan, & Ball, 2005).

For over a decade, Hill and Ball (2004) worked on conceptualizing and measuring Mathematical Knowledge for Teaching (MKT). MKT is described as the knowledge needed to teach mathematics that goes beyond mathematical content and pedagogy to address student thinking (Hill, Rowan, & Ball, 2005). It expands upon Shulman's (1986) work on Pedagogical Content Knowledge by acknowledging the nuances of teaching and learning mathematics within the school context. Hill, Ball, and Schilling (2008) identified specific domains within content and pedagogical knowledge in mathematics; they recognized that someone with a great deal of content knowledge in mathematics may not be able to understand how to teach students who have misconceptions. To further examine MKT, Hill, Ball, and Schilling (2008) created measures to determine teachers' levels of MKT. Results consistently showed that MKT is indeed a strong predictor of student learning, as measured by standardized tests (Hill & Ball, 2005).

A research method that has increasingly been used to indirectly examine teachers' practices and pupil learning opportunities beyond standardized tests is an analysis of classroom lesson plans, assessment tasks, and pupil work. Stecher, Borko, Kuffner,

Martinez, Arnold, Barnes, et al. (2006) examined teachers' level of reformed practice in mathematics and science by analyzing classroom artifacts with a rubric. Classroom observations were conducted to test the reliability and validity of the scores. Significant positive results showed strong possibilities for this method. Similarly, King, Schroeder, & Chawszezewski (2001) examined the influence of teaching practices on pupil learning by scoring the assessment tasks and pupil work with the Research Institute on Secondary Education Reform (RISER), a rubric focused on the levels of authentic intellectual work. Findings favored assessment tasks that generated higher scores as greater learning opportunities for pupils. The RISER was used for the QCS Project, the source of case studies for this dissertation, because it valued characteristics of social justice, such as making meaningful connections beyond the classroom and critical thinking. However, the instrument is described in greater detail in the next chapter. Recently, a team from RAND developed an instrument using vignettes to measure the extent of reformed teaching practices in mathematics (Stecher, Le, Hamilton, Ryan, Robbin, & Lockwood, 2006). They used the vignettes with interviews, observations, and a survey and found it to be a tool with the potential to be used on a large scale with improvements suggested by participating teachers. These studies attempted to capture teaching practices with more authentic measures. It is challenging to make a strong connection between teaching practices and pupil learning, especially because practice-based research requires the collaboration of schools. Nevertheless, being explicit about observable classroom characteristics, and using multiple pupil learning measures, can help mathematics educators to better define the qualities of reformed teaching methods.

Learning to teach mathematics is not a simple task that can be studied in a linear manner. Teaching occurs in various stages and within multiple contexts. In the literature reviewed above, several studies demonstrated the importance of examining past experiences and how beliefs influence classroom practices and the process of becoming a teacher. Many of these studies focused on beliefs, attitudes, and perceptions; however, most of them relied on one methodology to examine research questions by focusing on either a qualitative or quantitative approach. Several of the qualitative approaches also focused on the experience of one participant. This can shed light on a specific issue, but makes the findings less applicable to a wider audience. Only one or two of the studies followed teachers from preservice to their first year(s) of teaching. Several of the qualitative studies also relied on interviewing and rarely included extensive observations of classroom practices. This limited any valid claims about teaching practices. Additionally, most of the studies were confined to a short period of time, usually a semester or one year. More longitudinal studies are necessary to examine the influence of teacher education over time.

The literature sheds light on the importance of both teacher education and school context. Findings indicated that methods courses and field experiences can be fertile ground for changing PT attitudes and beliefs about the nature of mathematics. Studies also addressed the issue of subject knowledge and how it can enhance teachers' practice and confidence. Some of the research connected teaching perceptions and practices to pupil mathematical learning; however, it was rarely examined empirically. Overall, the research presented valuable insights into the process of learning to teach mathematics;

some of the findings were more discrete and confined to specific aspects of the process, rather than the whole picture.

### Summary

Mathematics education has undergone several changes over the past fifty years, with NCTM at the forefront of major reform efforts. Although changes can take time and confront many challenges, the NCTM's commitment to the improvement of mathematics education has led to significant reforms over the past decade. Through the efforts of several mathematics educational leaders, researchers, and teachers, mathematics education has made a great deal of progress; however, much work is needed to increase collaboration across the nation and to improve policies and practices that support these efforts. Furthermore, at the local level, much needs to be learned about how to advance the teaching and learning of mathematics for all students.

The literature reviewed on mathematics reform efforts showed that there are many layers and aspects to adopting a reformed pedagogy. Simply having a reformed curriculum does not automatically mean that a teacher will enact the curriculum in a truly reformed manner (Collopy, 2003; Remillard & Bryans, 2004). It is important to further research teacher learning experiences, mathematical knowledge, and the role of school context. The few studies connecting reformed teaching practices to pupil learning suggested that higher levels of conceptual mathematical knowledge are gained in comparison to more traditional teaching methods (Klein et al., 2000; Le et al., 2006; Senk & Thompson, 2003). However, several of these studies did not take the school context into account and were not always clear about the criteria used to define reformed

teaching. Future research needs to take the teaching practices a step further by connecting pupil learning outcomes with multiple measures of assessment.

The learning to teach literature revealed several patterns about the complex process. It was evident that prior knowledge and experiences could affect the lens from which preservice teachers learn how to teach, which is consistent with sociocultural theory (Ball, 1989; Grossman, 1990). The university and school contexts could play a key role in providing meaningful experiences for preservice teachers (Tabachnick & Zeichner, 1984). The same findings applied to learning to teach elementary mathematics literature (Harkness et al., 2006). Gaps in the literature call for more longitudinal studies and connections among the experiences teachers have before and during their first years of teaching. Nuthall (2004) argued that research has failed to bridge the theory-practice gap due to limited studies that do not continually gather in-depth data to track changes in teaching and pupil learning over time. Nuthall suggested that research needs to link teaching and learning, which is consistent with the literature reviewed.

To address various gaps in the literature, this study examines teachers' learning experiences over a two-year period and considers the role of both the teacher education program and school context. It uses a mixed-method approach to examine the teaching process and its influence on pupils' mathematical learning, rather than relying on one method of analysis. It also focuses on the transition from preservice preparation into the first-year of teaching, where there is a lack of research. A great deal of in-depth data will be collected over time to provide a detailed account of teachers' thoughts and actions and link this to their pupils' learning. The multiple-method approach offers a complete



picture of the teaching process to inform and improve mathematics teacher education at the elementary school level. The next chapter explains the methodology that guided the data collection and analysis procedures for this study.

## Chapter 3

### METHODOLOGY

This chapter first restates the purpose and research questions of the study and then presents the methods and procedures used to guide data collection and analysis. In this chapter, the following sections are included: research design, participants and contexts, data collection, instrumentation, data analysis, and limitations of the methods. A discussion of the rationale for the mixed-method approach is integrated throughout various sections.

The purpose of this study was to examine preservice elementary teachers' learning and teaching experiences and how they are linked to their pupils' learning. The following questions were explored through a mixed-method research design:

1. How do preservice elementary school teachers' past schooling and teacher education experiences (i.e., mathematics methods course and field experiences) influence attitudes and perceptions about the teaching and learning of mathematics?
2. How are preservice elementary teachers' mathematics teaching practices influenced by prior schooling and teacher education experiences?
3. What are characteristics of the mathematics teaching practices of first-year teachers? How do prior experiences and current school contexts shape perceptions and pedagogical practices in mathematics? To what extent do practices reflect reformed mathematics pedagogy?
4. How do first-year teachers' pedagogical practices influence pupils' mathematical learning?

## Research Design

A mixed-method approach utilizing both survey and case-study research methods guided data collection over a two-year period from August 2005 to July 2007. The National Research Council (2002) argues that research designs can be strengthened significantly by using multiple methods that integrate “quantitative estimates of population characteristics and qualitative studies of localized context” (p. 108). Mixed methods research is an expansive and pluralistic approach that “can answer a broader and more complete range of research questions” than a single method (Johnson & Onwuegbuzie, 2004, p. 21). Furthermore, multiple methods are advantageous for capturing both depth and breadth of complex issues (Teddlie & Tashakkori, 2003; Creswell, 2003). Use of multiple methods also enhances validity, as using more data sources allows for triangulation. To thoroughly investigate the research questions, the surveys, as well as interview and observation protocols, were constructed to closely connect to the problem identified and discussed in Chapter One: mathematics education has shifted toward reformed practices, which have been challenging for teachers to adopt.

### *Quantitative Methods*

The quantitative portion of this study consists of surveys and analyses of teacher tasks and pupil work. The pre- and post-surveys were administered to all PTs taking a mathematics methods course in the fall of 2005. Similar to Darling-Hammond, Chung, and Frelow (2002), who used surveys to identify teachers’ level of perceived preparedness and efficacy, the survey examined PTs’ perceived preparedness to teach mathematics. The surveys examined the attitudes and beliefs about the teaching and

learning of mathematics in a broad sense. Additionally, the survey asked PTs about their experiences in prior K-12 schooling, field placements, and the mathematics methods course. This allowed for relationships to be examined with a wide lens by analyzing PTs' responses about their experiences, beliefs, and perceived level of preparedness with a larger sample prior to an in-depth investigation of specific cases. Overall, the surveys contributed to the description of PTs' experiences and attitudes.

To examine the relationship between teaching practices and pupil learning, case study participants collected several assignments and assessments used in the classroom, along with several class sets of pupil work. Analyses of pupil work have been carried out in several studies with the use of various instruments (Borko, Kuffner, Arnold, Creighton, Stecher, Martines, Barnes, & Gilbert, 2007; Chan, Tsui, Chan, & Hong, 2002; Luke, Freebody, Shun, & Gopinathan; 2005). In some cases, the studies included teacher tasks and pupil work but no classroom observations. Many of these studies found a positive relationship between higher level teacher tasks and pupil achievement; i.e., students who were given tasks that were more cognitively demanding displayed greater depth of knowledge. For the purpose of this study, the Research Institute on Secondary Education Reform (RISER) instrument, developed with Fred Newmann's Authentic Assessment scales, was used to analyze the mathematics assessments that the teachers created and the student work produced in response to the assessments (Newmann and Associates, 1996). Including an analysis of pupil work allowed consideration of outcomes of classroom practices. Although both quantitative methods provide descriptions about preservice teachers' experiences, beliefs, practices, and their pupils' learning, it is still important to

capture a more in-depth picture of these elements through qualitative methods to better understand the process of learning to teach mathematics at the elementary school.

### *Qualitative Methods*

The qualitative methods in this study consisted of two longitudinal case studies. Case studies are valuable because they provide a rich description of various processes or events (Merriam, 1997). Case studies provide an in-depth understanding of a particular case in greater complexity (Merriam, 1997; Stake, 1995). They capture the “real-life context” that can offer insights to explain complex processes in a bounded context (Yin, 1994, p. 25). In addition, case studies allow for flexibility with a variety of techniques to understand the case, which also enhance data triangulation (Stake, 2000). Overall, the in-depth longitudinal case studies provided a multi-dimensional account of the learning to teach process, which offered multiple measures for investigating the various research questions of this study.

The main part of this study consisted of two longitudinal case studies, which were part of the larger Qualitative Case Studies (QCS) project, as mentioned in Chapter One (see Appendix A to read more about the QCS project). The two participants of this study were selected among the first QCS cohort of twelve participants because they were both receiving a M.Ed. in Elementary Education and came from different educational and cultural backgrounds. They were followed upon entry into the program (August 2005) and into the end of their first year of teaching (June 2007). The case study participants took the same mathematics methods course in the fall semester of 2005, when they completed the surveys. They were also interviewed nine times and were observed

teaching fifteen times over a two-year period. This offered an in-depth account of their experiences, beliefs, attitudes, and teaching practices. In addition, investigating the participants' words and actions verified their consistency and/or change over time.

#### *Access and Entry*

Permission to conduct research with human subjects was sought by following the procedures through Boston College's Institutional Review Board. Consent was obtained from every participant, participating university professors, and the administrators from the school sites where observations occurred. Appendix F includes IRB consent forms for this study.

### Participants and Contexts

#### *Participants*

This study had a varying number of participants for each stage and year of the study (see Table 3.1). During the first year, all participants were preservice elementary school teachers. All PTs enrolled in a mathematics methods course during the fall semester of 2005 were surveyed at the beginning and end of the course. To recruit participants, I obtained consent from the mathematics methods professors. Three professors taught the four sections of the elementary mathematics methods course. The population size was 102 and the total sample size for the pre-survey was 85, an 83% response rate. For the post-survey, I was only interested in those who had taken the pre-survey; thus, the post-survey had a sample of 75, which was a 73.5% response rate. To deal with missing data from those who did not participate in the post-survey, only the

data from the 75 participants who completed both surveys were used. Therefore, the final n for the survey was 75.

Table 3.1

*Participants and Timeline of Study*

| Fall 2005             | Spring 2006  | Fall 2006 to July 2007 |
|-----------------------|--------------|------------------------|
| Pre- and Post-Surveys |              |                        |
| n= 75*                | Case Studies | Case Studies           |
| Case Studies          | n=2          | n=2                    |
| n=2                   |              |                        |

*Note.* Case study participants are included in the survey sample.

As stated previously, the two case study participants, Sonia and Riley, were selected from the QCS project because they both focused on elementary education, but came from different backgrounds. As described in-depth in Chapter Five, both had differing entering characteristics and practicum experiences, which reflected upon their practice once they became full-time teachers. Table 3.2 displays a summary of the differing experiences the two case study participants presented in their background, field placements, and first-year of full-time teaching.

Table 3.2

*Background Information of Participants*

| Name  | Cultural Background | Mathematics Background   | Field Placements and Curriculum   | First-Year School Context and Curriculum   |
|-------|---------------------|--|---|--|
| Sonia | Hispanic American   | Montessori elementary school<br><br>Successful in mathematics high school<br><br>Enjoyed learning mathematics with a conceptual understanding  | Practicum : 4 <sup>th</sup> grade, urban school, reformed curriculum<br><br>Student Teaching: same  | 2 <sup>nd</sup> grade- Bilingual urban school<br><br>reformed curriculum   |
| Riley | Caucasian           | Catholic elementary school<br><br>Unsuccessful in mathematics because she did not understand the procedures<br><br>Would have liked to have been more confident in her content knowledge | Practicum: 2 <sup>nd</sup> grade, suburban school, mixture of reformed and traditional curriculum with an emphasis on textbook use<br><br>Student Teaching: 5 <sup>th</sup> grade, suburban school, same curriculum | 4 <sup>th</sup> grade- suburban school<br><br>traditional textbook with some reformed curriculum lessons as supplement |

*Contexts*

Research was conducted at Hillside College<sup>1</sup>, a private university in New England, and several urban and suburban public elementary schools located in nearby cities. The teacher education program offers both a traditional four-year undergraduate degree and a graduate degree that can be completed in a twelve-month period. This study focused primarily on the one-year graduate level teacher education program at the

<sup>1</sup> Pseudonyms of all institutions and participants are used throughout this study to maintain anonymity.



university's school of education because case study participants were enrolled in the graduate program.

As part of this graduate level teacher education program, participants' field experiences consisted of one practicum in the fall of 2005 and student teaching in the spring of 2006. Observations took place at local partnership schools, where participants were placed for their field experiences. After participants graduated, they were followed into their first year of teaching and observed at their respective schools. As first-year teachers, Sonia was hired at a dual-language elementary school, where she taught a second grade bilingual class, and Riley taught fourth grade at a suburban school.

#### Data Collection

Using a funnel approach to data collection, the surveys captured a wide angle, while the case studies provided close-up perspectives on the various research questions. Data collection procedures for this study are described in Tables 3.3 and 3.4. During the first year of the study, pre- and post-surveys using Likert-scale items were administered to all preservice teachers (n=75) enrolled in an elementary mathematics methods course during the fall of 2005 (see Appendix B). The mathematics surveys were administered in various forms and with different approaches to meet the preferences of participating professors during the first and last week of the courses. Two professors allowed administration of paper surveys during class. One professor allowed me to speak to the classes for five minutes and send an email with a link to the online version of the survey. Although data entry was tedious for the paper surveys, it increased the response rate. On the other hand, the data from the online survey was easy to export into SPSS and

provided a convenient format for students, but yielded a lower response rate. Once all data were collected, the surveys were assigned identification numbers and the consent forms with the participants' names were removed to maintain anonymity. Finally, I created a database in SPSS to organize the survey data. Once the database was complete, I double-checked surveys responses of each participant with SPSS entries to increase accuracy of data entry. Additionally, observations of one mathematics methods course were conducted and course artifacts were collected to provide contextual information related to survey and interview data related to the course.

An ethnographic lens was used to observe one of the mathematics methods professors and the structure of this course. This professor was selected for observations because he taught the graduate section taken by the two case study participants. Ethnographers seek to understand participants' views of their lives and give an account of that cultural world (Tedlock, 2000). The course was observed a total of four times during the semester. The foci of the observations were the professor's teaching methods and the discourse among the professor and preservice teachers. As the researcher, I did not participate in any of the course discussions. My role was solely to observe the elementary mathematics methods course to avoid affecting the actions of the participants in the field. During the observations I drew a sketch of the classroom with the location of each of the preservice teachers. Preservice teachers were identified with abbreviations, such as WF2 for the second white female and BM1 for the first black male, and so forth. I maintained detailed field notes about the classroom discourse and interactions. Walking around the room when preservice teachers worked in groups helped me capture the discussions

across the entire class. This particular course was chosen because the two case study participants were students in the class, and I wanted to better understand their mathematics methods course experiences.

For a two-year period, the experiences of two participants were explored through interviews, observations, and artifacts that guided the development of in-depth case studies. The two participants were selected from those who completed the survey and were part of the QCS project. Data collection for the case studies included the following: (a) nine semi-structured interviews; (b) fifteen classroom observations; (c) collection of participant artifacts (*e.g.*, coursework, program materials, lesson plans); and (d) a sample of pupil work (*e.g.*, unit assessments, problem solving projects, worksheets, assessments). Tables 3.3 and 3.4 show the timing of the data collected and methods used for data analysis.

The interview process takes the researcher into the participants' world by uncovering their tacit views and making them visible. Deeper understandings can develop through ongoing in-depth interviews where interviewer and participants construct knowledge related to the questions of inquiry (Fontana & Frey, 2000). Interviews and participant artifacts allowed for detailed examination of participants' experiences and an understanding of their perceptions about the teaching and learning of mathematics. The observations and pupil work samples offered a first-hand account of their teaching practices and the learning opportunities they created for pupils.

Table 3.3

*Wide Lens Data Collection and Data Analysis Procedures (Year 1)*

| Data Sources                            | Description  | Data Analysis  |
|---|--|--|
| Surveys                                 | (a) Pre- survey in the elementary mathematics methods course<br>(b) Post-survey in the same course<br><i>Fall2005</i> (n = 75) | - Descriptive statistics<br>- Paired t-tests<br>- Correlations<br>- Multiple regression analyses to determine how experiences predict the variance on PTs' perceived level of preparation and attitudes towards teaching mathematics |
| Mathematics Methods Course Observations | Four 75minute observations<br><i>Fall 2005</i>   | - Multiple readings of field notes to describe the course structure and discussion format  |

Table 3.4

*Case Study Data Collection and Analysis Procedures (Year 1 and 2)*

| Data Sources            | Description and Timeframe  | Data Analysis   |
|-------------------------|--|---|
| Longitudinal Interviews | Nine 1-2 hour interviews:<br><br>Year One ( <i>Fall 2005-Summer 2006</i> )<br>a) Background<br>b) Practicum<br>c) Methods and foundations courses<br>d) Student teaching<br>e) Pupil work, assessments, and learning<br>f) Completion of teacher education program<br><br>Year Two ( <i>Fall 2006 – Summer 2007</i> )<br>g) Beginning teaching and school context<br>h) Pupil work, assessments, and learning<br>i) Reflection on first year of teaching and future career plans | - Multiple coding methods focused on influential experiences on pedagogy and ideas about pupil learning |
| Field Observations      | 15 classroom observations:<br><br>Year One ( <i>Fall 2005-Spring 2006</i> )<br>- One practicum observation   | - Multiple coding methods focused on pedagogy and pupil learning  |

|                       |   |   |
|-----------------------|---|---|
|                       | - Four student teaching observations  | - Constant comparative method used with interview and pupil work data for triangulation |
|                       | Year Two ( <i>Fall 2006 – Spring 2007</i> )   |   |
|                       | - 10 observations during first year of teaching (5 in Fall; 5 in Spring)  |   |
| Participant Artifacts | Year One:   | - Selective coding methods connected to the participants' interview data                |
|                       | - Coursework (major assignments, lesson plans, autobiography)   |   |
|                       | - Practicum journal entries   |   |
|                       | Year Two:   |   |
|                       | - Lesson plans and curriculum materials related to the field observations   |   |
| Pupil Work Samples    | 12 full class sets of pupil work:   | - Selective coding used to triangulate with interview and observational data            |
|                       | Four sets from Year One ( <i>Student Teaching</i> ) and eight sets from Year Two ( <i>First-year Teaching</i> ), including: | - Newmann's Authentic Assessment Rubric   |
|                       | a) Pupil work corresponding to the observations   |   |
|                       | b) Samples of a culminating project and two related assignments   |   |
|                       | c) Various mathematics assessments  |   |

During the second year of the study, case study participants were first-year teachers at elementary schools. For optimal comparison purposes, one participant taught at a suburban school and one taught at an urban school. Selecting participants from different educational contexts during their first year of teaching made the case studies applicable to different school contexts.

Classroom observations revealed how participants' teaching practices evolved over time. Observational data were essential to the qualitative inquiries of this study. Using an ethnographic lens, researchers seek to understand a process by observing events that take place to influence a participants' behavior and provide an account of their culture (Angrosino & Mays de Perez, 2000). Observations take researchers directly into the participants' worlds and provide firsthand accounts of their personal experiences and actions. They are fundamental to understanding the complexities of context while

uncovering tacit patterns as evidenced by both dialogue and action. The observations focused on pupil learning by examining their interactions, dialogue, and engagement. Pupil work samples (i.e., mathematics assessments) were collected to provide additional evidence of pupil learning.

## Instrumentation

### *Surveys*

Creating the mathematics education pre-survey was a long and tedious process requiring multiple steps. First, I searched the ERIC database for examples of surveys pertaining to the teaching and learning of mathematics, attitudes towards mathematics, and mathematics methods courses. Next, I gathered 15 sample surveys that overlapped with the purpose. Then, I examined the surveys and highlighted items that were possible candidates for the survey. Given the purpose of the study, I divided the pre-survey into the following four sections about mathematics: attitude and past experiences, teaching and learning, methods course expectations, and diverse learners. I made several revisions with the help of the three participating mathematics methods professors. Five drafts of the pre-survey were constructed before the final version was complete (see Appendix B).

Most of the 48 items were on a four-point Likert scale ranging from “strongly agree” to “strongly disagree.” However, the section about the practicum experience included a fifth option, “not applicable.” The fourth and fifth drafts were given to a small group of people to pilot, examine, and provide feedback regarding the wording of items and item order. The post-survey, constructed similarly to the pre-survey, was changed once the pre-survey was administered, and a factor analysis was completed (see Appendix C). The

post-survey included 31 items identical to those in the pre-survey, except for changes in the stems of the items. For example, questions pertaining to topics and strategies taught in the mathematics methods course on the pre-survey were phrased in terms of what preservice teachers expected and viewed as “important for [them] to learn.” The same items were rephrased for the post-survey to ask whether “the methods course taught...” preservice teachers a particular strategy such as “how to assess student learning in mathematics.” The questions that asked about preservice teachers’ past experiences were replaced with questions about practicum experiences. For example, item 3 on the pre-survey stated, “I had several positive experiences with mathematics as a K-8 student.” There was no point in asking questions related to PTs’ past schooling experiences on the post-survey, because these responses should not have changed. Moreover, the majority of PTs enrolled in a mathematics methods course also attended a practicum during that same semester. One of the goals of the post-survey was to capture these experiences. For example, item 5 on the post-survey stated, “My cooperating teacher used a conceptual method (i.e., problem-solving, open-ended Qs) to teach math.”

The overall factor analysis of the pre-survey accounted for 79.3% of the total variance among responses and items loaded onto 13 factors. However, conceptually, the items fit into seven factors. When the instrument was forced into seven factors, the analysis accounted for 66.8% of the variance. The rotated component matrix and conceptual understanding were used to divide the items into seven factors.

Next, reliability tests were run to examine the scales as indicated by Cronbach’s alpha, which examines the internal consistency of the scales within an instrument. The

following were the seven factors and their reliability: 1. attitude toward mathematics ( $\alpha = .912$ ); 2. negative experiences ( $\alpha = .780$ ); 3. procedural mathematics ( $\alpha = .612$ ); 4. conceptual mathematics ( $\alpha = .626$ ); 5. course expectations ( $\alpha = .921$ ); 6. confidence to teach ( $\alpha = .879$ ); and 7. social justice ( $\alpha = .648$ ). The overall psychometric properties of the instrument were sound. Seven factors had high reliability levels. Two items did not load well onto the factors where they fit conceptually; thus, I removed them from the scale analyses. Nevertheless, 46 out of 48 items scaled well. The two items that were not included in the scale analyses were items 10 and 18. Item 10 stated, “I used hands-on materials as a K-12 student.” Item 18 stated, “I want to teach math the same way I learned it.” This was not surprising, because the language used in these items was vague. Interpretation of item 18 would be dependent on the way in which participants experienced mathematics as K-8 students. To conduct an analysis and report on the responses of the items would be to commit a measurement error<sup>2</sup>. The responses to the items would vary in meaning and interpretation. If many people chose “strongly disagree” to item 18, this does not automatically imply that they would like to teach in a more conceptual approach. One would need to disaggregate the responses about their past schooling experiences to make sense of the response. Furthermore, item 10 covered a wide span of grades. Participants may have indicated strongly agree, but this would not specify whether they used the hands-on materials nor whether it was effective in helping them learn the mathematical concepts. Therefore, the two items were omitted from all analyses. To respond to this error, more precise language was used in the post-survey,

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<sup>2</sup> A measurement error is the result of poor question wording or questions being presented in such a way that inaccurate or uninterpretable answers are obtained (Dillman, 2000).



which defined terms and directly asked participants whether they planned to teach mathematics in a traditional or conceptual manner (see items 14 and 15 in Appendix B). For example, Item 14 states, “I plan on teaching math in a procedural way (facts, skills, etc...).” Similarly, the post-survey also had highly reliable scales. The instrument was divided into five factors: attitude towards mathematics ( $\alpha = .709$ ); teaching practices ( $\alpha = .751$ ); practicum experiences ( $\alpha = .696$ ); methods course experiences ( $\alpha = .893$ ); and preparation to teach ( $\alpha = .888$ ).

#### *Interview and Observation Protocol*

The semi-structured interview protocols, which were part of the QCS project, were constructed with a team of researchers (See Appendix D). Informed by the work of Susan Moore Johnson (2004) and studies conducted at the National Center for Research on Teacher Education (Kennedy, Ball, & McDiarmid, 1993), interview protocols were constructed through a rigorous and systematic group process. First, the overarching purpose of the interview was discussed by the larger group. Next, a small group developed specific questions and brought them back to the larger group for revisions. Then the protocol was piloted with two preservice teachers who met criteria similar to those met by participants in the QCS study. Based on the pilot, suggested changes were made to both the content and organization of the protocol. Finally, the larger group discussed and revised the protocol for a third time and approved of a final version. This iterative process was followed for the development of each interview protocol, providing for consistency and validity across multiple interviewers.

During the first year of the study, case study participants were interviewed six times (see Table 3.4). The following themes were the foci of the interviews: one—educational background, program and teaching expectations; two—practicum experience; three—teacher education and A&S coursework; four—student teaching experience; five—assessment and pupil learning; and six— general program experience, expectations for how the program will influence teaching, and future plans. During the second year of the study, participants were interviewed three additional times as first-year teachers. The following themes were the foci of the interviews: seven—beginning first year teaching experiences, school context, and goals for pupils; eight—pupil learning and teaching practices; nine—reflection of first year teaching experience, goals for next year, pupil learning, and the role of the teacher education program. Throughout each interview, participants were also asked about their own mathematical content knowledge, experiences with teaching mathematics, and how social justice played a role in their classrooms.

The observation protocol was constructed in a similar manner as the interview protocol. According to Merriam (1997), observations help to triangulate emerging findings and provide knowledge about the context of the study. Observations were useful in examining participants' pedagogical practices in elementary school mathematics. As part of the QCS project, the goal of the researchers was to design an in-depth qualitative tool that would be rich in description (see Appendix E). During the six-month development period of the observation instrument, the iterative process consisted of an examination of existing protocols, readings of the conceptual literature on teaching for

social justice, the construction of five drafts, and multiple pilots of the instrument. Once the final version was established, researchers observed in pairs to establish consistency across observers.

The classroom observations provided a firsthand look into how participants evolved as teachers over time. They also allowed for a better understanding of the participants' school contexts. The foci of the observations were teaching, pupil learning, and social justice. Teaching included both content knowledge and pedagogical skills as observed by participant actions. Pupil learning consisted of academic, social, and emotional learning. The academic learning included both a conceptual understanding of the mathematical content and procedural skills. These aspects of learning were examined via classroom interactions, dialogue, and engagement. Social justice considered issues of equity, the classroom community, teacher expectations, and differentiating instruction to meet the range of pupil needs.

### *Artifacts*

Several teacher and pupil artifacts were collected for the two case study participants as part of the QCS project. During the first year of the study, preservice teachers' artifacts included their autobiographies, major papers and projects completed as part of their coursework, journal entries written about their field placement, lesson plans, and inquiry projects. During the second year of the study, first-year teachers' artifacts consisted of lesson plans and assessment tasks they developed and used to teach mathematics. For the two year study, participants were asked to collect pupil artifacts that included class sets of major mathematics assessments, projects, and assignments that connected to classroom

observations. The pupils in this study were from participants' first year of teaching with one class set in an urban school context and another class set in a suburban school context. The classroom artifacts (i.e., mathematics assessments) were analyzed using Newmann's Authentic Assessment scales, which are explained in the next section.

### Data Analysis

Data analysis procedures for this study are outlined in Tables 3.3 and 3.4. Quantitative data analyses were carried out with SPSS, a software package used for organizing data, conducting statistical analyses, and generating tables and graphs that summarize data. This approach involved several steps. First, descriptive statistics were applied to analyze overall item response percentages and note any possible trends in responses. Then, correlations examined the relationships among past experiences, field experiences, the methods course, attitudes about mathematics education, and confidence to teach. Paired t-tests were then completed to compare the differences in preservice teachers' attitudes and perceived level of preparedness between the pre- and post-surveys. Lastly, two multiple regression models were created to examine how past schooling and the teacher education program accounted for preservice teachers' a) attitude towards mathematics and b) perceived level of preparation to teach mathematics. Chapter Four explains the confirmatory regression models in greater detail, including a description of the variables, missing data, the hypotheses, results, and a post-hoc power analysis.

Qualitative data analyses were carried out with HyperRESEARCH, a software program used for managing and coding qualitative data, allowing for easy retrieval and analysis of the corpus of interview and observational data. Analysis considered both

interview and observation data. Categories across domains, which reflected participants' thoughts, practices, and assessment procedures, revealed recurring patterns and emerging themes that helped to make sense of the data generated. Data analysis was an ongoing iterative process, and data reduction methods were employed throughout the data collection stage by focusing on themes that directly connected to the research questions. Triangulation was made possible by applying a consistent set of codes to the interviews, observations, and artifacts to examine both teachers' beliefs and practices in elementary school mathematics. The overarching goal of the ambitious data collection and analysis process was to create a comprehensive design that strengthened the validity of the research findings.

To measure level of reformed teaching practices, this study used definitions provided by the literature as selective coding themes with the field observations. The study analyzed pupil work using selective codes to connect pupil learning with field observations. Additionally, the Research Institute on Secondary Education Reform (RISER, 2001, see Appendix G) instrument, developed with Fred Newmann's Authentic Assessment scales, was used to analyze the mathematics assessments as tasks and the student work that was produced in response to the assessments (Newmann, 1996). This instrument assisted the QCS research team in examining the teacher tasks by analyzing the knowledge being constructed, relevance to the real world and pupils' lives, and the level of mathematical communication expected. It also assisted in scoring the pupils' work by rating the level of mathematical analysis, their written mathematical communication, and conceptual understanding. Prior to scoring the assessment tasks and

pupil work, members of the research team participated in two intensive two-day training sessions on use of the Newmann rubric to score the assessments. The first two-day training was led by one of the designers of the RISER. After the training, pairs of scorers were given sets of artifacts according to their subject area of expertise. A high rater consistency was established. Pairs rated the assessment tasks within one-point agreement 91% of the time and rated pupil work within one-point agreement 90% of the time. Once this rater agreement was established, the artifacts were divided among pairs according to subject area knowledge (for more information about this process, see Gleeson, Cochran-Smith Mitchell, & Baroz, 2007). The artifacts used for this dissertation were analyzed by two raters. With help from a member of the QCS team, the artifacts pertaining to the two case study participants were randomly assigned and rated. A sample of ten pupils' mid-year and end-of-year mathematics assessments from each classroom during participants' first year of teaching were randomly selected to be part of the analysis. Among the pupil assessments provided by Sonia, only thirteen pupils had both mid-year and end-of-year assessments. Riley's classroom artifacts included both assessments for 21 of her 22 students. However, analyzing the same sample of pupil assessments from both classes was preferable. Therefore, the final sample of ten was small due to the limited availability of both assessments. An example of how assessments were scored is provided in the pupil learning results section of Chapter Five.

As stated previously, this study was closely connected to the conceptual framework presented in Chapter One and strengthened by the use of multiple-methods over a longitudinal period (Yanchar & Williams, 2006; Chatterji, 2005). To thoroughly

investigate the research questions, systematic procedures were followed throughout all stages of data collection and analysis. During data collection, the research questions of interest were directly investigated, and contextual factors were considered through instrument development by including piloted surveys, observations, and interview protocols (Fontana & Frey, 2000; Dillman, 2000). Additionally, some of the instrument development, data collection, and data analysis procedures were carried out in a Consensual Qualitative Research (CQR) process with a small research team, which added to the validity and reliability of the study (Hill, Thompson, & Williams, 1997). “CQR highlights the use of multiple researchers, the process of reaching consensus, and a systematic way of examining the representativeness of results across cases” (Hill et al., 1997, p. 519). Rather than relying on an individual researcher’s interpretation or understanding, data collection and analysis were agreed upon by a team of researchers to avoid researcher bias. “This method is based on the assumption that complex issues involve multiple perspectives and levels of awareness” (p. 523).

#### Limitations of the Design

The longitudinal and multiple-method design of this study was extremely ambitious. Although I attempted to design a very comprehensive study, I recognize that more could have been included to strengthen the design. One limitation of the study was the small number of cases, which do not account for a wide range of experiences. The two cases could also limit the generalizeability of the findings. However, the depth of the cases compensated, in part, for the small quantity of participants. Additionally, it would have been valuable to survey the participants from the mathematics methods course one

year later when they were in their first year of teaching. However, this would have been logistically difficult; the survey sample would have likely been small and not as informative. The design could have been strengthened by incorporating pupil interviews and baseline mathematics assessments. This was not possible due to time constraints, IRB related issues, and limited resources. Considering the factors discussed above, the research design was sufficiently comprehensive to address the research questions of interest. As it stands, the corpus of data required considerable time to collect and analyze. The goal was to capture the experiences of the participants and provide insight into the field of mathematics teacher education research. The methodology used in this dissertation certainly afforded that opportunity.

#### Summary

This chapter discussed the methods used to collect and analyze data. First, the research questions were restated, followed by a rationale for the mixed-method research design. At each stage of the data collection process, participants, along with their respective university and school contexts, were described. Then, data collection and analysis procedures were provided for both quantitative and qualitative aspects of the design. Lastly, limitations of this study were taken into consideration.

The next two chapters report the results of this study. Chapter Four focuses on the survey results that examined preservice teachers' attitudes and perceptions about teaching and learning mathematics. Chapter Five presents the two case studies of learning to teach mathematics. The cases present a chronological narrative account of participants' backgrounds, teacher education experiences, and first year of teaching. The chapter also



includes the analysis of pupil work as it connects to the two participating teachers' classroom practices. An interpretive summary is provided at the end of each results chapter to highlight major findings and themes with the purpose of addressing the research questions.

## Chapter 4

### SURVEY RESULTS: ATTITUDES AND PERCEPTIONS ABOUT TEACHING AND LEARNING MATHEMATICS

As previously explained, data for the first year of this study included surveys of preservice elementary school teachers enrolled in a mathematics methods course. This chapter reports survey findings by focusing on preservice teachers' attitudes and perceptions about the teaching and learning of mathematics. Specifically, this chapter examines the following research question, as stated in Chapter One:

1. How do preservice elementary teachers' past schooling and teacher education experiences (i.e., mathematics methods course and field experiences) influence their attitudes and perceptions about the teaching and learning of mathematics?

Pajares (1992) argues that teachers' beliefs ought to be a focus of educational research because beliefs can influence both perceptions and behaviors. Cognitive science research also maintains that one's prior knowledge and beliefs strongly affect how one makes sense of new ideas (Donovan & Bransford, 2005; Nunez, 2000; Schoenfeld, 1983). The first section of this chapter explains the survey data analysis (n=75), including a description of the variables, missing data, descriptive statistics, correlations, independent t-tests, and regression models. Taken together, survey results indicated that past experiences and the teacher education program influenced preservice teachers' perceptions of learning to teach mathematics at the elementary school level. An interpretive summary of the survey results is provided to situate findings within the literature on preservice teachers' attitudes.

## Survey Results

### *Preliminary Analysis*

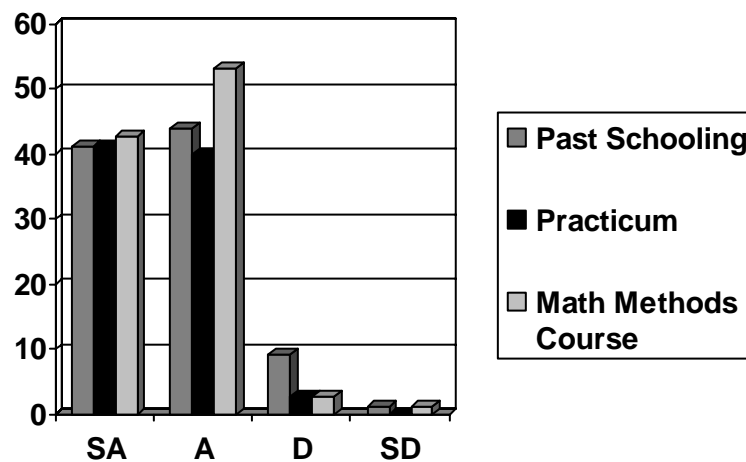
Prior to conducting analyses, descriptive statistics of pre- and post-survey items of interest were examined to determine any unusual response patterns or possible trends. Although no unusual patterns were detected, data were clearly missing; thus, this issue is addressed in the next section. Descriptive statistics of items were also examined to guide selection of the variables used in the analyses.

When considering the elements of the conceptual framework, I became interested in responses on three unique items on the post-survey that directly asked preservice teachers about the perceived impact of their past K-8 schooling, practicum, and mathematics methods course on their future teaching practices (see Figure 4.1). The results across all three were very similar, suggesting an important role for each in shaping PTs' future teaching of mathematics. Table 4.1 shows the percents corresponding to the data illustrated in Figure 4.1. The percents are based on the total n of 75 to avoid an inflated percent due to missing data. The stem for the three items stated, "The following will have a major impact on the way I teach math in the future." The PTs were then asked to respond to this statement specifically about their past K-8, practicum, and methods course experiences.

Table 4.1

*Experiences Influencing Preservice Teachers' Teaching Practices by Percentages*

|                   | Past K-12 Schooling | Practicum Experiences | Mathematics Methods Course |
|-------------------|---------------------|-----------------------|----------------------------|
| Strongly Agree    | 41.3%               | 41.3%                 | 42.7%                      |
| Agree             | 44.0%               | 40.0%                 | 53.3%                      |
| Disagree          | 9.3%                | 2.7%                  | 2.7%                       |
| Strongly Disagree | 1.3%                | 0%                    | 1.3%                       |

*Figure 4.1.* Elements influencing preservice teachers' teaching practices by percentages.

Another important point is that the “practicum experiences” question was only applicable to 54 respondents. Eighty-five percent either strongly agreed or agreed that past experiences would have a major impact on their future teaching practices. Eighty-one percent strongly agreed or agreed that their practicum experiences would be influential, and 96% said that the mathematics methods course would have a major effect on their future teaching. The valid percent for the practicum experience item was well over 90.0% in agreement among those who responded. The data revealed the importance

of the three experiences in shaping perceived teaching practices. Paired t-tests indicated that no statistically significant differences existed between any pair of means of the three items.

Results suggested that preservice teachers perceived their prior schooling, the practicum, and mathematics methods course as having an impact on their teaching practices. However, further analyses were needed to examine the relationship and influence of these three elements of the conceptual framework. First, correlations were used to examine how these experiences related to preservice teachers' attitudes and perceptions about mathematics education. Then, paired t-tests were carried out to determine changes between pre- and post-surveys. Paired t-tests also examined differences among items, such as participants' perceptions about teaching with reformed or traditional methods. Finally, regression models were created to analyze the extent to which past schooling, the practicum, and methods course accounted for the variance in level of preparation and attitude towards teaching mathematics. In the next sections, I explain the procedures taken to address missing data and describe the variables used in the aforementioned analyses.

### *Missing Data*

The first analyses I examined were descriptive statistics on the items of interest to this study. Four of the items had missing data, ranging from one to three cases. The data appeared to be missing at random; no patterns were visible. For the two items on the pre-survey that were missing data, I replaced the data with an unconditional mean substitution; i.e., I replaced missing data with the mean of the item. Although this can

reduce the variance of the scores, for the two instances where there were missing data, only one or two responses were not present; therefore, an unconditional mean substitution would not have a major influence on the spread of the data. It was important to replace missing data, because the sample size was fairly small; three cases were about 5% of the total. This helped to avoid statistical analysis issues with missing data and maintained the power of the analyses.

For the two items with missing data on the post-survey, I replaced missing data with a conditional mean substitution. The conditional mean substitution was the best choice for the missing data because the objective was to enter a value closest to what was expected. To compute an expected value, I looked at participants' pre-survey responses and replaced their post-survey response with the mean score of those who had similar responses on the pre-survey. For example, for the item, "I am confident in my ability to teach mathematics," one response was missing. The participants' pre-survey response to this item was "agree," recorded as a value of three. Thus, I selected all the cases of those who "agreed" and computed the mean of their post-survey responses for this item. The mean score for this group was 3.2, which was used to replace the missing data.

The set of items about the practicum had a substantial amount of missing data. In these cases, participants selected "not applicable," because they were not in a practicum during the semester the survey was administered. There were 21 cases with missing data for this set of items, which posed a serious problem. There was not a viable solution for replacing missing values. Therefore, I selected a listwise deletion for analyses involving this item. This method allowed inclusion of the same participants, but decreased the

sample size substantially (n=54). For analyses that included items about the practicum, interpretations were made with caution, acknowledging a loss of power (as seen in the regression model) and the possibility of reduced variance or bias in the sample. Analyses that were not related to the practicum maintained a sample of 75.

### *Variables*

Throughout this chapter, I refer to specific variables by names that describe the constructs being examined to discuss the results without using the entire item. For example, I use the term *positive K-8 math* when referring to the item “I had several positive experiences with mathematics as a K-8 student.” These names become particularly important when the regression models are presented because the dependent variable was created with two items. Below is a description of the constructs captured by the survey and considered in this study.

*Past Experiences.* To examine preservice teachers’ prior schooling experiences in mathematics, the following independent variables were used: *positive K-8 math* and *positive 9-12 math*. The two variables take account of preservice teachers’ grades K-8 and 9-12 past schooling by asking the extent to which these experiences were positive on a scale from “strongly agree” to “strongly disagree.”

*Practicum.* The independent variable *positive practicum* was used to determine perceptions of PTs’ practicum experiences. An item on the post-survey inquired about participants’ practicum experience by asking the extent to which this experience was positive. However, only 54 of the students who completed the survey, or approximately 72% of the sample, were in a practicum during the fall semester of 2005. This item was

also limited because it only considered the practicum, where preservice teachers visit the classroom once or twice a week during the semester. This variable does not take into account full-time student teaching. By focusing solely on the practicum, this item does not accurately represent preservice teachers' field experiences. Thus, it should be carefully interpreted.

*Mathematics Methods Course.* To determine whether the methods course was influential, the independent variable *math course strategies* was used. For this item, participants were asked whether they “learned a variety of teaching strategies” in the course. Among the items about the mathematics methods course, this was the best overall indicator for whether preservice teachers had a positive experience from the strategies they gained.

*Attitude about Mathematics.* The dependent variable *positive math attitude* indicated participants' attitude towards mathematics. The item stated, “I like mathematics.” Another indication of their attitude was the item, “I am looking forward to teaching mathematics.” The variable *look forward* was used to get a sense of PTs' perceptions about teaching mathematics.

*Mathematical Content Knowledge.* The dependent variable *proficiency* served as a self-reported measure of content knowledge. The survey inquired whether participants perceived themselves as “proficient in mathematics.” There are many dimensions to teachers' mathematical content knowledge, and multiple measures are better indications of this knowledge. However, for the purposes of this study, a general sense of preservice teachers' perceived proficiency in mathematics was valuable.



*Preparation to Teach.* The two dependent variables, *confidence* and *prepared*, were indicators of preservice teachers' perceived level of preparation to teach mathematics. The variables consisted respectively of the items: "I am confident in my ability to be a good mathematics teacher," and "I am prepared to teach mathematics." Teachers need both the confidence and preparation to teach mathematics; therefore, these two items were considered possible outcomes.

In addition to these variables, the correlations of other items, such as inquiring about the practicum, mathematics methods course, and perceptions about teaching mathematics, were examined. They are described in the next section, along with their respective results.

### *Correlations*

To examine the paired relationship between various items and the way in which participants responded, bivariate two-tailed Pearson's correlations were conducted at the .05 alpha level. Among the six items of interest on the pre-survey, all correlations were statistically significant ( $p < .001$ ). Findings showed a positive relationship among preservice teachers' attitudes towards mathematics, their prior schooling experiences, and perceived proficiency in mathematics.

Results displayed in Table 4.2 indicate a positive relationship between preservice teachers' attitude towards mathematics and positive prior schooling experiences in mathematics at the K-8 grade level ( $r = .599$ ,  $p < .01$ ). Participants' *positive math attitude* had an especially strong positive relationship to their perceived *proficiency* and positive high school experiences with mathematics ( $r = .719$ ,  $p < .01$ ). Undoubtedly, these

constructs are all interrelated. If preservice teachers perceived themselves as highly proficient in mathematics, they were likely to be more confident ( $r = .585$ ,  $p < .01$ ), look forward to teaching mathematics ( $r = .563$ ,  $p < .01$ ), and have a higher positive attitude towards mathematics ( $r = .713$ ,  $p < .01$ ). Similarly, preservice teachers' attitudes and self perceptions were related to their own experiences as students learning mathematics. Hence, it is important to consider preservice teachers' past schooling as potential influences on entering attitudes and perceptions about mathematics.

Table 4.2

*Relationships among Attitudes and Prior Schooling Experiences in Mathematics*

| Pre-Survey Items                    | 2      | 3      | 4      | 5      | 6      |
|-------------------------------------|--------|--------|--------|--------|--------|
| 1. Positive math attitude           | .599** | .719** | .713** | .661** | .553** |
| 2. Positive K-8 math                |        | .539** | .526** | .455** | .368** |
| 3. Positive 9-12 math               |        |        | .599** | .508** | .440** |
| 4. Proficient at math               |        |        |        | .563** | .585** |
| 5. Looking forward to teaching math |        |        |        |        | .504** |
| 6. Confident in ability             |        |        |        |        |        |

\*\* Correlation is significant at the 0.01 level (2-tailed)

To investigate the paired relationship between items about preservice teachers' practicum experiences, perceptions of their cooperating teacher (CT), attitudes about mathematics, and perceived preparation, bivariate two-tailed Pearson's correlations were obtained at the .05 alpha level. Table 4.3 displays results from the analyses among these items of interest on the post-survey. Findings indicated that a positive math attitude had a positive relationship to participants' perceived level of preparation ( $r = .306$ ,  $p < .01$ )

Table 4.3

*Relationships among Attitudes and Practicum Experiences*

| Post-Survey Items                   | 2     | 3      | 4      | 5      | 6      | 7     | 8     | 9     | 10    |
|-------------------------------------|-------|--------|--------|--------|--------|-------|-------|-------|-------|
| 1. Positive math attitude           | -.074 | .306** | .794** | .566** | .326** | .168  | .196  | .241  | .140  |
| 2. Positive Practicum               |       | .099   | .031   | -.115  | -.003  | -.138 | .182  | -.158 | .258  |
| 3. Prepared to teach math           |       |        | .397** | .438** | .139   | -.149 | .068  | .141  | .120  |
| 4. Looking forward to teaching math |       |        |        | .711** | .311** | .011  | .188  | .116  | .288* |
| 5. Confident in ability             |       |        |        |        | .412** | .031  | .055  | .193  | .083  |
| 6. Teach conceptual math            |       |        |        |        |        | .275* | .313* | .268  | .112  |
| 7. Teach procedural math            |       |        |        |        |        |       | .215  | .297* | .156  |
| 8. CT conceptual                    |       |        |        |        |        |       |       | .153  | .081  |
| 9. CT traditional                   |       |        |        |        |        |       |       |       | .149  |
| 10. Practicum, major impact         |       |        |        |        |        |       |       |       |       |

\* Correlation is significant at the 0.05 level (2-tailed)

\*\* Correlation is significant at the 0.01 level (2-tailed)

and stronger positive relationship to their confidence to teach mathematics ( $r = .566$ ,  $p < .01$ ). Their attitude also had a positive relationship with intention to teach mathematics in a conceptual manner ( $r = .326$ ,  $p < .01$ ). This relationship did not hold for participants who planned to teach mathematics with a procedural focus ( $r = .168$ ,  $p > .05$ ).

Results indicate that preservice teachers' attitudes about mathematics were not associated with a positive practicum experience ( $r = -.074, p > .05$ ). This may have been the case because elementary school teachers are generalists and not specialists; thus, mathematics is one of many subjects they are expected to teach (Ball, 1989; Li, 2008). Surprisingly, there were no statistically significant relationships between the practicum experience and any of the other items examined in the analyses. However, there was a modestly significant positive relationship between eagerness to teach mathematics and belief that practicum had a major impact ( $r = .288, p < .05$ ). Another modest positive relationship existed between preservice teachers' plans to teach with both a conceptual and procedural manner ( $r = .275, p < .05$ ). This relationship was not strong, indicating minimal covariance in the way preservice teachers responded to the items; i.e., there was some similarity between the ways participants responded to the two approaches. In addition, findings showed that a teacher's intent to instruct in a procedural manner related to whether he or she had a cooperating teacher who taught in a procedural manner ( $r = .297, p < .05$ ).

A similar moderately positive relationship existed between those who planned to teach mathematics in a conceptual manner and had a cooperating teacher who taught in a conceptual manner ( $r = .313, p < .05$ ). Several of the correlations obtained on items about perceived future teaching practices only had about 10% of shared variance. This was not surprising; it is simple enough for participants to agree to a future teaching practice on a survey item, but this might not be an accurate representation of expected teaching practices. It is important to consider the limitations of self-reporting, especially when

surveying teachers' perceived teaching practices. Thus, multiple assessment methods provide a more accurate account of preservice teacher experiences (Darling-Hammond, 2006).

To examine the relationships among preservice teachers' mathematics methods course experiences, attitudes about mathematics, approaches to teaching mathematics, and perceived preparation, bivariate two-tailed Pearson's correlations were run at the .05 alpha level. Table 4.4 displays results from the analyses among items pertaining to these topics on the post-survey. Some of the findings from Table 4.3 are shown in Table 4.4 in cases where the same variables were included. Thus, I do not repeat a discussion of the shared findings. Results indicated a moderate positive relationship between participants who had a more positive attitude towards math and whether they learned a variety of strategies in the mathematics methods course ( $r = .273, p < .05$ ), planned to teach mathematics in a conceptual manner ( $r = .326, p < .01$ ), were going to require their students to memorize facts ( $r = .274, p < .05$ ), and agreed that the mathematics methods course would have a major impact ( $r = .268, p < .05$ ). Preservice teachers who learned a variety of strategies in the methods course was significantly related to an increased desire to teach mathematics ( $r = .371, p < .01$ ), confidence ( $r = .277, p < .05$ ), and belief that the course would have an impact on their teaching practice ( $r = .440, p < .01$ ). An increased agreement that the mathematics methods course would have an impact was also significantly related to an increase in looking forward to teaching mathematics ( $r = .360, p < .01$ ) and confidence ( $r = .291, p < .05$ ). Participants' level of confidence was also

associated with whether they would encourage students to use multiple strategies ( $r = .279$ ,  $p < .05$ ), a characteristic of teaching with a conceptual focus.

Table 4.4

*Relationships Among Attitudes and the Mathematics Methods Course Experiences*

| Post-Survey Items                     | 2     | 3      | 4      | 5      | 6      | 7     | 8      | 9      | 10     |
|---------------------------------------|-------|--------|--------|--------|--------|-------|--------|--------|--------|
| 1. Positive math attitude             | .273* | .306** | .794** | .566** | .326** | .168  | .066   | .274*  | .268*  |
| 2. Learned a variety of strategies    |       | .192   | .371** | .277*  | .149   | .043  | .142   | -.013  | .440** |
| 3. Prepared to teach math             |       |        | .397** | .438** | .139   | -.149 | .227*  | .047   | .210   |
| 4. Looking forward to teaching math   |       |        |        | .711** | .311** | .011  | .140   | .061   | .360** |
| 5. Confident in ability               |       |        |        |        | .412** | 0.031 | .279*  | .137   | .291*  |
| 6. Teach conceptual math              |       |        |        |        |        | .275* | .382** | .155   | .014   |
| 7. Teach procedural math              |       |        |        |        |        |       | .051   | .601** | -.083  |
| 8. Encourage multiple strategies      |       |        |        |        |        |       |        | .016   | .119   |
| 9. Require students to memorize facts |       |        |        |        |        |       |        |        | -.109  |
| 10. Methods course, major impact      |       |        |        |        |        |       |        |        |        |

\* Correlation is significant at the 0.05 level (2-tailed)

\*\* Correlation is significant at the 0.01 level (2-tailed)

Similar to findings related to perceptions about cooperating teachers' classroom practices shown in Table 4.3, results showed that whether one planned to teach in a conceptual manner related to whether one would encourage students to use multiple

strategies ( $r = .382, p < .01$ ). This positive relationship was stronger for those who planned to teach mathematics in a procedural manner and planned to require their students to memorize facts ( $r = .601, p < .01$ ). These findings suggest that preservice teachers were familiar with characteristics commonly associated with the two approaches to teaching mathematics. A relationship between preservice teachers' plans to teach with both approaches ( $r = .275, p < .05$ ) is not surprising; there can be overlap among strategies to teach mathematics where both conceptual and procedural knowledge are valued. Similar to correlations in paired items about the practicum, most of the paired items about the mathematics methods course did not have more than 10% shared variance. Thus, it is important to carefully interpret the survey results and conduct further analyses to better understand existing relationships among preservice teachers' prior schooling, practicum experiences, and the mathematics methods course.

#### *Paired T-tests*

Paired t-tests were conducted to determine significant differences in the mathematics attitude and confidence to teach over the course of the semester (see Table 4.5). The paired t-test was run with a two-tailed 95% confidence interval. Results indicated that PTs in the mathematics methods courses had statistically significant positive changes in their attitudes towards mathematics. They also became significantly more confident in their overall ability to teach mathematics.

Table 4.5

*Overall Statistically Significant Differences on Pre- and Post-Survey Results*

| Item   | Mean (pre to post) | Test Results         |
|--|--------------------|----------------------|
| Positive attitude towards math                 | 2.076 to 2.280     | $t = 3.401, p < .01$ |
| Confident in ability to be a good math teacher | 1.932 to 2.139     | $t = 3.110, p < .01$ |

To examine preservice teachers' perceptions of their future teaching practices, I analyzed responses to two items on the post-survey: "I plan on teaching math in a conceptual way (for understanding, problem-solving)" and "I plan on teaching math in a procedural way (facts, skills, etc...)." Figure 4.2 shows participants' responses to these two items by percentages. Results indicated that 100% of preservice teachers strongly agreed or agreed that they planned to teach mathematics in a conceptual way. In contrast, only about 70% strongly agreed or agreed that they planned to teach mathematics in a procedural way. Paired t-tests showed a statistically significant difference ( $p < .001$ ) between preservice teachers' responses to the two items in favor of a conceptual teaching method.

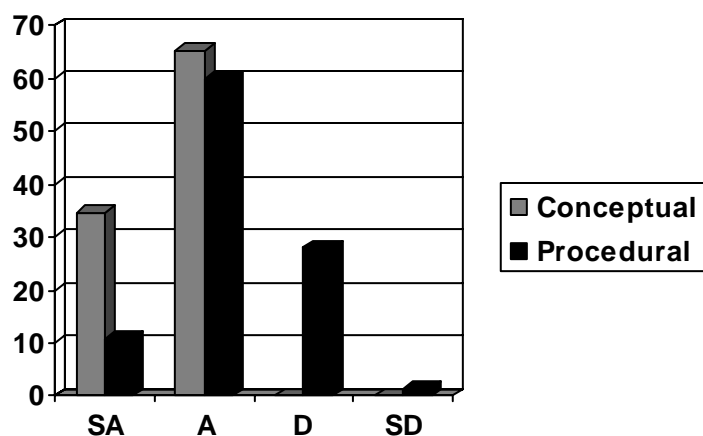


Figure 4.2. Participants' planned approaches to teaching mathematics by percentages.



Another finding showed that approximately 80% of preservice teachers strongly agreed or agreed that: “As a K-8 student, I mostly learned mathematics in a traditional manner (i.e., textbooks, worksheets, rules, lectures).” However, the majority also disagreed or strongly disagreed with the following statement: “I want to teach mathematics the same way I learned it.” There was a statistically significant difference in responses to the two items ( $p < .0001$ ). This suggests that preservice teachers who learned mathematics in a traditional manner would like to teach it differently than the way in which they were taught. However, the desire to teach in a reformed manner can be difficult to put into practice. Rasmussen and Marrongelle (2006) argue that teaching in a manner consistent with NCTM reform recommendations may be overwhelming for teachers, because part of the challenge includes the ability to understand pupils’ thinking and use it to develop mathematical ideas. This can be a struggle for beginning teachers, who in most cases already have feelings of uncertainty about their teaching, due to their lack of classroom experience. Having the ability to use pupils’ prior knowledge and in-class strategies to guide instruction is a skill that develops with years of teaching experience. In addition, prior to teaching in a reformed manner, a teacher must value the classroom characteristics of reformed teaching and agree to have reformed goals as a part of their classroom practice (Remillard & Bryans, 2004).

### *Regression Analyses*

Ordinary least squares (OLS) hierarchical regression was completed (SPSS 15.0). The *prelookfwd* served as the outcome variable. This variable was computed by taking the mean of responses from items “I am prepared to teach” and “I look forward to

teaching.” The two items were selected because they provided a sense of preservice teachers’ levels of attitude and preparation to teach mathematics. The responses from the two items were divided by two so that the outcome variable was on a 1-4 scale, which was consistent with the predictor variables. This section presents results of the ordinary least squares simple and multiple regression models. For the multiple regression model, the predictor variables were entered as follows: *positive K-8 math* was the first predictor, *math course strategies* was next, and the *positive practicum* was last. First I entered *positive K-8 math* into the model; research suggests that prior schooling can have a strong influence on teachers due to their countless hours spent as students observing their own teachers (Lortie, 1975; Ball, 1989). Participants also spent more time as K-8 students than as student teachers. Next I entered *math course strategies* because the mathematics methods course was specifically designed to prepare preservice teachers to teach mathematics, whereas teaching mathematics may not be a focus of the practicum (Ebby, 2000). Following a confirmatory approach, I hypothesized that the variation found in preservice teachers’ feelings of preparation and anticipation to teach mathematics after being in the teacher education program for at least one semester could be explained in terms of the variables listed above. In statistical terms, the hypotheses can be expressed

$$\text{as: } \begin{array}{l} H_0 = \beta_{\text{positiveK8math}} = 0 \\ H_a = \beta_{\text{positiveK8math}} \neq 0 \end{array} ; \begin{array}{l} H_0 = \beta_{\text{mathcoursestrats}} = 0 \\ H_a = \beta_{\text{mathcoursestrats}} \neq 0 \end{array} ; \text{ and } \begin{array}{l} H_0 = \beta_{\text{positiveprac}} = 0 \\ H_a = \beta_{\text{positiveprac}} \neq 0 \end{array} . \text{ The}$$

significance level was set at the 0.05 two-tailed level. Prior to running this model, the individual influence each predictor variable had on its own was examined, as described next.

*Single Predictors.* Before constructing the multiple regression models, I carried out three simple regression models to examine the amount of variance of each predictor variable in *prelookfwd*. Table 4.6 shows a summary of each of the regression statistics and its significance. The first two predictors accounted for a significant portion of the *prelookfwd* on their own ( $p < .01$ ). *Positive K-8 math* accounted for 12.5% of the variance in the outcome variable ( $R^2 = .125$ ,  $F = 10.45$ ,  $p < .01$ ). Next, the predictor variable *math course strategies* explained 12.3% of the variance in *prelookfwd* ( $R^2 = .123$ ,  $F = 10.23$ ,  $p < .01$ ) on its own. The *positive practicum* variable did not account for a significant proportion of the variance in *prelookfwd* ( $R^2 = .005$ ,  $F = .277$ ,  $p > .05$ ) by itself. In fact, positive practicum only accounted for 0.5% of the variance in the outcome variable by itself. This may have been due, in part, to its smaller sample size ( $n = 54$ ), which may have been biased, or insufficient power; the other two variables did not have any missing data ( $n = 75$ ).

Table 4.6

*Simple Regression Statistics (Prelookfwd as Outcome Variable)*

| Predictor Variable     | R Square | Adjusted R Square | Unstd. Coefficient | Standardized Coefficient | F-value | Sig. |
|------------------------|----------|-------------------|--------------------|--------------------------|---------|------|
| Positive K-8 Math      | .125     | .113              | .457               | .354                     | 10.45   | .002 |
| Math Course Strategies | .123     | .111              | .789               | .351                     | 10.23   | .002 |
| Positive Practicum     | .005     | -.014             | .157               | .073                     | .277    | .601 |

*Multiple Regression Model with Three Predictors.* The overall regression of *prelookfwd* on *positive K-8 math*, *math course strategies*, and *positive practicum* was significant [ $R^2 = .157$ ,  $F(3, 54) = 3.095$ ,  $p < .05$ ]. Overall, the variance explained by the three predictors differed significantly from zero; thus, we rejected the null. Tables 4.7 and 4.8 show the overall model summary, significance levels, and coefficients. The *positive K-8 math* variable accounted for approximately 10.7% of the variance in *prelookfwd*, while *math course strategies* accounted for an additional 4.8% of the variance. However, *positive practicum* did not account for a significant amount of additional variance in *prelookfwd* (0.2%). Together, the three variables accounted for approximately 15.7% of the variance on *prelookfwd*, leaving almost 85% of the variance unaccounted.

Table 4.7

*Model Summary and Significance of Three Predictors*

| Predictors      | $R^2$ | $\Delta R^2$ | $F$   | $p$  | $DW$  |
|-----------------|-------|--------------|-------|------|-------|
| 1. PK8          | .107  | .107         | 6.203 | .016 |       |
| 2. PK8, MCS     | .155  | .048         | 4.667 | .014 |       |
| 3. PK8, MCS, PP | .157  | .002         | 3.095 | .035 | 2.043 |

Note. Dependent Variable (constant): PrepLookfwd to teach Math; Predictor Variables: Positive K-8 math (PK8), Math course strategies (MCS), and Positive practicum (PP); DW = Durbin-Watson

Table 4.8

*Coefficients of Multiple Regression Model*

| Predictors             | $b$  |
|------------------------|------|
| Positive K-8 Math      | .178 |
| Math Course Strategies | .264 |
| Positive Practicum     | .047 |

The regression solution for this model was:

$$\hat{Y}_{prelookfwd} = 0.999 + 0.178X_{positiveK8math} + 0.264X_{mathcoursestrats} + 0.047X_{positiveprac},$$
 as shown in

Table 4.8. This means that if all three predictor variables had a value of 0, there would be a predicted *prelookfwd* score of 0.999. Thus, without the positive K-8 math, math course strategies, or positive practicum, any person would argue that he or she was not prepared or eager to teach mathematics. However, it is not possible to have a predictor score of 0, because the *prelookfwd* outcome variable was on a four-point scale from 1-4, with a higher score being more favorable (or in stronger agreement). Thus, it makes sense that one who did not have such positive experiences would begin with a lower rating for *prelookfwd*. However, it makes more sense to discuss how the predictor variables accounted for the outcome in the model. These values indicated that with every increased rating in *positive K-8 math* there was almost a 0.178 increase (i.e. 1= .178, 2= .356) in *prelookfwd* and approximately a .264 increase when the rating increased in math course strategies while holding all other variables constant. However, there was only a slight increase in the outcome (.047) with an increase in positive practicum. For example, if a participant answered “agree” to the three predictor variables, it equaled a score of a three for each item on the survey and their predicted score for *prelookfwd* was  $2.466 = .999 + (.178 \times 3) + (.264 \times 3) + (.047 \times 3)$ . According to this model, one who “agreed” to all three items yielded an approximate score of 2.47 on *prelookfwd*, indicating stronger agreement to be prepared and look forward to teach mathematics than one who strongly

disagreed and obtained a response of one with an outcome baseline score of one, considering a four-point scale.

The Durbin-Watson statistic tests for a relationship between contiguous pairs of points. It performs a 1-lag autocorrelation test. This reveals whether or not the value obtained for one data point is dependent on the previous, or whether a 1-lag autocorrelation exists. Table 4.7 indicates that  $DW = 2.043$ . The DW obtained was higher than the upper limit of 1.67; therefore, we failed to reject the null, or to accept  $H_0$  and conclude that there was no statistically significant autocorrelation in our regression model. In addition, collinearity statistics for this model were inspected. Results indicated that multicollinearity was at a minimum because the tolerance was .993 when the third predictor variable was added. Similarly, the Variance Inflation Factor (VIF) was 1.01 with all three predictors, indicating a minute amount of multicollinearity. Prior to entering the *positive practicum* variable, the tolerance was slightly lower and VIF was higher, suggesting that another variable might have helped to stabilize the model. However, the lowered sample size reduced its power; hence, I created a model without the positive practicum variable as a comparison.

*Multiple Regression Model with Two Predictors.* The overall regression of *preplookfwd* on positive *K-8 math* and *math course strategies* was statistically significant [ $R^2 = .208$ ,  $F(2, 75) = 9.441$ ,  $p < .001$ ]. Overall, the variance explained by the two predictors differed significantly from zero; thus, we rejected the null. Tables 4.9 and 4.10 show the overall model summary, significance levels, and coefficients. This model had a higher F-value and was statistically significant. The *positive K-8 math* variable accounted

for approximately 12.5% of the variance in *prelookfwd*, while *math course strategies* accounted for an additional 8.3% of the variance. Taken together, the predictor variables could explain approximately 20.8% of the variance on *prelookfwd*. Although the model was significant, nearly 80% of the variance that was unaccounted for in *prelookfwd*, which supports the argument that a multitude of variables influence preservice teachers' attitudes and preparation to teach mathematics. The regression solution for this model was:  $\hat{Y}_{prelookfwd} = 0.942 + 0.192X_{positiveK8math} + 0.330X_{mathcoursestrats}$ . Similar to the first model, this means that if both predictor variables had a value of 0, there would be a predicted *prelookfwd* score of 0.942. However, a value of 0 is not possible.

Table 4.9

*Model Summary and Significance of Two Predictors*

| Predictors                                     | $R^2$ | $\Delta R^2$ | $F$    | $p$  | $DW$  |
|--|-------|--------------|--------|------|-------|
| 1. Positive K-8 Math                           | .125  | .125         | 10.447 | .002 |       |
| 2. Positive K-8 Math<br>Math Course Strategies | .208  | .083         | 9.441  | .000 | 2.164 |

Note. Dependent Variable (constant): PrepLookfwd to teach Math

Table 4.10

*Coefficients of Multiple Regression Model*

| Predictors             | $b$  |
|------------------------|------|
| Positive K-8 Math      | .192 |
| Math Course Strategies | .330 |

The values indicate that with every increased rating in *positive K-8 math* there was almost a 0.192 increase (i.e. 1= .192, 2= .384) in *prelookfwd* and approximately a .330 increase with increased ratings in math course strategies. Thus, the coefficients of the predictors increased when *positive practicum* was removed from the model. Using the same example as the first model, a participant who “agreed” to the two items on the survey would have a predicted *prelookfwd* score of  $2.508 = .942 + (.192 \times 3) + (.330 \times 3)$ . Similar to the first model, one who “agreed” to the two items would yield an approximate score of 2.51 on *prelookfwd*, indicating greater feelings of preparation and anticipation to teach mathematics than one without positive experiences and with a response of “disagree,” or an outcome baseline score of one out of four. However, this model included all 75 cases, which could have strengthened the model with the possibility of less bias.

The Durbin-Watson statistic for this model was 2.164. The DW obtained was higher than the upper limit of 1.68; therefore, we failed to reject the null or to accept  $H_0$  and conclude that there was no statistically significant autocorrelation in our regression model. Results indicated that multicollinearity was at a minimum because the tolerance was a .962 when the second predictor variable was added. Similarly, the Variance Inflation Factor (VIF) was 1.039 with two predictors, indicating a small amount of multicollinearity.

*Post-Hoc Power Analysis.* To evaluate the effect size of the regression models, I computed post-hoc power analyses. The first model with three predictors (see Table 4.7) had a moderate level of power ( $1 - \beta = 0.73$ ) with a sample of 54 and medium effect size



( $f^2 = 0.19$ ), which could have influenced the predictors' level of significance. The second model with two predictors (see Table 4.9) had a very high level of power ( $1 - \beta = 0.97$ ) with a medium effect size ( $f^2 = 0.26$ ) at the alpha level of .05. Thus, the smaller sample size in the first model could have been limited because it only included participants who were in a practicum during the semester of this survey's administration, whereas the second model included the entire sample.

Results from the survey showed several statistically significant positive relationships among preservice teachers' attitudes towards mathematics, confidence to teach mathematics, and the various elements of the conceptual framework: past schooling, mathematics methods course, and practicum. While the paired t-tests obviously showed a significant difference in favor of participants planning to teach mathematics with a conceptual approach, there were significant correlations between conceptual and procedural approaches, implying some overlap in the way in which participants responded to the two approaches. Regression models confirmed that components of the conceptual framework were influential in predicting a significant portion of preservice teachers' preparation and attitude toward teaching mathematics. The next section situates survey results within the literature to consider their conceptual meaning.

### Interpretive Summary

The goal of this chapter was to examine preservice teachers' attitudes and perceptions about mathematics education. Surveys were administered to elementary school preservice teachers ( $n = 75$ ) during the first and final week of their mathematics methods course. The pre-survey sought to capture participants' entering attitudes about

mathematics and inquired about their experiences as K-12 students. The purpose of the post-survey was to examine possible changes in preservice teachers' attitudes about mathematics, their perceptions about teaching mathematics, practicum experience, and mathematics methods course experience. Analyses consisted of correlations, paired t-tests, and regression models to examine how past schooling, the practicum, and methods course related to preservice teachers' attitudes and perceptions of mathematics. What follows is an interpretive summary of the findings.

Findings indicated a strong relationship between PTs' attitudes about mathematics and their prior schooling experiences. A positive increase in participants' attitudes towards mathematics was related to their K-8 prior schooling ( $r = .599, p < .01$ ) and to their high school experiences ( $r = .719, p < .01$ ). Although both experiences had positive relationships with PTs' attitudes, their high school experiences in mathematics had a greater shared variance with their attitudes, suggesting that high school experiences in mathematics may have a stronger influence on PTs' attitudes. This is logical; at the high school level, mathematical content becomes more challenging, and those with a more positive experience were more likely to have succeeded in the courses. Similarly, an increased response to being proficient in mathematics had a strong positive relationship with attitude towards mathematics ( $r = .713, p < .01$ ). In addition, participants' perceived proficiency was related to both their prior K-8 ( $r = .526, p < .01$ ) and high school ( $r = .599, p < .01$ ) experiences in mathematics. Thus, correlation results indicated that those with more positive prior schooling experiences had more positive attitudes towards mathematics and considered themselves more proficient. These findings support a

qualitative study conducted by Ellsworth and Buss (2000), who examined preservice teachers' attitudes towards mathematics by analyzing their autobiographies. They found that past teaching models was the most salient theme because preservice teachers' commonly reported that their interest in or attitude towards mathematics was positively or negatively affected by past teachers.

Attitudes about mathematics can also influence preservice teachers' own confidence to teach mathematics. Bursal and Paznokas (2006) measured the relationship between preservice teachers' mathematics anxiety and their confidence to teach mathematics and science. Pre- and post-surveys about mathematics anxiety and mathematics teaching self efficacy were administered during the beginning and end of two semester-long methods courses. Results indicated that those with a higher level of anxiety had lower confidence levels in their teaching and vice versa. Findings from this dissertation indicate that participants with more positive attitudes towards mathematics also had greater confidence in their own ability to teach mathematics. In addition, findings from paired t-tests indicated that preservice teachers had a significant increase in both their attitude towards mathematics and confidence to teach mathematics over the course of the semester. These results suggest that positive changes in PTs' attitudes and confidence can occur over even a semester long mathematics methods course. These findings differed from those of Vinson, et al. (1997), who compared PTs' mathematics anxiety before and after taking methods courses emphasizing the use of manipulative materials. Pre- and multiple post-survey results indicated no significant difference in the mathematics anxiety scale after the first quarter of classes in the fall; however, significant

differences showing a reduction of mathematics anxiety were evident after the winter, spring, and summer quarter classes. Thus, although immediate changes cannot always be detected, preservice might be affected over time by learning opportunities in the mathematics methods course. However, there could have been additional factors, such as an enriching practicum experience, that influenced changes in participants' attitudes and confidence.

Descriptive statistics from the post-survey clearly showed that more than 80% of participants perceived their prior schooling, mathematics methods course, and practicum experiences as having a major impact on their future teaching practices. The multiple regression model confirmed that all three variables accounted for a significant proportion of preservice teachers' perceived level of preparation and their attitude towards teaching mathematics. Nevertheless, the three factors combined accounted for only 15% of the desired outcome variable including preservice teachers' looking forward to teach mathematics and viewing themselves as prepared. Thus, numerous factors beyond those used in the model in this study influence PTs' preparation for and attitudes about teaching mathematics. Furthermore, the practicum was not a significant factor on its own. When the variable was removed from the model, the prior schooling and mathematics methods course variables accounted for 20% of the variance on the outcome variable. This may have been due in part because the survey did not take full-time student teaching into consideration. Practicum experiences vary in the learning opportunities they provide for preservice teachers, especially when PTs are only required to visit the classroom one day a week (Ebby, 2000). Perhaps the practicum is not focused on providing preservice

teachers with skills to teach mathematics because elementary school teachers are usually expected to teach several subjects. The mathematics methods course is specifically focused on helping PTs develop their mathematical content knowledge and pedagogical skills. In addition, prior schooling experiences can influence preservice teachers' own views on teaching and their attitudes towards mathematics. It is likely that they emulate the qualities of some of their own teachers (Lortie, 1975; Ball, 1989).

It is particularly important to acknowledge that preservice teachers enter teacher education programs with a wealth of knowledge from their prior schooling. Although in some cases, the goal of a course is to change or challenge entering assumptions about the role of teaching, PTs can also have positive perspectives about teaching upon which complementary ideas can be built. For example, survey results suggest that PTs had an ideological stance in favor of reform-oriented teaching of mathematics. The mathematics methods course could be built upon PTs beliefs, which were more positive and fertile than expected. However, this does not necessarily mean that they will teach in a reformed manner. Meaningful experiences need to foster and develop this stance into practice within the classroom, as the next chapter shows through two case studies. Teaching mathematics with a reform practice can be challenging for teachers, who in most cases are learning to teach in a way that is completely different from the way that they were taught mathematics (Ball, 1989). Studies have found that first-year teachers, in particular, have difficulty teaching in a reform-oriented manner (Ball, 1989; Hart, 2001). Although they may have been trained to adopt a reformed practice during their preservice years, the

school context of their first year plays a major role, especially when mandated curricula espouse contrary practices (Warfield, Wood, & Lehman, 2005).

The three components of the conceptual framework, including prior schooling, the mathematics methods course, and practicum, can be of great importance in preparing elementary teachers to teach mathematics. Findings presented in this chapter suggested that preservice teachers' past experiences, combined with a teacher education program, played a role in shaping perceptions about teaching mathematics. Results also indicated that preservice teachers' attitudes and perceptions about teaching mathematics were related to their confidence to teach mathematics. Although findings from the surveys provided a better understanding about preservice teachers, the next chapter extends this study to examine what happens after graduation. Chapter Five presents case studies of Sonia and Riley, who were followed for a two-year period. Their experiences of learning to teach mathematics were investigated from entry into the teacher education program to the end of their first year of teaching.

## Chapter 5

### CASE STUDIES: LEARNING TO TEACH MATHEMATICS

John Dewey wrote, “Everything depends upon the quality of the experience which is had. The quality of any experience has two aspects. There is an immediate aspect of agreeableness or disagreeableness, and there is its influence upon later experiences” (1938, p. 27). This chapter presents case studies of two preservice teachers’ experiences of learning to teach mathematics from entry into a teacher education program to the end of the first year as full-time classroom teachers. The purpose of the case studies was to capture the learning and teaching experiences of the participants from their own perspectives. The emphasis was on examining their experiences and the process of learning to teach mathematics (Merriam, 1997). A careful and in-depth analysis of the data collected over a two-year period provided a holistic picture of the participants’ experiences, addressing the research questions outlined in Chapter One.

The case studies were specifically structured to address the elements of the conceptual framework outlined in Chapter One. For example, beginning with backgrounds and prior schooling experiences permitted me to make allowances for characteristics and beliefs that the participants brought into the program. This was followed with findings from Sonia and Riley’s experiences in the teacher education program. This considered both interview and observation data about the mathematics methods course and their field placements in order to include teaching practices. Then I extended the analysis into their classroom practices as first-year teachers, incorporating classroom observations and pupil work samples. Finally, I summarized the relationships

among participants' experiences, recognizing that the process of learning to teach mathematics is non-linear. I found that the way in which each part of the conceptual framework influenced teachers' beliefs and practices was nuanced due to their differing backgrounds, school contexts, and student population.

In this chapter, I discuss how participants' experiences shape both perceptions and practices, the degree to which their classroom teaching reflects a reformed practice, and how their practice influences learning. These experiences are examined from a sociocultural perspective, which considers learning to be a complex process that occurs on multiple levels (Feiman-Nemser, 1983; Geertz, 1973). I analyze the influences upon the two participants as they learned to teach elementary school mathematics. In this chapter, I present the most salient themes that emerged from their experiences, drawing on interviews, observations, teacher artifacts (i.e. coursework, lesson plans, reflections), and samples of their pupils' work, which are triangulated to enhance validity.

Adopting two aspects of Maxwell's (1992) conceptualization of validity, I provide an accurate account by using the participants' perspectives, actions, and experiences as much as possible when analyzing and deriving conclusions. Analyses of the case studies in this dissertation take account of what Maxwell refers to as "descriptive validity" and "interpretive validity." In addition to the factual information and the articulation of the meanings attached to the concepts by the research participants are other considerations that assure the validity of the study (Maxwell, 1992). Unlike traditional definitions of validity, which favor scientific knowledge and research approaches, validity here is understood in terms of credibility and transferability (Lather,



2001). Credibility is the “extent to which the data, data analysis, and conclusions are believable and trustworthy” and transferability is defined as the reader “determining the degree to which a study is “transferable” to [his] own context of interest” (Lather, 2001, p. 244).

In the sections that follow, I first provide chronological, descriptive, narrative case studies of the two participants, Sonia and Riley, separately. The case studies include a description of their backgrounds, beliefs, and teacher education experiences. Then, I present a descriptive analysis of their teaching practices as first-year teachers. Sonia is an example of one who espoused a reformed practice, while Riley attempted to adopt a balanced approach by mixing both traditional and reformed methods. However, analysis of interviews and observations indicated that teachers’ beliefs about teaching mathematics were inconsistent with their classroom practices.

Second, I present their students’ mathematics assessments results from their first year of teaching. For the final analysis, Riley and Sonia’s mid-year and end-of-year mathematics assessments, along with matching samples of pupil work, were examined. The RISER was used to establish a rating for both the assessment tasks and pupil work. The assessment tasks were district-made and were not a direct reflection of the teachers’ values; however, there were implications for the school context, how curricula influenced teaching, and what the pupils learned.

The last section is an interpretive summary that discusses findings from both case studies and the common themes that applied across participants’ multiple experiences. In both cases, their experiences served as strong predictors of their first-year classroom

practices. They both attempted to meet the needs of all of their pupils, but would have been more successful with increased knowledge of both the mathematical content and pupils' understanding of the content. I argue that participants' past schooling experience, field experiences, the mathematics methods course, and first-year school context were interrelated as they shaped participants' perceptions and teaching practices in mathematics (Ball & Cohen, 1999). Thus, experiences that reinforced similar ideas, whether they emphasized conceptual understanding or procedural practice, had considerable influence on teachers' beliefs and actions.

#### Sonia's Case: Understanding the Whole

In this case study, interview data indicated that Sonia believed in teaching mathematics for understanding. The parallel experiences from her own childhood education to teacher education experiences supported her beliefs and attitudes about the teaching and learning of mathematics, which emphasized conceptual knowledge. Sonia's story appeared to be very complete, or "whole," because she was surrounded by reinforcing ideas. However, her practice did not quite match her beliefs. She strove to teach with a reformed pedagogy. While some of her classroom practices reflected these efforts, she struggled to scaffold and extend pupils' understanding. This was due to gaps in her mathematical knowledge and her scant teaching experience. As a first-year teacher, she was still in the beginning stages of developing her teaching practices.

### *Educational Background*

Sonia was raised in El Paso, Texas, a Mexican-American community where she valued her bilingual and bicultural identity. As an elementary school student, she commuted daily to Juarez, a bordering town in Mexico, to attend a Montessori school where she learned mathematics with hands-on experiences and a focus on conceptual understanding. She stated that through this school experience, she always “learned the *why* of things,” and how important it was (Interview 1). Later, it became evident that this lasting elementary school experience permeated her teacher education experience and role as a teacher, as she reiterated the significance early on in her autobiography of learning:

The Montessori method really cultivates a desire to learn, by piquing children’s curiosity, and always pushing students to learn conceptually; finding out not only the how of things, but most importantly the *why*. This was especially powerful in math, where all mathematical concepts we learned by visualizing and manipulating different objects to understand their properties and relationships. Proving these mathematical concepts to ourselves was a powerful learning experience. Because of my Montessori experience, I believe there is no better way of learning mathematics, and in fact, any other subject, than by truly understanding the concepts behind them. (Fall, 2005)

Sonia made it clear that it was “no mistake” that her parents, who worked in the field of education, chose to place Sonia and her sisters in the Montessori school where she would have a more “progressive” educational experience and become academically bilingual

(Interview 1). Due to her positive experiences with mathematics at the Montessori school, Sonia recalled being very confident in her mathematical content knowledge and being academically prepared for her transition to a private Catholic middle to high school in the United States, where she was “ahead” in mathematics due to her schooling in Mexico.

She took algebra in eighth grade and continued taking higher level mathematics courses during her high school years, when the instruction shifted from a reformed to a procedural approach. Hence, Sonia noted a transition in her mathematics education when she took AP calculus and had trouble understanding the higher level concepts beyond the expectations of passing tests:

I had the same teacher for math all four years, and he was really nice. I loved geometry. Actually I think that was my favorite. I was good at math. I was always really good at math, but by that time that AP calc came around, it was just like I wouldn't make the effort to understand some things. That just goes to show that even then I could still pass tests, and we didn't really have a book. So it was always the same five exercises that we did that were on the test, which is too bad.

(Interview 1)

Her high school mathematics experiences ultimately led Sonia to fear mathematics during her years at a prestigious university in California. She explained, “I became really scared of math, and if you would have told me that I once was good at it, I wouldn't have believed you” (Interview 1). In hindsight, she would have preferred being “more challenged in math” and “push[ing] [her]self when given the option” to take the AP Calculus exam, which her teacher did not make mandatory (Interview 1).

In college, Sonia majored in psychology, but found she was increasingly interested in educational issues. During her junior year, she studied abroad in Paris, where she conducted a small study that compared teacher-student relationships in the U.S. and French schools. During her senior year, she began taking more education related courses, “volunteered in schools serving immigrant and inner city populations, and was able to see first-hand how unjust certain life situations can be, and how education can truly provide a way to better oneself, and one’s community” (Autobiography). Sonia also struggled to embrace her desire to become an educator because she was at an esteemed university where the school culture was such that everyone was expected to “become brilliant doctors or lawyers,” and she felt pressure to make “tons of money” after graduating. However, her choices in courses and research made it “obvious” that she wanted to become an educator (Interview 1).

After graduation, Sonia moved back to El Paso for a year and worked as a research associate for the Southwest Math and Science Partnership, a project funded by the National Science Foundation at a Texas university. There, she learned about several school reform initiatives and became engrossed in discussions about education. Her awareness of the achievement gap only confirmed her desire to teach as a way of being an agent of change. The following year she was accepted to Hillside College’s Urban Scholars Program, which focused on preparing teachers for urban schools. There she earned a M.Ed. in Elementary Education and a teaching license with a Teaching English Language Learners (TELL) certification. From early on, Sonia was committed to

teaching in urban public schools, which are traditionally underserved and understaffed by highly qualified teachers (Ingersoll, 2004).

### *Learning to Teach*

During the summer of 2005, Sonia started the teacher education program at Hillside College, where she took three courses and observed a fifth grade classroom that was part of a local school district's summer program. It was not a great initial experience. Sonia thought that her condensed reading methods course was oriented towards teaching very "basic" reading concepts, and the fifth grade classroom was disorganized. According to Sonia, this was a major change from her role at a Texas university, where she listened to university professors and administrators discuss macro-level issues in education. This change disrupted her expectations of teaching, as it created doubts about continuing the teacher education program. She feared that the program would emphasize practical knowledge in favor of theoretical knowledge, which she was accustomed to learning as a research assistant. Nevertheless, after the first semester, Sonia shifted her perspective about the teacher education program. Based on her methods courses and field placement, she realized how important it was to have practical knowledge and skills, as well as the theoretical background of teaching strategies.

*Field Experiences.* During the fall semester, Sonia took five graduate courses and went to her practicum two and one-half days each week. For both her practicum and student teaching, she was placed at an urban school, where she worked with a diverse student population and implemented the *Investigations* curriculum in a fourth grade classroom. Sonia believed that "children learn best when they're taught in ways that

they're able to understand.” In the excerpt below, she stated that her belief was supported by hands-on lessons:

I think that the times I had manipulatives, it was cool. The kids enjoy it. Well, a couple of things . . . having manipulatives, and my second math lesson was on estimating large numbers. So I brought all these beans and put them in different containers. Right off while I was preparing for the lesson, they were excited for math time. [Students] already knew [the lesson would be hands-on], and I had to bring in different things to measure with . . . cups and, not necessarily traditional measuring devices, but little tools that they could use as their measure to estimate the quantity. And so that made for an interesting lesson that they were kind of excited to get into. So those things I find are effective. (Interview 2)

Although the use of manipulative materials can provide a concrete representation for students to visualize mathematical ideas, it does not necessarily mean that they will automatically learn the concepts being modeled in the lesson. Similarly, a lesson designed to be “fun” does not guarantee learning (Baroody, 1989). Sonia’s goal was to create an interactive learning environment, but as a preservice teacher she rarely spoke about extending students’ mathematical knowledge in an in-depth manner.

*Mathematics Methods Course.* Meanwhile, Sonia learned a variety of methods for teaching mathematics in her methods course. She enjoyed the mathematics methods course even though she considered it a lot of work. Sonia also thought the technology aspect of the course was timely. When asked about the professor’s teaching methods, she

thought it was effective that he modeled what he taught and created learning situations that included the perspective of the student:

I think he was good in ... giving us problems to do on our own and trying to change them to make them a little more challenging, using base four as opposed to base ten. That would have been too easy, and actually using the manipulatives was good. . . . If you had never seen them, if you're not used to manipulatives, they can be foreign...[and] very confusing. So I like that he tried to integrate them and always had some aspect of us being students in a way. (Interview 3)

For Sonia, the connections between the mathematics methods course and practicum were clear. She expressed an “immediate” sense of learning through the linked experience of the practicum where she “could see the relevance” of her mathematics methods course. She stated, “Sometimes in math whatever we were studying, it was exactly what we were studying in my classroom. So it was really easy to see the connections” (Interview 3). Similar to findings from one of Ebby’s (1999) case studies, a “mutually reinforcing” interaction between coursework and field placement provided an “empowering experience” that allowed Sonia to “envision” her role as a facilitator of students’ understanding of mathematics (p. 92).

Additionally, Sonia linked her teacher education experiences to her past Montessori schooling experiences, which made it easier for her to accept reformed methods presented in the course. In a sense, she had already bought into the pedagogy due to such positive experiences. She noted that others, however, seemed to struggle



more with the mathematics methods course because they did not have the prior experiences or knowledge to connect to new methods presented in the course.

*Teaching Practice.* During her student teaching, Sonia had more opportunities to teach mathematics with *Investigations*, a reformed curriculum. Earlier in the school year, she was hesitant about the curriculum because she heard it being criticized by other teachers, although she half-heartedly thought it was “fine.” She agreed with the curriculum’s emphasis on “student thinking,” but disagreed with the school district’s strict implementation schedule that required specific lessons to be taught on particular days in preparation for district-made unit exams. Nevertheless, the more experience she had to teach with *Investigations*, the more she accepted its purpose:

I think in math ... the way *Investigations* is set up, it’s good because it provides a lot of opportunities for kids to show how they know. So it’s not just ‘solve the problem.’ It’s solve the problem *and* show how you did it to show how you know. So there’s a lot of asking students to reveal their thinking, to make their thinking explicit, or be clear either by writing it out by showing it to you. So that is a good way of assessing student understanding in math. It’s not just in their work but in the process and in their thinking. (Interview 5)

It was evident that her perspective on *Investigations* changed over time. Initially Sonia was lukewarm about its effectiveness, but later appreciated its purpose. She never accepted everything the curriculum had to offer, but thought it was a helpful teaching guide.

In the two mathematics lessons I observed Sonia during student teaching, she tried to implement her beliefs and attitudes about teaching mathematics with a conceptual approach, but fell short of her goals. This finding is similar to a study suggesting that beginning teacher practices are often inconsistent with beliefs due to external influential factors, such as immediate classroom situations (Raymond, 1997). Data analyses suggest that Sonia's self perception as a teacher was not completely consistent with her teaching practices in the classroom. She was very critical of herself and constantly reflected on the areas she felt needed improvement. Nevertheless, her classroom management would detract from instructional time and the learning tasks were often incomplete. In one lesson, she had pupils play a "Guess my Rule" game by personal attributes, such as pupils with and without jewelry, then connect it to a fraction, such as five out of sixteen pupils are wearing jewelry. Then they made a representation of the fraction and discussed what the numerator and denominator meant.

During another lesson, Sonia planned a mathematics review session on properties of two-dimensional shapes, where pupils were in teams of three and took turns answering open-ended questions that they had to explain on the group's white board. For example, Sonia showed the class a triangle with two given angle measurements and asked them to figure out the missing angle and share the different strategies for solving the problem. Asking open-ended questions and requiring pupils to justify their answers was a common practice for Sonia and characteristic of reformed teaching (Sawada, Piburn, Judson, Turley, Falconer, & Benford, et. al, 2002). However, when there was time for pupils to

share their strategies, Sonia rarely asked them to extend their thinking and did not often address the pupils' mathematical ideas and misconceptions.

Other areas where Sonia appeared to struggle were classroom management and figuring out her role as a teacher. This may have resulted from the transition that occurred from being an observer and teaching assistant in her practicum, to taking on the lead teaching role during her student teaching. Additionally, a course on classroom management was not required in her teacher education program, because the assumption was that the methods courses would integrate this topic as it pertained to particular subjects. Maintaining control of the class was very difficult for Sonia. Her classroom teaching experiences made her further realize that to create a community of learners and plan engaging lessons, she needed to have “practical” skills as well as “theoretical” knowledge.

*Summary.* Time and time again, Sonia connected her Montessori schooling experiences to her field experience and mathematics methods course, where similar teaching methods reinforced the conceptual focus on learning mathematics. Therefore, it was expected that her teaching practice would reflect the same teaching opportunities she was given. At the completion of the teacher education program, Sonia stated the following:

...from my Montessori background and from the math methods class, I think conceptual learning is really important. I'm really a fan of having children understand math and having them explore mathematical relationships by having physical materials...and math can seem fun for kids when they have unifix

cubes and when they have all these games to play, which is good because [math] is such an important skill for them to learn. (Interview 6)

When explicitly asked if she would like to teach mathematics the way she learned it as an elementary school pupil, Sonia replied, “Definitely!” She planned to continue teaching with a more conceptual focus the following school year, but it was easier said than done.

### *First Year of Teaching*

As a first-year teacher, Sonia demonstrated a commitment to diverse pupils by becoming a second grade bilingual teacher at an urban school. At her first-year school site, she was required to use *Investigations*, the same reformed curriculum she used at her field placement site. It was no surprise that Sonia made an effort to teach in a reformed manner because every experience she had in her mathematics education emphasized the same form of instruction. She was responsible for teaching mathematics to two classes, including her own class and the second grade class of another first-year teacher next door, who was also responsible for teaching science and social studies. After the pupils had lunch, the first class would come in for mathematics for 60 minutes, followed by the second set of pupils, who would have the last 60 minutes of the school day to learn mathematics. By the time pupils settled in from lunch, transitioned from the other class, and prepared to go home, the daily mathematics lesson would only be approximately 50 minutes. Sonia often expressed frustration in teaching mathematics for such a limited time period, but she tried her best to maximize classroom instructional time.

*Teaching Practice.* Analysis of observational data showed that her practice did not clearly reflect what she had stated in her interviews and learned in the teacher

education program. For example, Sonia was very conscientious of the questions she would ask her pupils, as she attempted to pose open-ended questions that elicited pupil thinking. However, as a first-year teacher, there were aspects of her classroom practice where she struggled to teach in a reformed manner. On occasion, pupils showed confusion and Sonia was uncertain how to scaffold their understanding. In the excerpt below, Sonia's lesson was focused on describing properties of shapes. In particular, pupils were asked to construct a rectangle using six colored tiles and then describe it.

Sonia: Who can describe their rectangle?<sup>3</sup>

Alisha: My rectangle has four sides.

Sonia: Very good, what else can you say?

Alisha: It has four angles.

Sonia: Yes. What else? Tell me how they are arranged so I can demonstrate it on the overhead. *Teacher shows her a 6 x 1 rectangle.* (see Figure 5.1)



Figure 5.1. Valerie's 6x1 rectangle.

Sonia: Does it look like this?

Alisha: No.

Sonia: Then you need to describe it to me, tell me more. Who can help her out?

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<sup>3</sup> The classroom dialogues were translated from Spanish when necessary.

Valerie: The rectangle has up to 6 sides. The red, red, and blue. You can put it over the green, and the sides are the same.

*Sonia pauses to redirect Estelle.*

Sonia: Estelle, can you go sit where I told you and change your color on the way?

*(Sonia refers to the discipline board where pupils are assigned pockets with three cards that they change from green to yellow to red.)*

*Sonia returns to probing Valerie then moves on.*

Sonia: Which sides are the same? Who else would like to describe their rectangle to the class?

Joseph: My rectangle has the same sides (see Figure 5.2).

Sonia: Can you be more specific. Which sides are the same? What else can you say about it?

Joseph: Both sides are three.

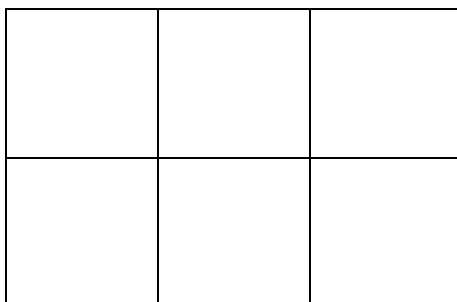


Figure 5.2. Joseph's 3x2 rectangle.

Sonia: What do you mean? What else can you say about it?

*Joseph walks up to overhead and shows the top and bottom rows he refers to as sides.*

*Teacher clarifies that there is a bottom side and a left side.*

Joseph: Oh, ok. There are three on the bottom, two on the side, and three on top.

During this lesson, Valerie showed uncertainty in her understanding, and Sonia moved on rather than helping her correctly describe the dimensions of her rectangle. Also, she did not correct pupils' misuse of the word "sides." They used the word "side" to describe the number of columns and rows. For example, one pupil described a rectangle by stating that it had "six sides," when it actually contained six tiles. By definition, a rectangle cannot be six-sided, but Sonia did not address the issue or probe her pupils to clarify their statements. In this case, it would have been to her pupils' benefit to have introduced the terms columns and rows. This was an example where Sonia could improve upon her *mathematical knowledge for teaching* (MKT), specialized knowledge including mathematical content knowledge, pedagogical skills in teaching mathematics, and an understanding of pupil thinking (Hill, Rowan, & Ball, 2005). The literature on MKT highlights the need for teachers to examine pupil thought processes to better guide the learning of mathematical concepts. Additionally, the unpredictability of reformed teaching that includes a student-centered approach can make it challenging for beginning teachers to know how to respond to pupils' misconceptions.

The misuse of terms and pupil confusion shown above could have been due to the inappropriate use of materials. For example, there appeared to be a clear lead for Sonia to discuss perimeter and area in the lesson. However, the pupils seemed distracted by the colors and the separate pieces. The specific *Investigation* lesson emphasized the use of

rows, columns, across, and down, as descriptors for rectangles. In this case, Sonia may have rushed through the lesson overview without paying attention to specifics.

In another lesson she asked a struggling pupil whether he understood an idea being discussed. When he replied, “No,” she further probed him to express what he misunderstood. After he stated, “I’m not sure,” she moved on with the lesson. Sonia was uncertain on how to approach pupils who had misconceptions, and she struggled to scaffold their learning. Nonetheless, she tried to emphasize a conceptual understanding and make the learning of mathematics engaging, but it was unclear whether pupils made connections among the mathematics concepts. In the rectangle lesson example above, Sonia probed her pupils to further explain their thinking and help their peers, hallmark characteristics of reformed teaching. However, she attributed curricular constraints in her teaching practices to accommodate the school district’s stringent implementation schedule. She also mentioned that challenges in time management made it difficult to thoroughly read over the daily lesson provided by the curriculum.

Sonia provided her pupils with opportunities to learn by allowing them to share strategies and use manipulative materials. This allowed pupils to draw on different mathematical models and have varied methods of accessing key concepts in the lesson. She was also dedicated to equipping her pupils with academic skills in both Spanish and English. In a later observation, the pupils generated multi-step word problems and solved one another’s problems.

Sonia: Who would like to share a story problem?<sup>4</sup> Wanda.

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<sup>4</sup> Original dialogue was in Spanish.



Wanda: Brenda was counting how many friends she had. She had 10. Wanda was also counting how many friends she had. She had some. In total they had 93 friends. How many friends does Wanda have?

Sonia: That's an excellent problem.

*Sonia repeats Wanda's story problem in English due to pupils' request.*

Sonia: First of all, who can tell me the number sentence they have?

Brenda: 10 plus something equals 93.

Sonia: Excellent, now let's try to solve the problem.

*Pupils share different strategies after the class has been given enough time to solve the problem.*

This example showed that pupils were expected to express their ideas in both Spanish and English, but Sonia often missed out on opportunities to engage pupils in higher levels of mathematical thinking. For example, in the excerpt above, Sonia gave her pupil verbal praise for creating a problem and immediately asked pupils to think of the number sentence, rather than think about the different elements of the problem and what the problem was asking them to find. In addition to asking for a number sentence, she could have asked for an alternative equation or strategy. In most of her mathematics lessons, Sonia required her pupils to communicate their strategies verbally, numerically, and with manipulative materials. This lesson was one of several examples where Sonia taught with a student-centered approach, but did not push her pupils to think more critically. It may have helped that Sonia's school district used a reformed curriculum, which aligned with her desire to promote a conceptual-based style of teaching. However, on several

occasions, she expressed that the district needed to provide teachers “more flexibility” with the curriculum, based on their pupils’ needs and understanding. For the most part, she attempted to follow the planned lessons because she did not have time to recreate new ones, especially when she had to translate the curriculum for her pupils. Although her school was in the process of becoming a dual-language school, they did not have the mathematics curriculum materials in Spanish, due to a lack of funding.

There was never a question of Sonia’s intention to teach mathematics with a focus on connecting the conceptual knowledge and computational skills. She claimed to have high expectations for all of her pupils with the understanding that there was a range of learners who learned at different paces; however, she needed more support to better meet the needs of her pupils. After a few months into her first year of teaching, she expressed the following goals in mathematics:

For math, I think getting them to express their thinking is key and it’s hard to do because some of them, they’re just learning how to do that. So getting them to express their thinking and getting them to explain their answers in writing so that other people can, so that, I know what they were thinking...for now it’s definitely getting them where they need to be in terms of their basic number facts, combinations of 10s, and doubles. That’s what they need to know, and not just that but making those, making the connection of using what they know to help them solve what they don’t know. I think that’s a big goal but I think in terms of math it’s also getting them to be able to do math in Spanish [that] is my big goal.

(Interview 7)

Sonia emphasized pupil thinking and linking it with their number sense. In addition to teaching the mathematics content, she was also responsible for pupils gaining fluency in Spanish. To do this, she would spend a great deal of time preparing for her mathematics lessons and translating materials for her pupils. She mentioned on several occasions that teaching with the reformed curriculum was very time-consuming because it would create specific vocabulary learning objectives, and she did not always read through the lesson guide thoroughly.

*Classroom Management.* Similar to her student teaching experiences, Sonia also had difficulty with classroom management during her first year of teaching, which is a typical for first-year teachers who often feel overwhelmed (Huberman, 1989). In her interviews, she spoke about the many pupils who exhibited behavior problems. She also expressed frustration with the daily changes and interruptions in her teaching schedule. For example, several pupils would be pulled out during reading and writing instruction, which would make continuity difficult because she would hesitate to teach a lesson when one-third of her pupils were out of the classroom. Additionally, it was not ideal for her to teach mathematics at the end of the day when pupils were tired and anxious for the school day to end. The transition made it tough because by the time her pupils were settled in, there would only be about 45-50 minutes of instructional time. Not surprisingly, Pianta, Belsky, Vandergrift, Houts, & Morrison (2008) recently found that time on task was a strong predictor of pupils' learning in mathematics. In Sonia's case, a limited amount of time on task could have potentially limited learning opportunities for her pupils. Another

aspect of teaching that Sonia wanted to improve upon was meeting the needs of all the pupils:

In math I struggle with *differentiating* because I have kids who are really quick and kids who really struggle, so I've started doing a lot more sharing...I'll make sure that, you know, one kid explains a certain problem, or I'll have them use cubes or us[e] different materials so that they're able to. Or sometimes, if the problems are  $24 - 16$  or whatever, I will make the number smaller. So [I do] little things like that, but I...feel like it is something that [I]definitely still have to learn more about. (Interview 7)

She expressed a desire to differentiate instruction more effectively for pupils because one method of instruction would not work for all pupils. This is a valuable insight beginning teachers often reach, but it can be challenging for them to deal with when the realities of teaching do not match the ideals they imagined (Friedrichsen, Chval, Teuscher, 2007).

*Mathematics Assessments.* Half way through the year, Sonia's pupils completed a district-mandated mid-year mathematics assessment. This served as a wake-up call for her to focus on more efficient teaching strategies. She was pleased that pupils were able to explain their strategies and connect the combinations of ten to larger numbers, for the most part. Based on the assessment results, she realized that she needed to take more time to regularly look at her pupils' work rather than waiting to see how they did on the end of unit exams. In other words, she was beginning to see the crucial role that inquiry could play to improve her teaching (Jaworski, 2006). Sonia also structured mini-lessons to address the specific needs of her pupils. For example, she noticed that her pupils were

solving problems by relying on tally marks for large numbers, so she taught them efficient strategies. Sonia presented a subtraction problem and showed them three ways to solve it, including drawing circles in groups of ten, using the hundreds chart, and subtracting the tens then ones. They discussed which was more efficient and why. Sonia stated, “[I]t makes it clear... why some strategies are better than others” (Interview 8). They also displayed the poster they created with the three different strategies as a reminder of the inefficient and efficient strategies. To be computationally fluent, pupils need efficiency, accuracy, and flexibility (Russell, 2000). Sonia was trying to help her pupils be flexible, but she noticed that they were using inefficient strategies that would sometimes lead to inaccurate answers when working with large numbers. In this case, Sonia deviated from the curriculum and created this lesson based on her knowledge of her pupils.

Towards the end of the school year, Sonia became more conscientious of her pupils’ mathematical levels of understanding. She would examine their work and make notes of what they did and did not quite understand and then group them accordingly for tailored mini-lessons. She also had a better handle on classroom management; pupils were much more respectful of her and each other. At the end of the school year, Sonia’s pupil took the district-mandated end-of-year mathematics assessment. This time, Sonia was much more pleased with the overall assessment results. She thought the test was a fair assessment of their learning and indicated that most of her pupils improved in mathematics.

*Summary*

From the very beginning, Sonia was cognizant of how her Montessori school experience, student teaching, and mathematics methods course helped her teaching practices become more reformed in nature. Upon the completion of her first year of teaching, I asked Sonia whether she thought it was realistic for first-year teachers to teach with a more conceptual focus. Surprisingly, she responded, “I don’t know.” Then she explained, “I had my Montessori experience [in] math, but I remember a lot of people in the math methods class, for example, who were like, ‘What?’, they were so lost and I thought, ‘This is so much fun!’” (Interview 9). Sonia recognized that she had an advantage due to her prior schooling experiences, which had given her the belief that a reformed practice was “a great way to teach math.” Furthermore, she acknowledged that accountability pressures also required pupils to do well on tests that were more traditional in format. Therefore, she thought it would be difficult for teachers to focus on reformed mathematics when assessments did not reflect a similar philosophy. She advocated for more authentic assessments requiring pupils to be interviewed and observed while completing a problem; she thought the assessments would be, “very time consuming but a little closer to assessing the real knowledge that children bring” (Interview 9). Sonia completed her response about reformed teaching by reiterating her personal stance:

I tend to like it more than not, but because kids need experience with manipulatives, they need to see how the math works and it needs to be concrete before it becomes abstract. So I think that a balanced approach is good, you know,

you need to drill certain facts but they need [to]... understand the algorithm for adding and subtracting. They just need to understand it. (Interview 9)

Sonia was clearly not extreme in her beliefs on reformed teaching and learning. This was reflected in her classroom practice as well because she tried to teach with a more conceptual approach, but did not expect her pupils to come up with every alternative solution. Instead, she selected strategies she wanted her pupils to share and modeled others to provide her pupils with more flexibility in their problem solving.

As found in the interviews and classroom observations, Sonia valued pupil understanding and encouraged divergent modes of thinking, consistent with the curriculum and reformed practice. She was certainly not a model of reformed practice, because in many instances she did not extend her pupils' thinking or probe their explanations; however, she made many efforts as a first-year teacher to improve her practice. As stated previously, Sonia's prior schooling experiences that focused on understanding mathematics in a conceptual manner gave her an advantage in adopting reformed practices. It is important for teachers to agree with the underlying philosophy of reformed teaching practices before they are able to enact them in the classroom (Remillard & Bryans, 2004). Nevertheless, reformed practices in mathematics require teachers to have more than a common belief; to enact a reformed pedagogy, teachers must have the skills and continued professional development that are supportive of such classroom practices.

#### Riley's Case: Connecting the Parts

In this case study, results indicated that Riley inclined towards what she perceived to be a "balanced" approach, or a mix of traditional instructional methods and hands-on

learning. As a young student, Riley struggled with mathematics, which led to a lack of confidence in her own content knowledge. This doubt became apparent as she learned to teach mathematics. Although Riley wanted to teach mathematics differently than the way in which she had learned it, she had not acquired the skills necessary to teach in a reformed manner. Riley attempted to use more hands-on lessons with her pupils, but she did not have adequate knowledge or experiences that modeled reformed teaching to fully help her pupils learn mathematics beyond procedures. Her lessons were often incoherent because contrasting ideas were presented in her course and field experiences. Thus, her classroom practices were the results of Riley's attempt to "connect the parts" from her varied experiences. As Riley learned to teach mathematics, her disjointed experiences influenced her beliefs, which were often uncertain and reflected in her practice where she utilized two different mathematics curricula.

### *Educational Background*

Riley was raised in a predominantly white suburban community where she attended a private Catholic school until the sixth grade. As an elementary school student, she learned mathematics in a more procedural manner where she recalled following steps and completing worksheets but not understanding the underlying mathematical concepts. She stated, "I remember just being taught mindless steps and not really understanding what I was doing." Due to this past schooling experience, Riley expressed frustration and admitted, "I hated math when I was a kid because I felt like I wasn't too good at it" (Interview 1). She consistently stated that she did not receive a "good" mathematics education and expressed a limitation in her mathematical content knowledge.



In high school, Riley did well enough to pass her mathematics courses, but struggled in both mathematics and science. She preferred history and English courses because those were her strengths academically. Additionally, Riley had an appreciation for the arts and went to a fine arts college in New England, where she majored in painting and avoided taking any mathematics courses. During the summer, she enjoyed teaching swimming lessons to young children and considered being a teacher. Her father taught science for several years and was an influential figure in her education. During her final semester in college, Riley attended a mathematics educational workshop at a nearby college where she was first exposed to more conceptual methods of teaching that focused on higher level thinking and problem solving. At this point, she planned on pursuing a teaching career. Hence, she took advantage of the opportunity to take a course related to education.

Upon graduating from college, Riley immediately began the Masters level teacher education program at Hillside College. She connected the mathematics education and summer courses to her prior learning experience when she began the teacher education program:

Taking my classes now, like we were talking about earlier, taking the math class now, I kind of feel gyped. I feel like I wasn't taught certain things the right way because with math, in particular, I remember learning how to add big digit numbers and would just cross out and carry the one. And you didn't really understand what you were doing. It was like you learned these steps, but you didn't know what they meant. And taking this course, I see now that they want

you to emphasize to students with toothpicks or whatever that you're actually moving a group of ten over. And that makes so much more sense to me, and I feel like that's the way you should have learned things. (Interview 1)

Riley's education courses had an immediate influence on the way she viewed teaching and learning in comparison to her own experiences as a student. She realized that teaching methods had changed, especially in mathematics, and it gave her a desire to teach better than how she had been taught in elementary school.

In this regard, Riley ruminated about her experiences as a learner and spoke about her various teachers. She enjoyed having teachers that were "warm and fuzzy," but thought others who were stricter and focused on the academic aspect were necessary as well. In her autobiography of learning, she stated, "Some of my teachers were child-centered, while others were more academic in their methods. I think the ones that were the best combined these different theories." Riley's attempt to find an affective and academic approach to teaching became a common theme as she learned to teach. When asked about her perceived role as a teacher, she deemed the skill of differentiating instruction important:

I think having a teacher [who is] motivated and presents the information in a way to each student is important. Some people pick things up easier than others. So I think the task of the teacher is to present the information in a way that makes sense for each individual. (Interview 1)

To reach the diverse learning styles of pupils, Riley realized that she needed to acquire a variety of methods as a teacher. Additionally, she thought that it was essential that pupils

make sense of what they were learning beyond rote memorization, which was continually emphasized throughout her teacher education experience. In Riley's case, it was clear that prior teaching models played an influential role in shaping her self-perception as a teacher of mathematics (Ellsworth & Buss, 2000).

### *Learning to Teach*

Riley began the teacher education program at Hillside College during the summer of 2005, when she took two courses and had a very positive initial experience. In particular, she enjoyed her reading methods course because she mentioned gaining several classroom strategies. She seemed to appreciate the practical strategies she learned in her methods courses, because she thought they could be easily transferred to the classroom.

*Field Experiences.* During the fall semester, Riley took five graduate courses and went at least one day a week to a second grade classroom for her practicum. For both her practicum and student teaching, she was placed at suburban schools where she worked with mostly affluent white pupils. For student teaching, she was placed in a fifth grade classroom. In both schools, *Everyday Mathematics* (EM) had been recently adopted and Riley had experience implementing the curriculum, which was more reformed with its emphasis on connecting mathematics to real world contexts. However, both cooperating teachers taught mathematics with a focus on procedures and relied heavily on the worksheets provided in *Everyday Mathematics* and *Harcourt. Harcourt*, which was traditional in format, was the curriculum used prior to the adoption of *EM*. For one of Riley's observed mathematics lessons, she taught addition of fractions with mixed

numbers. The EM curriculum suggested that pupils be taught to add whole numbers first and then fractions. In contrast, her cooperating teacher told her to model the procedure from right to left with the reasoning that pupils would have to learn it that way eventually. Unless her cooperating teacher was to suggest another teaching method, Riley would not deviate much from the curriculum, as illustrated by this statement about *EM*: “It’s a program that’s set up. So I didn’t really have to do a whole lot of preparation on my own, inventing stuff. I just sort of followed it.” (Interview 4) In mathematics, she relied on the curricula rather than creating her own lessons. This was different from her approach to teaching reading and writing, where she developed her own engaging lessons because of her comfort with the curriculum.

*Mathematics Methods Course.* Meanwhile, Riley was learning to teach mathematics with a conceptual focus in her mathematics methods course, which was different from her student teaching experiences. As she learned about reformed methods for teaching mathematics, she showed a desire to adopt aspects of this practice to provide her pupils with the learning opportunities she did not receive:

As I study how to teach math in my methods class, I am appreciating it so much more. I wish I had been taught math in a way that showed me what was actually happening when I calculated a problem. Instead I was taught a series of mindless steps, or a means to an end, without substance. (Autobiography)

She thought it was important for pupils to understand the concepts rather than to complete worksheets without hands-on experiences. It was also valuable that the mathematics methods course instructor modeled the teaching practices he espoused:

With my methods courses, I think in math again, I think he did a great job of that because he'd give us the manipulatives to work with. Sometimes I felt like he would give us the problem as if we were the students and maybe he'd change it. To teach kids about base ten, he gave us a base five to kind of throw our thinking off as if we were in their shoes, and that was kind of nice to see how they might feel, the students. (Interview 3)

The mathematics methods course was not clearly linked to the classroom where she completed her practicum or student teaching. One of the few assignments that attempted to link the methods course to the practicum required preservice teachers to teach a mathematics lesson that incorporated the use of manipulative materials. To complete this assignment, Riley taught a second-grade lesson focused on multi-digit addition using base ten blocks. In the excerpt below, Riley recalled having a positive teaching experience because the pupils enjoyed using the manipulatives:

I liked getting experience teaching with the manipulatives because we've been learning about that in my math class, using the base ten blocks and stuff. And I remember when I was little using the unifix cubes, and I don't know if the way the teacher used it wasn't effective or what. But I remember hating it. I remember not liking the cubes. And these kids seemed to enjoy playing with the cubes and using the mats that I made up. (Interview 2)

However, teaching one hands-on lesson was not enough for Riley to master a reformed pedagogy, because her cooperating teachers were not modeling the conceptual approach to teaching mathematics presented in the methods course. In some cases, having

contrasting field experiences can be a beneficial and comparative insight; when both field experiences are very different from what is being taught in the methods course, it can be difficult for PTs to make sense of their own learning and practice (Ebby, 1999).

*Teaching Practice.* During student teaching, Riley still lacked confidence in teaching mathematics, as shown in this dialogue. In particular, she felt anxious when pupils were confused and she was unsure about her own understanding of the mathematical topic:

Researcher: What do you feel the most comfortable teaching?

Riley: Language arts, reading, and writing for sure. Even though math is really structured and laid out, I just, I think that's what I've said from the beginning. I feel nervous with math just because. ...I feel a little less confident in math myself, even when I prepare the whole lesson, when a kid has confusion about something and you have to interpret their confusion and try and correct it, sometimes their confusion then gets me a little confused. And I try and cover that up and not let them know that I'm confused about math, too....That's where I feel a little nervous. (Interview 4)

During a fractions lesson, Riley taught with an emphasis on the procedures. She modeled step by step how to add fractions with unlike denominators while the fifth grade pupils took notes on what was written on the board. In the excerpt below, Riley and the pupils exchanged a few questions about adding fractions and one pupil showed his method of finding a common denominator.

Problem on board:  $\frac{2}{3} + \frac{2}{5} =$

Riley: What can we do?

Max: You can multiply them by each other. (*Max refers to the denominators.*)

Riley: Yes, or you can also do what?

Kylie: Make a list.

Riley: Yes you can also make a list.

CT: 5<sup>th</sup> graders, you're going to notice that you can use Max's method, but sometimes it may give you too much of a big number to work with and the list will give you a smaller one sometimes.

Riley: Yes, and I think in this case Max's method will be the smaller one in the list.

Max shared his method of multiplying both denominators, but Riley's cooperating teacher jumped in and reminded the pupils that this may not be the best way of finding the lowest common denominator and that the numbers may be too large. Therefore, Riley showed the pupils that they should write down two lists of multiples for the denominators until they find one that is common, even though listing all the multiples can be time consuming. It would be effective for pupils to determine equivalent fractions with the same denominators or to examine the definition of adding fractions, such as

$\frac{a}{b} + \frac{c}{d} = \frac{ad+bc}{bd}$ . When solving the problem above, it would translate to

$\frac{2}{3} + \frac{2}{5} = \frac{(2 \times 5) + (3 \times 2)}{3 \times 5} = \frac{10+6}{15} = \frac{16}{15} = 1 \frac{1}{15}$ . It would be beneficial for pupils to see a

concrete model to better visualize what it means to add fractions before moving to the abstract form.

Once the short lesson was complete, the pupils were assigned two practice pages in their mathematics workbook. Again, Riley did not deviate much from the curriculum in this lesson. Focusing on procedures and discrete skills was perhaps a safe way for her to deal with her lack of confidence in mathematics. It may not have been the best lesson to observe, because her cooperating teacher was in the classroom and interrupted her teaching on several occasions, which may have made Riley feel uncomfortable to try a different method. Aside from her uncertainty in teaching mathematics, Riley appeared to be very comfortable when she was in front of a classroom. She engaged pupils seamlessly as she conversed with them while teaching.

*Summary.* Riley often expressed frustration from her conflicting experiences in the methods course and practicum. When she spoke about her practicum, she stated, “I didn’t always see some of the methods [from the course] being put into practice [in the practicum]...I think math and reading are so important right now. It’s really important to see those two specifically matching up with what we’re learning. That was disappointing for me.” Nevertheless, at the end of the teacher education program, Riley maintained a positive attitude about teaching mathematics:

I always felt that math is a struggle for me. So I really want to do a good job teaching math. One of my goals is to focus on a particular subject; math might be it. I’m not sure yet. I haven’t decided, but I still feel like that’s a struggle because I struggled with it, but it’s kind of motivating me to work harder at it. I definitely have a lot more confidence because I knew nothing about teaching math before. I’ve learned names of manipulatives that I knew nothing about. I’m anxious



[excited] to incorporate those. I'm anxious to start this new math program, too. It seems very exploratory and hands on, so I think that's good. (Interview 6)

This is one example of how a mathematics methods course can be influential, despite contradictory field experiences. Riley's negative experience as a young learner of mathematics gave her the desire to teach differently. Several times, she remarked, "Why wasn't I taught that way?" Based on her teacher education experiences, she planned to provide such learning opportunities for her pupils. She was also excited about her school adopting a reformed curriculum that would give Riley the opportunity to teach mathematics with a more hands-on approach. Riley's experience was a paradox because she agreed with many aspects of reform, but did not have a full understanding of how it was carried out in the classroom.

#### *First year of Teaching*

As a first-year teacher, Riley taught fourth grade at a suburban school that used both reformed and traditional curricula for mathematics instruction. However, she quickly learned that the majority of the required lessons were to be taught from *Scott Foresman*, the traditional curriculum, while *Investigations*, the reformed curriculum, was used as an occasional supplement. Her school had a long-term planning guide that arranged the mathematics benchmarks with accompanying lessons. In many cases, there were units that did not include a single lesson from the reformed curriculum. However, Riley would occasionally attempt to provide her pupils with hands-on experiences by integrating interactive activities with the traditional worksheets. She also taught

mathematics in the morning for one hour, after the class completed their beginning of the day activities organized in a morning meeting.

*Teaching Practice.* Analysis of observational data showed that Riley mostly taught mathematics from the traditional curriculum. Her teaching practice was somewhat inconsistent with the beliefs and attitudes she stated in the interviews and experienced in the teacher education program, a phenomenon common to many teachers (Raymond, 1997). Her lessons typically followed the same sequence, which included an interactive presentation of the topic, teacher modeled procedures or examples, and pupils practicing the skill on a worksheet. In seven of the ten observed lessons during her first year of teaching, Riley wrote problems on the board, modeled how to solve them while eliciting pupils' input, and required pupils to complete worksheets directly from the traditional curriculum. In one lesson, the class reviewed challenging mathematics problems from the mid-year assessment. Among the ten observations, only three lessons were taught with the reformed curriculum. She mentioned that in many units, the school benchmarks did not include one lesson from the reformed curriculum. However, she incorporated hands-on activities when possible, and made the short lectures very interactive.

Consistent with a reformed approach to teaching mathematics, Riley accepted different strategies for solving problems, but was not able to extend some of her pupils' learning opportunities. This was due in part to her lack of confidence and limited mathematical content knowledge, as she expressed in several interviews. For example, below is an excerpt from a lesson in which Riley reviewed items pupils missed on the

mid-year mathematics assessment. During this lesson, she ignored the possibility of extending pupils' thinking by exploring an alternative strategy.

Riley: Okay, now we're getting into some terms, and vocabulary is where some of us get tripped up. Question 8 says, "find the sum:  $6,384 + 99$ ." What does sum mean?

Todd: It means the total of adding two numbers.

Riley: Yes, it's the answer to an addition problem. So what do I need to do to solve it?

Rebecca: First you need to rearrange the numbers so they're on top of each other.

Riley: Okay.

Jonah: Well, you don't even need to do that! You can just add 100 and subtract a 1.

Riley: Yes, that's a really good strategy.

*Riley continues to model the procedure of solving the problem by aligning the two numbers vertically then adding the sum from right to left.*

Riley validated Jonah's alternative strategy, but does not take advantage of the teaching moment. Instead of asking him to explain why it worked and was a more efficient strategy, she solved it with the standard algorithm and moved on to the next problem.

Riley's limited mathematical knowledge for teaching frequently left her at a loss for ideas to challenge the high achieving pupils. For example, in one interview she expressed her comfort in teaching with the more traditional curriculum and admits to being

uncomfortable with problems that were challenging or extended beyond her mathematical knowledge:

So I think with *Scott Foresman*, at least the way I taught it, you know, I tried to mimic the textbook page where we don't have the textbooks and write the title, write some of the vocabulary words and what they mean, then do a couple examples, and then the kids would go and do some of the practice work with it. The only thing that made me uncomfortable was those challenge problems on the worksheets where it goes kind of beyond what you've taught them so then there'd be like, 'I don't get this one,' and I'd be like, my God! (Interview 9)

Nevertheless, Riley made an extra effort to help her struggling learners by providing the majority of the lecture notes on print so that Billy and Ronnie, two struggling pupils, were able to focus on the lesson rather than copying what was on the board. During a lesson on simplifying fractions, Riley walked over to Ronnie after she presented the lecture and the following discussion occurred:

Riley: What is  $\frac{3}{3}$  equal to?

Ronnie: 9

Riley: That is  $3 \times 3$ . We are doing division. If you have 3 slices of pizza and you have 3 people. How many slices does each person get?

Ronnie: 1

Riley: Yup.

Riley was able to present a meaningful context for division to make the content accessible for Ronnie, who consistently struggled in mathematics. Riley connected the

problem with a tangible example to scaffold the pupil's understanding. However, it was not clear whether Ronnie fully understood, although he provided a correct answer. Her division example was not the correct model for the type of fraction she was teaching. This example fit a partition model of division, which is commonly used with word problems that involve sharing. Riley confused whole numbers with fractions; in this case, the whole was not clearly defined. If the three slices made a whole pizza, then each person would have  $\frac{1}{3}$  of the pizza. An accurate model would be showing Ronnie equivalent fractions that make 1 whole, such as  $\frac{4}{4}$  and  $\frac{2}{2}$ . She could have also shown that  $\frac{1}{3} + \frac{2}{3} = \frac{3}{3} = 1$  by using a concrete model such as pattern blocks.

When asked about the mathematics curricula she used, Riley expressed that she liked teaching from the traditional curriculum and felt comfortable using it, but thought the reformed curriculum was also valuable and complementary:

I don't think [the two curricula are] all that different because sometimes with the *Scott Foresman* I like to go to the previous pages and do the hands-on activity. So I don't think [students] really notice like 'oh, this is an *Investigations* lesson,' as opposed to *Scott Foresman*. I do like the *Scott Foresman*, but some of the *Investigations* lessons I think are really good like the hands-on. I think it's a good mix. For example, I had one parent [who] was anxious when we were going to start long division and she wanted to know which way I taught it. I said, 'Well, we do one *Investigations* lesson and they kind of explore what it means to divide

by like sorting you know, and then the rest is *Scott Foresman*. They're pretty much learning the traditional algorithm, but I'm not opposed to them doing partial products [an alternative method] if it helps them with their understanding.' So I sent home both methods from a reference book so she could preview it with her child. So I think it's fine. I like having both [curricula]. (Interview 8)

Although Riley found value in both curricula, she noticed a difference in her preparation time and recognized that *Investigations* required more preparation time. She stated, "*Investigations* is a little bit harder because I think the prep time is different. . . . You have to read more whereas with Scott Foresman, it's a little bit easier to just open it and do a lesson" (Interview 8).

*Mathematics Assessments.* In the middle of the school year, Riley's pupils completed a district-mandated mathematics assessment. The results motivated Riley to reevaluate her teaching. She was disappointed that her pupils were confused over simple terms, such as finding the "difference." The teachers in her grade level made a chart of missed questions and noticed some similarities. Riley stated that she and her colleagues thought part of the problem was the format and wording of the test. However, the pupils should have been able to complete the problem if they had thought about it more (see Figure 5.3). For example, Riley stated:

Some of it I was just horrified by, like 'find the difference' and it was a subtraction problem. I had a few of them come up to me and say 'I don't know what to do' because they saw that vocabulary word 'difference' and that messed

them up even though they could look at it and they know how to do a subtraction problem...and it had the symbol. (Interview 8)

|  |
|--|
| <p>10. Find the difference.</p> $\begin{array}{r} 8,401 \\ - \quad 382 \\ \hline \end{array}$ <p>A) 8,089<br/>B) 8,181<br/>C) 8,029<br/>D) 8.019</p> |
|--|

*Figure 5.3.* Problem Sample.

The fact that Riley's pupils saw the numerical mathematics problem and had difficulty interpreting the directions indicated that they may not have been exposed to more than one model of subtraction. Riley was especially shocked because her school taught vocabulary specifically for mathematics. After this test, she added words to their vocabulary list such as compute, represent, and difference. She tailored her instruction by focusing on individual needs.

Towards the end of the school year, Riley's pupils took the end-of-year mathematics assessment. Riley thought the test was a fair assessment of her pupils' learning and was pleased with the overall results. Although she spent classroom time reviewing the mid-year assessment with her pupils and tailored her teaching to meet individual pupil needs, she did not spend extra time reviewing prior to the end-of-year mathematics assessment. She explained that they had already spent time throughout the

spring preparing for the state test and thought that the point of the assessment was to have a real sense of what her pupils learned.

*Classroom Management.* An aspect of Riley's teaching that seemed to have an influence on her pupils' learning was the classroom community she created. Riley had an excellent command of the classroom and had minimal management difficulties. Her school district provided professional development to prepare its teachers to use *Responsive Classroom*, an approach to creating a safe classroom environment that promotes optimal pupil learning by valuing social, emotional, and academic growth. As part of this classroom management system, Riley had a daily morning meeting with her pupils where they would greet everyone, share experiences, discuss any current issues, and play a game to start the day. This helped Riley establish a respectful classroom where the pupils followed directions and stayed on task for the most part, without having a list of rewards and consequences to motivate them. Her classroom community established an environment with the potential for her pupils to be challenged at a higher level in mathematics, but Riley was not well-prepared with either a deep knowledge of mathematical content or a model of reformed pedagogy. Additionally, Riley's own anxiety about teaching mathematics could have played a role.

### *Summary*

For Riley, it was important to have a "balance" between the two methods for teaching mathematics. As a preservice teacher, she stated, "You need that balance. It'd be hard to do some things, like a fun activity all the time" (Interview 3). At the end of her



first year of teaching, Riley reiterated her belief about using both approaches, but acknowledged that the school primarily used the traditional curriculum:

I think one of the complaints was that kids weren't getting enough practice with the *Investigations* when that was all they had and that's part of the reason they purchased the *Scott Foresman*, to supplement it. I think in the younger grades *Investigations* is used a lot more, whereas in fourth grade, I have some *Investigations* and mostly *Scott Foresman*. I think it's the opposite in the younger grades. So maybe it's good as a foundation but then when you get into the higher concepts you do need to practice those steps, like, long division. You can't just do it once and get the idea of division. You have to know how to divide. You need a balance. (Interview 9)

Although Riley had a good intention of making sure her pupils acquired the skills of mathematics (i.e., procedures) and still understood the concepts, she confused a reformed approach with hands-on activities. Without having observed another teacher model a reformed practice, she may not have developed a fundamental understanding of key characteristics of a reformed classroom. It is not about creating "fun activities," but rather it is about challenging pupils to engage in higher levels of thinking and explain their understanding of a concept through multiple representations (Hiebert & Carpenter, 1992).

Riley's school context and the mandated curriculum played an important role in her classroom practice. In theory, the school adopted both reformed and traditional curricula. In practice, it was very clear that the traditional curriculum was more commonly used with an occasional reformed lesson as a supplement, as evidenced by the

yearly benchmark plans. Fortunately for Riley, the curriculum matched her teaching style, which was more procedure-based, with some attention to a conceptual understanding and hands-on learning. Without a prior experience of teaching reformed mathematics, Riley accepted the use of two mathematics curricula at her school and did not question the benchmarks, which required mostly Scott Foresman lessons.

### Pupil Learning

To connect teaching practices to pupil learning, I used the RISER, which examined 1) the level of authentic intellectual opportunities via classroom assessments, and 2) learning outcomes based on pupil work. For the participants in this study, mid-year and end-of-year mathematics assessments were scored according to the RISER<sup>5</sup> rubric. Both assessments were district-made and did not reflect the teachers' ability to create an authentic and intellectually challenging assessment. However, the assessments did reflect the types of tasks the teachers used as guides for their instruction, because they were consistent with the curriculum materials in both school settings. Table 5.1 shows the results of the district-made assessments, as rated by the RISER, which is on a 10-point scale, and mean scores of their pupil work, which is on a 12-point scale (see Appendix

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<sup>5</sup> This instrument categorizes the thinking most people do in the world into three criteria that make up authentic intellectual work (Newmann & Associates, 1996). The first criterion is construction of knowledge. Authentic experiences are ones in which students go beyond reproducing information that has been given to them and apply information to new situations to construct their own meanings. The second criterion is disciplined inquiry. Authentic experiences engage students in activities where they (a) draw from an extensive content knowledge base, (b) gain an in-depth, rather than superficial, understanding of the material, and (c) express their understandings through extensive writing or other methods of communication. The third criterion is value beyond school. Authentic experiences have meaning that goes beyond the classroom where students are able to make connections between their work and the world around them. Learning opportunities must engage students in all three of the categories to be considered exemplars of authentic intellectual work. Authentic intellectual work is consistent with pupils' learning for conceptual understanding because of the emphasis on the creation, not reproduction, of knowledge, in-depth inquiry, and important and relevant learning opportunities.

G), where a higher score is more favorable. Studies using the RISER have consistently found lower scores on mathematics because the instrument emphasizes and values elaborated written communication, which is not always evident in mathematical tasks (Newmann, Lopez, & Bryk, 1998).

Table 5.1

*Assessment Task Scores and Mean of Pupil Scores*

| Teacher | Assessment | Task Score | Pupil Score |
|---------|------------|------------|-------------|
| Sonia   | Mid-year   | 6          | 4.7         |
|         | End-year   | 7          | 5.8         |
| Riley   | Mid-year   | 5          | 4.9         |
|         | End-year   | 5          | 6.4         |

According to the RISER scores, Sonia's assessments were more authentic and intellectually engaging (scores of 6 and 7), while Riley's were slightly less authentic (score of 5 on both). Considering that Sonia's district used a reformed curriculum and Riley's district relied more heavily on a traditional curriculum, it makes sense that Sonia's assessment tasks would be rated higher. Reformed curriculum usually includes more contextual-based problems, which is valued by the RISER, rather than problems focused solely on computation.

For example, Figures 5.4 and 5.5 show two sample problems from participants' end-of-year assessments. Sonia's assessment consisted of open-ended questions that gave pupils the opportunity to respond in multiple ways, while Riley's assessment was a

multiple-choice format with one correct answer per question. The assessments themselves reflected a differing view of mathematics; one offered flexibility, while the other was linear. According to the RISER, Sonia's assessment was rated higher overall.

8. Sue has \$0.87. What coins could she have?

9. How are these shapes different?

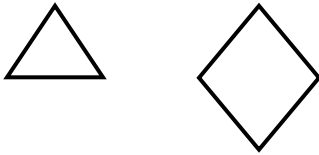
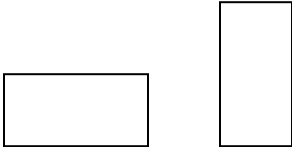


Figure 5.4. Sonia Sample Assessment Items.

11. 
$$\begin{array}{r} 97 \\ \times 6 \\ \hline \end{array}$$

A) 562  
B) 5,642  
C) 582  
D) 542

23. Choose the letter beside the word that best describes each set of figures.



A) congruent  
B) similar  
C) neither

Figure 5.5. Riley Sample Assessment Items.

For example, in the RISER's Elaborated Written Communication standard for Mathematics Tasks, the scores range from 1 to 4. A score of a one= Fill-in-the-blank or multiple choice exercises for a task that requires no extended writing, only giving mathematical answers or definitions. This description of a one is the best fit for Riley's assessment for that particular standard. Two= Short-answer exercises where the task can be answered with one or two sentences or phrases and pupils are asked to show their work without much detail. Sonia's assessment was a two because it required pupils to explain their answers to the open-ended questions, but did not ask them to elaborate or use more than one method. To merit a four, a task must be focused on analysis and persuasion, where tasks explicitly call for generalization and support with models and solutions as evidence. It is important to examine assessment tasks because they reveal the level of mathematical thinking of pupils (Henningsen & Stein, 1997).

Mean scores for pupils in both classes improved from the mid-year to the end-of-year assessment. The two assessments were not comparable because there was a difference in grade level, content, and assessment format. This study did not set out to compare whether one classroom learned more than the other because the mathematical knowledge being taught and assessed was different. Table 5.2 shows specific scores for individual pupils in each classroom (based on the second RISER scale evaluating pupil work, see Appendix G). In most cases, pupils made gains. Due to the small sample size, significant differences were not tested. The sample was small because both assessments were not available for every pupil in one of the classes. Therefore, among the pupils who had both a mid-year and end-of-year assessment, I drew a random sample of ten per

class. Based on the assessments that were available, 10 pupils from each class were randomly selected as part of this analysis. Although the gains of each class were modest, scores appeared to be moving in the right direction. However, the scores could have been the result of factors other than teaching practices, such as school context, assessment design, and individual pupil ability. The pupil gains were also very close.

As stated previously, the two assessments were not comparable because there was a difference in grade level, content, and assessment format. It was clear that factors other than the teacher may have been influential. For example, the curriculum and school contexts were very different. Although the assessments were district-made, they still reflected the type of mathematical ideas taught and learned. As explained in chapter two, several studies have indirectly analyzed teaching practices by examining teachers' lesson plans, assessment tasks, and pupil work (King, Schroeder, & Chawszezewski, 2001; Stecher et al., 2006). They found that analyses of teaching artifacts were valid indicators of teachers' level of reformed teaching practices. In these cases, the RISER showed that Sonia and Riley's assessments were aligned with their teaching practices, their stances toward teaching mathematics, and the environments in which they learned and taught mathematics.

Sonia taught at an urban school, with a racially, culturally, and linguistically diverse high school population and a low SES. The school was under-funded, and, along with many other demands that were placed on her as a first-year teacher, Sonia was expected to translate the mathematics curriculum. Sonia also struggled with classroom management, a challenge faced by most first-year teachers (Huberman, 1989). Due to the

rigid schedule, her pupils only had 50 minutes for mathematics. Notwithstanding, she was extremely committed to the pupils, the bilingual mission of the school, and held high expectations for her pupils. Proponents of reformed teaching would argue that her practices allowed her diverse pupils to better access the content through increased opportunities with divergent modes of thinking (Secada & Burman, 1999).

Table 5.2

*Pupil Assessment Scores*

| Teacher | Pupil     | Mid-Year Assessment | End-of-Year Assessment |
|---------|-----------|---------------------|------------------------|
| Sonia   | Joshua    | 3                   | 4                      |
|         | Sarita    | 6                   | 9                      |
|         | Juanita   | 4                   | 4                      |
|         | Arturo    | 3                   | 7                      |
|         | Rebecca   | 3                   | 6                      |
|         | Sue       | 7                   | 9                      |
|         | Jose Luis | 7                   | 6                      |
|         | Alejandro | 3                   | 4                      |
|         | Veronica  | 5                   | 4                      |
| Riley   | Rebecca   | 5                   | 6                      |
|         | Valerie   | 5                   | 5                      |
|         | Jackie    | 4                   | 6                      |
|         | Betty     | 3                   | 5                      |
|         | Aly       | 4                   | 3                      |
|         | Jonah     | 8                   | 9                      |
|         | McKenzie  | 4                   | 8                      |
|         | Mac       | 4                   | 7                      |
|         | Anna      | 6                   | 7                      |



In contrast, Riley taught at a suburban school where a high proportion of the student population was Caucasian and came from more affluent backgrounds. The school building was new and equipped with state-of-the-art technology. She also had a full-time aide because one of her pupils had Asperger's syndrome. Although the required curriculum was more traditional, Riley attempted to vary the activities and meet the needs of her pupils while they worked individually. It was also advantageous that her classroom had such few discipline problems and pupils had more time on task.

Analysis of classroom observations suggested that Sonia had a more reformed teaching style, while Riley had a more traditional teaching style with a mix of reformed characteristics. Riley's observed content knowledge was consistent with her interviews, where she expressed the need to strengthen her content knowledge. Although it appeared that participants' instructional styles differed, there was also much overlap in the strategies they implemented to provide learning opportunities for their pupils. The shared strategies included pupils explaining their thinking and using multiple representations, although some of this was integrated in a superficial manner. Results of their observations did not necessarily support what participants stated in their interviews. However, observations of teaching practices were closely connected to the assessment types, which may have influenced their roles as teachers. Teaching practices were consistent with the curricula they were required to use at each school, making the case that curriculum can play a crucial role in supporting reformed teaching practices; however, this is only one step in the process, as teachers ultimately decide how they will enact the curriculum (Ball & Cohen, 1996). Results from classroom observations also

indicated that both teachers found it difficult to extend their pupils' understanding of the content and make connections to the real world, which could have required them to go beyond the curriculum.

Given both cases, it was no surprise that pupil assessment scores improved. Both were committed to their pupils' learning needs and worked very hard to meet those needs. However, their scores might have increased further if certain context-related factors were improved, such as allotting sufficient time and engaging pupils in developmentally appropriate tasks (Henningesen & Stein, 1997). As first-year teachers, their classroom practices reflected a combination of their teacher education and past schooling experiences, which is common when teaching mathematics (Ball, 1989; Hart, 2001). It would not be a realistic expectation, for example, for Riley to have taught in a completely reformed manner when she never had an opportunity to teach mathematics in this way and her school required a traditional curriculum. Sonia and Riley's experiences followed patterns that made their practices predictable. In the final section, I summarize the experiences of Sonia and Riley, and how they influenced their practice and pupils' learning.

#### Interpretive Summary

This chapter presented two case studies examining the process for learning to teach elementary school mathematics. Findings were based on interviews, observations, and collected classroom artifacts over a two year period as participants were followed from preservice teacher education into their first-year of full-time teaching. I argued that their past schooling experience, field experiences, the mathematics methods course, and

first-year school context were intricately related as they worked to shape participants' perceptions and teaching practices in mathematics. This argument is supportive of the research by Ball and Cohen (1999), who suggest that teachers can be influenced by a multitude of factors, including those in the conceptual framework. What follows is a summary of how their experiences shaped their pedagogy and a discussion of two themes, including their views about practical and theoretical knowledge, as well as classroom-related factors that influenced their practice and pupils' learning of mathematics.

Analyses of Sonia and Riley's experiences illustrated that teaching practices were clearly influenced by components of the conceptual framework: past schooling experiences, the teacher education program, and school contexts. Figure 5.6 is a visual model of their experiences with mathematics education. The black color indicates a reformed mathematics experience, while the light gray color represents a traditional mathematics experience. Note that the line between reformed and traditional is not clear; this contrast shows the distinction between Sonia and Riley's experiences. The abbreviations are as follows: PS = past schooling, FE= field experience (i.e., practicum and student teaching), MM= mathematics methods course, SC = first-year school context, and TP = teaching practices.

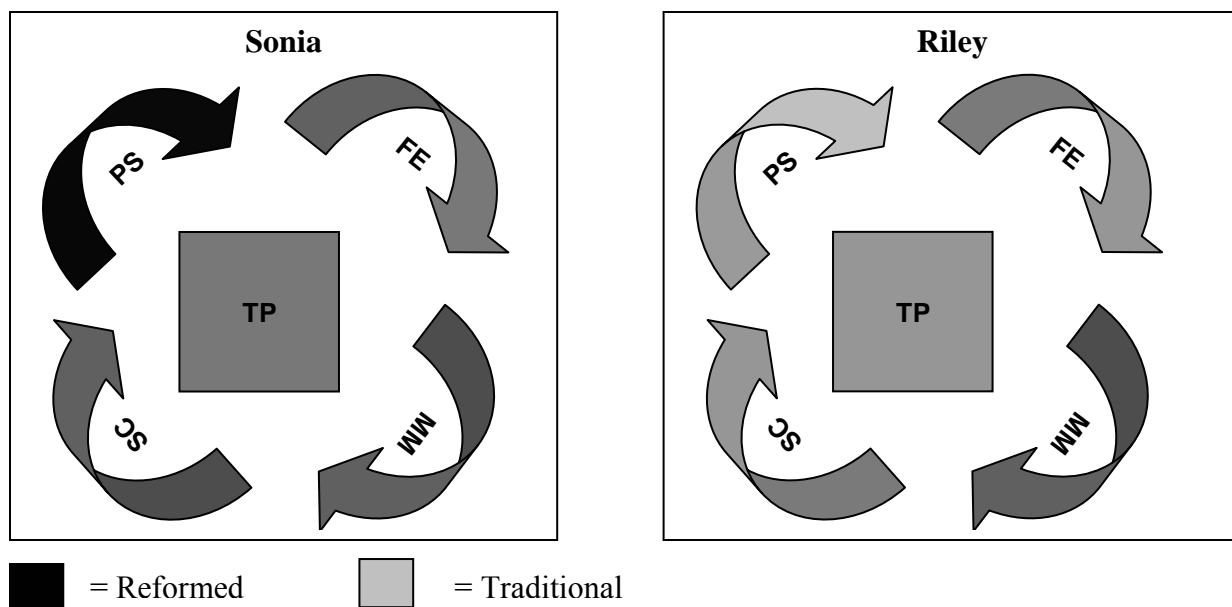


Figure 5.6. Teachers' Experiences with Reformed Mathematics.

If prior learning experiences were an accurate indicator of expected teaching practices, Sonia should have taught using a reformed method (as shown by the darker shade), and Riley with more non-reformed practices with some characteristics of a reformed pedagogy (as shown by a lighter shade of gray). Essentially, they practiced what they learned and learned by practicing (Ball, 1989; Ball & Cohen, 1999; Grossman, 1990; Wideen, et al., 1998). For the most part, this appeared to be true in the two cases. However, a sliding scale with different shades would be more appropriate in these instances. It is not easy to categorize teaching practices as reformed or non-reformed when there is overlap in teaching strategies (Sawada et al., 2002). There are complex thought processes that occur as these experiences are shaped by each other to influence both beliefs and practice.

Sonia and Riley each entered the teacher education program with an ideological stance about teaching and learning mathematics that had been shaped by past teaching models (Lortie, 1975). From a sociocultural perspective, their stances were the lenses from which they viewed their methods course and field experiences (Geertz, 1973). Although participants did not change dramatically in their ideology toward mathematics education, the teacher education programs and school contexts refined and solidified their stances (Goos, 2005; Vygotsky, 1978). Sonia knew that she wanted to teach mathematics with an emphasis on conceptual understanding as she learned it in her Montessori school, but she did not have the strategies necessary to do so prior to the teacher education program. Sonia was fortunate to have entered with a meaningful experience as a learner of mathematics, as most teachers have traditional experiences with learning mathematics like Riley (Ball, 1989; Ellsworth & Buss, 2000). Regardless of their pasts, both participants had positive experiences in their mathematics methods course. For Riley, it was one of the only experiences she had with reformed practices, but it was enough of a model to help her realize the value of learning mathematics beyond procedures. Although Riley's field experiences did not reinforce a reformed view of mathematics, the experiences gave her practice teaching mathematics in the classroom. This classroom experience, along with teaching strategies she learned in the mathematics methods course, may have helped to lower her level of anxiety toward teaching mathematics and increased her level of confidence (Bursal & Paznokas, 2006; Vinson et al., 2007).

The interactions between coursework and field placements provided a strong base from which Sonia and Riley developed their roles as mathematics instructors (Ebby,

2000). Their experiences were also consistent with studies that examined the positive influence mathematics methods courses have on preservice teachers' attitudes towards mathematics (Clift & Brady, 2005; Lubinski & Otto, 2004; McGinnis et al., 1998); however, the case studies in this dissertation went beyond perceptions to examine practices. Riley's experience was similar to a case where a student teacher was followed during her final year in a teacher education program, because they both had field experiences that did not espouse a reformed practice (Eisenhart et al., 1993); both student teachers ultimately enacted a practice that was more procedural than conceptually based in mathematics. The limited experience with reformed teaching in a methods course did not change Riley's perceptions dramatically. On the other hand, Sonia's experience was much more comprehensive. Her past schooling, field placements, and the methods course had a shared philosophy of reformed teaching, which helped her to understand the whole picture and adopt a conceptual approach to teaching mathematics.

Other differences between Sonia and Riley were their views on theoretical and practical knowledge. Sonia entered the teacher education program with an expectation of learning the theories of teaching and found herself initially disappointed at her summer reading methods course that had a focus on practical classroom strategies. However, she quickly realized the value of having practical knowledge along with theory after she entered the classroom. Riley's perception was different; she began the program with a desire to learn practical skills to implement in the classroom. She never disregarded theories, but her attention was on the practical, which could have been another reason that her field experiences were more influential on her practice than was the mathematics

methods course. Attaining a balance and close connection between theory and practice in a teacher education is challenging, yet crucial. Studies have argued that reflecting on one's practice and engaging in meaningful theory-based tasks can better prepare mathematics teachers (Leikin & Levav-Waynberg, 2007; Garcia, Sanchez, & Escudero, 2006). Participants in this study were required to reflect about teaching and assigned readings, but the connections made between their field placements and the course appeared to be more subjective and dependent on the placement and individual.

A pervasive finding from the experiences of these teachers illustrated the central role that school and classroom contextual factors play. Specifically, results indicated that the school demographics, mathematics curricula, and classroom management influence how and what mathematics is taught and learned. Studies have repeatedly shown that resources vary greatly between urban and suburban schools (Berliner, 2005; Ingersoll, 2004). Teachers in urban schools have less parental support and fewer financial and physical resources. In these cases, Riley had greater access resources and technology, while Sonia was expected to translate her mathematics curriculum from English to Spanish for her bilingual pupils. Additionally, the population of pupils in their classrooms were racially, linguistically, and economically different. However, both teachers wanted to work with their respective student population as first-year teachers and tried diligently to meet the range of learning needs in their classrooms.

The classroom factor that also appeared to affect teaching practices was classroom management. Riley appeared to have greater command of her fourth grade classroom and experienced minimal disruptions, which thereby permitted pupils more

time on task. Sonia often struggled to keep her second graders focused on instructions, make quick transitions, and provide ample time for pupils to complete their work.

Differences in student population, school policies, or personal characteristics might have accounted for the difference between Riley and Sonia's styles. However, both stated a desire for a course on classroom management, even though it was anticipated that they would nonetheless experience such challenges as first-year teachers (Johnson, 2004).

Participants' experiences with varied mathematics curricula as preservice teachers affected how they enacted curricula as first-year teachers. Sonia was only exposed to *Investigations* during her field experience and was required to use the same curriculum during her first year of teaching, rather than learn a new format. Although she initially had her reservations about the curriculum, she slowly realized that she agreed with its purpose of teaching mathematics with a conceptual focus, which gave her greater motivation to enact it. Nevertheless, as a first-year teacher, she stated that it was still difficult to implement, especially because she was not familiar with the content expectations at the second grade level. Riley was exposed to cooperating teachers who used both *Everyday Mathematics* and *Harcourt*, which could have validated her use of both curricula as a first-year teacher. Although she had heard criticisms of *Investigations*, she was eager to use it, but quickly realized that it was only used occasionally with *Scott Foresman* as the primary curricula. However, Riley was more comfortable using *Scott Foresman*, as she thought it was easier to implement as well. At the end of their first year of teaching, both participants felt greater confidence with their knowledge of the mathematics curricula. Thus, they would have appreciated additional preparation on



using curricular materials as preservice and beginning teachers. As part of their initial orientation to their schools, Riley and Sonia were given brief overviews of the curricula, but neither found such an overview sufficient. Curricula have often been used as a catalyst for reformed teaching practices (Ball & Cohen, 1996; Collopy, 2003), and this study supports a similar finding. The curricula used by the teachers was consistent their beliefs and where their teaching fell on the scale ranging from reformed to non-reformed classroom practices.

This summary highlighted relevant themes that emerged from participants' experiences of learning to teach mathematics. I argued that past experiences and components from both the teacher education program and school context had overlapping influences on teaching practices and pupil learning. The next chapter summarizes findings from both results chapters, discusses implications for improving teacher education based on the study, and makes recommendations for future research.

## Chapter 6

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study examined the process of learning to teach mathematics at the elementary school level. In this chapter, I address the research questions posed in this study by discussing the findings presented in Chapters Four and Five. This closing chapter includes the following sections: summary of the study, discussion of findings, conclusions and implications, limitations of the study, and recommendations for future research.

#### Summary of the Study

The purpose of this study was to explore how preservice elementary teachers' past K-12 schooling and teacher education experiences influenced their attitudes and perceptions about the teaching and learning of mathematics. The investigation focused on how beliefs and teaching practices evolve over time by following participants into their first year of teaching. This offered an extended exploration of the characteristics of their teaching practices and how their prior learning experiences and school contexts shaped both perceptions and pedagogy in mathematics. In addition, the extent to which teaching practices reflected reformed mathematics pedagogy and how these practices influenced pupils' mathematical learning were analyzed.

A mixed-method approach of survey and qualitative case-study research methods was utilized to collect and analyze data over a two-year period. To thoroughly investigate the research questions, analyses of surveys, interviews, observations, and pupil work were conducted. During the first year of this study, pre- and post-surveys using Likert-

scale items were administered to all preservice teachers (n=75) enrolled in an elementary mathematics methods course. For a two-year period, the experiences of two participants were explored through longitudinal interviews, observations, and an examination of artifacts (i.e., teacher lesson plans, assessments, and pupil work) to develop in-depth case studies.

Informed by sociocultural theory, this study was based on the premise that teacher beliefs and experiences shape their practice; thus, the goals of this study were to understand both the relationship among these variables and their influence on pupil learning. Specifically, this study examined the following questions:

1. How do preservice elementary teachers' past schooling and teacher education experiences (i.e., mathematics methods course and field experiences) influence attitudes and perceptions about the teaching and learning of mathematics?
2. How are preservice elementary teachers' mathematics teaching practices influenced by prior schooling and teacher education experiences?
3. What are the characteristics of the mathematics teaching practices of first year teachers? How do prior experiences and current school contexts shape perceptions and pedagogical practices in mathematics? To what extent do practices reflect reformed mathematics pedagogy?
4. How do first year teachers' pedagogical practices influence pupils' mathematical learning?

The conceptual framework for this study was developed and informed by literature on learning to teach (Grossman, 1990; Wideen, Mayer-Smith, & Moon, 1998).

Several underlying assumptions of this framework viewed the combination of prior schooling experiences, teacher education programs (including the mathematics methods course and practicum experiences), and school contexts as key factors that inform teaching practices. This study explored the existing relationships among those factors. Using sociocultural theory, I argued that learning is a co-constructed process that occurs within and is influenced by multiple contexts (Geertz, 1973; Vygotsky, 1978; Goos, 2005). This theory acknowledges that teacher practices operate under a set of value-laden cultural ideas (Gee, 1996). Hence, the various components of the conceptual framework (i.e., prior schooling, teacher education) shape these values and subsequent teaching practices. The next section discusses the findings of this study and their implications for improving teacher education for preservice and beginning elementary school teachers in the area of mathematics.

#### Discussion of Findings

The purpose of this study was to understand how prior schooling, teacher education experiences, and school contexts influence attitudes and perceptions, teaching practices, and pupil learning. This section presents findings on how participants' experiences influenced their attitudes, perceptions, and practice. While survey and case study results are interwoven throughout the discussion, survey findings did not extend beyond preservice teachers' attitudes and perceptions. Thus, findings from the case studies were used to extend the discussion on the relationships among teacher learning experiences, school contexts, teaching practices, and pupil learning beyond the preservice

period. Particular attention was paid to how the findings of this study compared and contrasted to the literature.

### *Past Schooling Experiences*

Survey findings indicated that preservice teachers with positive experiences in their past schooling had more positive attitudes towards mathematics and greater confidence in their ability to teach mathematics. Both cases supported this argument as well. For example, Sonia frequently spoke about her positive experience in Montessori school, where she learned mathematics with an emphasis on conceptual understanding. Her prior schooling also shaped her stance toward teaching mathematics. In Riley's case, she had a negative association with mathematics because her prior schooling was focused primarily on traditional methods for learning mathematics. She expressed a desire to teach mathematics differently than the way in which she was taught as an elementary student because she wanted to provide her pupils with a more positive learning experience.

Ellsworth and Buss (2000) examined preservice teachers' attitudes towards mathematics by analyzing their autobiographies. They found "past teaching models" to be the most salient theme. Preservice teachers commonly reported that their interest in or attitude towards mathematics was positively or negatively affected by past teachers. Survey and case study results both support the research suggesting that prior schooling experiences, or "apprenticeship of observation" (Lortie, 1975), are influential in shaping preservice teachers' ideas about teaching and learning (Ball & Cohen, 1999; Feiman-Nemser, 1983; Grossman, 1990; Wideen et al., 1998).

### *Teacher Education Experiences*

Results from paired t-tests indicated that preservice teachers had a significant increase in both their attitude towards mathematics and confidence to teach mathematics over the course of the semester. After completing the teacher education program, Riley expressed greater confidence in her ability to teach mathematics. She stated that she learned several strategies in the mathematics methods course and was looking forward to incorporating hands-on learning activities into her teaching. These results suggested that positive changes in PTs' attitudes and confidence can occur over a short period, and possibly have a lasting effect over time with additional support.

These findings were different from those of Vinson et al. (1997), who compared PTs' mathematics anxiety before and after taking methods courses emphasizing the use of manipulative materials. Pre- and multiple post-survey results showed no significant difference in the mathematics anxiety scale after the first quarter of classes in the fall; however, a significant reduction in mathematics anxiety was present after the winter, spring, and summer quarter classes. Thus, although immediate changes cannot always be detected, preservice teachers might be affected over time by learning opportunities presented in the mathematics methods course.

For example, survey results showed that PTs had an ideological stance in favor of reformed approaches to teaching of mathematics, including an emphasis on developing pupils' conceptual understanding. In this study, the mathematics methods courses presented a variety of concrete and pictorial models to represent processes of numerical operations. Exposure to such models helped Sonia and Riley to better conceptualize the

algorithmic procedures traditionally taught in elementary schools. Similarly, findings from other studies suggest that mathematics methods courses can influence preservice teachers' attitudes towards using conceptual approaches to teach mathematics (Harkness et al., 2006; McGinnis et al., 1998). However, this does not necessarily mean that they will actually teach in a reformed manner.

As stated above, preservice teachers tend to have an ideological stance in favor of reformed teaching practices in mathematics, which typically emphasize a conceptual understanding. All survey participants agreed that they planned to teach mathematics with a conceptual approach. From the very beginning, Sonia wanted to teach mathematics with a reformed approach because that was how she had been taught, and she valued having a conceptual understanding of mathematics. On the other hand, Riley was taught mathematics with an emphasis on memorizing formulas and practicing procedures. Her experience gave her the desire to provide pupils with more positive opportunities to learn mathematics. Pajares (1992) made a strong argument for educational research to study teachers' beliefs on the premise that beliefs influence teachers' perceptions and practices. In their studies on curriculum enactment, Remillard and Bryans (2004) found that teachers' beliefs have a strong influence on the decisions they make when implementing curriculum. Thus, understanding teachers' attitudes and perceptions is of great importance. However, attitudes and perceptions in favor of a reformed approach to teaching mathematics are only the beginning. Eisenhart et al. (1993) studied the mathematics teaching perceptions and practices of a preservice teacher and found that although she had the desire to teach mathematics with a conceptual approach, her

practices emphasized procedural knowledge. This shows how tensions can exist between perceptions and teaching practices. In this dissertation, both case study participants integrated teaching strategies consistent with characteristics of reformed teaching, but struggled to extend pupil understanding due to limited experience teaching mathematics, disconnected teaching models, and various factors related to school context.

The interactions between coursework and field placements provided a strong base from which Sonia and Riley developed their roles as mathematics instructors (Ebby, 2000). Their experiences were also consistent with studies that examined the positive influence mathematics methods courses have on preservice teachers' attitudes towards mathematics (Clift & Brady, 2005; Lubinski & Otto, 2004; McGinnis et al., 1998); however, the case studies in this dissertation went beyond perceptions to examine practices. Riley's experience was similar to a case in which a student teacher was followed during her final year in a teacher education program. Both had field experiences that did not espouse a reformed practice (Eisenhart et al., 1993); both student teachers ultimately enacted a practice that was more procedural than conceptually based in mathematics. The limited experience with reformed teaching in a methods course did not change Riley's perceptions dramatically. Without reinforcing teaching models and experience with reformed curriculum, it would have been an incredible leap for Riley to teach with a reformed approach. On the other hand, Sonia's experiences were much more consistent. Her past schooling, field placements, and the methods course had a shared philosophy of reformed teaching, which reinforced her commitment to a conceptual approach to teaching mathematics. When methods courses are more clearly linked to



field experiences, preservice teachers can also make stronger connections between theory and practice.

In addition, Sonia and Riley had different views on theoretical and practical knowledge. Sonia entered the teacher education program with the expectation of learning the theories of teaching and found herself initially disappointed at her summer reading methods course, which focused on practical classroom strategies. However, she quickly realized the value of having practical knowledge along with theory after she entered the classroom. Riley's perceptions were different; she began the program with a desire to learn practical skills to implement in the classroom. She never disregarded theories, but her attention was on the practical, which could have been another reason that her field experiences were more influential than the mathematics methods course on her practice. Participants in this study were required to reflect about teaching and assigned readings, but the connections made between their field placements and the course appeared to be more subjective and dependent on the placement and individual.

### *First Year of Teaching*

As explained in Chapter Five, if prior learning experiences were an accurate indicator of expected teaching practices, Sonia should have taught with a reformed method and Riley with a mix of more traditional and reformed methods. Essentially, they practiced what they learned and learned by practicing (Ball, 1989; Ball & Cohen, 1999; Grossman, 1990; Wideen et al., 1998). For the most part, this appeared to be relevant in the two cases. However, findings from classroom observations confirmed that it is not easy to categorize teaching practices as reformed or traditional when there is overlap in

teaching strategies. There are complex thought processes that occur as these experiences are shaped by each other to influence both beliefs and practice. Riley and Sonia both attempted to provide meaningful learning opportunities for pupils and could continue improving upon their practices with continued support. They were both reflective about their teaching practices. However, observations showed that their mathematical content knowledge was not in depth, because they struggled to scaffold pupils' mathematical knowledge and made some mathematical errors when they taught. It was also challenging to compare Sonia and Riley's teaching practices because they had very different initial characteristics, field experiences, and first-year school contexts.

One classroom factor that affected teaching practices was classroom management. Riley appeared to have greater command of her fourth grade classroom and experienced minimal disruptions, which provided pupils more time on task. Sonia often struggled to keep her second graders focused on instructions, make quick transitions, and provide ample time for pupils to complete their work. Differences in student population, school policies, or personal characteristics might have accounted for the differences between Riley and Sonia's styles. However, both stated a desire for a course on classroom management, even though it was anticipated that they would experience such challenges as first-year teachers (Johnson, 2004).

Participants' experiences with varied mathematics curricula as preservice teachers affected how they enacted curricula as first-year teachers. Sonia was only exposed to *Investigations* during her field experience and was required to use the same curriculum during her first year of teaching, rather than learn a new format. Nevertheless, as a first-

year teacher, she still found *Investigations* difficult to implement, especially because she was not familiar with the content expectations at the second grade level. Riley was exposed to cooperating teachers who used both *Everyday Mathematics* and *Harcourt*, which could have validated her use of both curricula as a first-year teacher. Although she had heard criticisms of *Investigations*, she was eager to use it, but quickly realized that it was only used occasionally, with *Scott Foresman* as the primary curricula. However, Riley was more comfortable using *Scott Foresman* because she thought it was easier to implement. At the end of their first year of teaching, both participants felt greater confidence with their knowledge of the mathematics curricula. However, they both felt that additional preparation with curricular materials as preservice and beginning teachers would have been beneficial. As part of their initial orientation to their schools, Riley and Sonia had been given brief overviews of the curricula, but neither felt such overviews to be sufficient.

Curricula have often been used as a catalyst for reformed teaching practices (Ball & Cohen, 1996; Collopy, 2003), and this study supports a similar finding. The curricula used by the teachers were consistent with their beliefs and how they taught on a range varying from reformed to traditional classroom practice. Hart (2001) found that although beginning teachers struggled to maintain reformed practices, they still tried to implement strategies they learned as preservice teachers, which appeared to be the case for both Sonia and Riley. However, it was difficult to do so with contextual constraints within schools, such as traditional curricula that did not match individual pedagogical philosophy. This is not to say that teachers should only use reformed curricula; reformed curricula do not

guarantee reformed teaching practices. As found by Remillard and Bryans (2004), teachers can use the same curriculum and demonstrate very different teaching practices.

Another area in which case study participants differed was their classroom assessments, which were both district-mandated. The two assessments Riley and Sonia used were not comparable because there was a difference in grade level, content, and assessment format. It was clear that factors other than the teacher may have been influential, considering that the assessments were district-made. The curriculum and school contexts were very different. Although the assessments were district-made, they still reflected the type of mathematical ideas being taught and learned. In these cases, the RISER showed that Sonia and Riley's assessments were complementary to their teaching practices, their stances toward teaching mathematics, and the environments in which they learned and taught mathematics. For example, Sonia's school district assessment was more authentic than Riley's assessment. Pupils in both classes made gains from the mid-year assessments to the end-of-year assessments. Although the gains of each class were modest, scores moved in a positive direction. The pupil gains were also very close. However, the scores could have been the result of factors other than teaching practices, such as school context, assessment design, and individual pupil ability. It would be inaccurate to suggest that one variable, such as teaching practices, had the greatest impact on pupil learning. Thus, it is important to consider the relationship among a variety of factors and how they influence pupil learning. Clearly, however, teachers do play an important role. The decisions that Riley and Sonia made about their classroom practices had a direct influence on their pupils' learning opportunities.

### *Summary of Interrelated Experiences*

Descriptive statistics from the post-survey clearly showed that more than 80% of participants believed that prior schooling, mathematics methods course, and practicum experiences had a major impact on their future teaching practices. The multiple regression model confirmed that all three variables accounted for a significant proportion of preservice teachers' perceived level of preparation and attitudes towards teaching mathematics. Nevertheless, the three variables combined accounted for only 15% of the desired outcome variable, including preservice teachers' looking forward to teach mathematics and viewing themselves as prepared. Thus, numerous factors beyond those included in the study influence PTs' preparation and attitude about teaching mathematics. Furthermore, the practicum was not a significant factor on its own. When the variable was removed from the model, the prior schooling and mathematics methods course variables accounted for 20% of the variance on the outcome variable. This may have been due in part to the fact that the survey did not take student teaching into consideration, which is often viewed as a more authentic experience because preservice teachers are in the classroom full-time. Practicum experiences can often range in the learning opportunities they provide for preservice teachers, especially when PTs are only required to visit the classroom one day a week (Ebbby, 2000). The three components of the conceptual framework, including prior schooling, the mathematics methods course, and practicum, are quite important when preparing elementary teachers to teach mathematics.

Results from the case studies show that additional factors influence perceptions and teaching practices after graduation. During the first year of teaching, school contexts, curricula, classroom management, and mathematical knowledge can influence teaching practices and pupil learning. Thus, first-year teachers must be provided with continual support as they develop their teaching practices. The next section presents implications for improving teacher education for preservice and beginning elementary school teachers in the area of mathematics.

### Conclusions & Implications

Operating within a sociocultural theory framework, this study viewed the process of learning to teach as complex and multi-layered. Teaching is shaped by values, prior knowledge, cultural ideas, and social exchanges; it evolves with varying experiences within multiple environments. Thus, the conclusions of this study were based on these assumptions and findings from the surveys and case studies. Implications were made about teacher education experiences and how they improve teacher learning, practices, and pupil learning.

*Building upon Prior Knowledge and Experiences.* Preservice teachers' prior schooling influences their attitudes towards mathematics and perceptions of the teaching and learning of mathematics. Thus, it is important that teacher educators learn about PTs' entering attitudes and perceptions in order to create learning experiences that connect their prior knowledge to new ideas. Although several scholars have argued that beginning teachers' socialization into teaching takes place when they are students, empirical work has not adequately researched the influence that past experiences have on preservice

teachers (Ball, 1989; Feiman-Nemser, 1983; Grossman, 1990; Lortie, 1975; Wideen et al., 1998). This study explored that issue as it pertains to mathematics teacher education. Initial attitudes and perceptions, such as those of Riley and Sonia, need to be taken into consideration by teacher educators. Considering a sociocultural framework in her research with preservice and beginning teachers, Goos (2005) examined how pedagogical identities develop. She claimed that it is the responsibility of teacher educators to engage preservice teachers in worthwhile and authentic activities that help them to bridge their own personal factors with contextual factors to adopt and practice the desired pedagogy.

For instance, mathematics methods professors can learn more about preservice teachers by fostering a reflection of prior schooling experiences through a critical autobiography. Ellsworth and Buss (2000) examined preservice teachers' attitudes towards mathematics by analyzing their autobiographies. They found that "past teaching models" was the most salient theme; preservice teachers commonly reported that their interest in or attitude towards mathematics was positively or negatively affected by past teachers. Like teachers who build upon pupils' prior knowledge to make content more relevant, teacher educators should build upon preservice teachers' existing knowledge when planning course instruction. Before a course learning objective is met, it is important for instructors to assess students' starting points and plan accordingly.

It is particularly important to acknowledge that preservice teachers enter teacher education programs with a wealth of knowledge from their prior schooling. Although in some cases the goal of courses is to change or challenge entering assumptions about the role of teaching, complementary ideas can build upon positive perspectives. For example,

survey results suggest that PTs had an ideological stance in favor of conceptual approaches to teaching mathematics. However, this does not necessarily mean that they will teach in a reformed manner. Riley and Sonia both wanted to incorporate reformed teaching practices, but found the actual practice difficult. Their experiences were also consistent with studies that examined the positive influence mathematics methods courses have on preservice teachers' attitudes towards mathematics (Clift & Brady, 2005; Lubinski & Otto, 2004; McGinnis et al., 1998). Meaningful teacher learning experiences need to foster teachers' belief in a conceptual approach so that it may develop into a teaching practice that emphasizes a conceptual understanding of mathematics. Harkness et al. (2006) suggested that mathematics methods courses should provide opportunities for PTs to engage in meaningful problem solving tasks to make sense of the mathematics and make connections to improve upon their future practices.

*Connecting Methods Courses with Field Experiences.* The interactions between coursework and field placements provided a strong base from which Sonia and Riley developed their roles as mathematics instructors, which was similar to cases explored by Ebby (2000). Riley's experience was similar to a case in which a student teacher was followed during her final year in a teacher education program. Both had field experiences that did not espouse a reformed practice (Eisenhart et al., 1993); both student teachers ultimately enacted a practice that was more procedural than conceptual. The limited experience with reformed teaching in a methods course did not change Riley's perceptions dramatically. Without reinforcing teaching models and experience with teaching for conceptual understanding, it would have been an incredible leap for Riley to



teach with a reformed approach. On the other hand, Sonia's experiences were much more consistent. Her past schooling, field placements, and the methods course had a shared philosophy of reformed teaching, which helped her to understand the whole picture and adopt a conceptual approach to teaching mathematics. When methods courses are more clearly linked to field experiences, preservice teachers can also make stronger connections between theory and practice.

Attaining a balance and close connection between theory and practice in a teacher education program is challenging, yet crucial. Studies have argued that reflecting on one's practice and engaging in meaningful theory-based tasks can better prepare mathematics teachers (Leikin & Levav-Waynberg, 2007; Garcia, Sanchez, & Escudero, 2006). Participants in this study were required to reflect about teaching and assigned readings, but the connections made between their field placements and the course appeared to be more subjective and dependent on the placement and individual. Furthermore, the practicum may not necessarily be focused on mathematics. Preservice elementary school teachers should have a balanced exposure to the different subjects they are required to teach, with particular attention to the proportion of instructional time that is required for each subject. This is of particular importance to graduate level teacher education programs that provide one or two field experiences, whereas undergraduate programs can include three or four different field experiences. Once preservice teachers have graduated, several school and classroom related factors have an influence on their teaching practices, and ongoing support needs to be provided.

*Mathematical Knowledge for Teaching.* Elementary school teachers need to take mathematics courses that help them to understand the mathematical content they are teaching on a deeper level. A growing body of research has shown that teachers need a deep understanding of the mathematical content to better understand the thinking of their pupils and how to guide them (Fennema, Franke, Carpenter, & Carey, 1993). Many scholars in the mathematics education community have agreed that although content knowledge is an important aspect of effective teaching, it is not sufficient (Kilpatrick, Swafford, & Fidell, 2001). Shulman (1987) first acknowledged this as he espoused the importance of “pedagogical content knowledge,” referring to the special nature of subject-knowledge required for teaching. This idea was further examined in studies revealing that elementary school teachers, in particular, lacked fundamental knowledge for teaching mathematics effectively (Ball, 1990; Ma, 1999). Hill, Rowan, and Ball (2005) investigated the various dimensions of mathematical knowledge for teaching (MKT) and tested an instrument developed to measure a teacher’s level of mathematical knowledge for teaching. They found that MKT had a significant difference by its positive influence on pupil achievement.

The dimensions in mathematical knowledge for teaching include knowledge of the content in elementary number and operations, knowledge of the pupils and content, and knowledge of the content in algebra, functions, and patterns (Hill, Ball, & Schilling, 2004). To measure the different dimensions, teachers were expected to analyze alternative algorithms, explain common mathematical rules, and construct concrete models to represent a number or operation. Teachers engaged in these higher level tasks

in the mathematics methods course were better able to understand the content and help their pupils understand concepts. Additionally, Osana, Lacroix, Tucker, and Desrosiers (2006) engaged elementary preservice teachers in problem solving tasks requiring them to categorize various mathematical problems according to their increased levels of cognitive complexity. They found that those who had higher levels of mathematical content knowledge, as determined by standardized test scores, were able to better discern and more clearly categorize nuanced complexities among the different problems. Mathematics methods courses should include problem-based tasks to challenge teachers' own understanding of the content and how they could effectively teach it to pupils. Although Sonia and Riley wanted to teach mathematics effectively and with understanding, they could have been better prepared by experiencing common problem scenarios in elementary school classrooms.

Hill and Lubienski (2007) further compared teachers' levels of mathematical knowledge for teaching in different school contexts and made an argument for greater equity among teachers. They found that teachers in underserved urban schools had lower levels of specialized mathematical knowledge than their counterparts in more affluent schools. This raised an issue of equity and access for pupils in urban schools. Although Sonia and Riley's levels of specialized mathematical knowledge were not tested, Sonia may have had a slightly higher level of content knowledge than Riley, which is encouraging considering their school contexts. However, both teachers could be much more effective with an increase in specialized mathematical knowledge.

Mathematics methods courses can be the start of this specialized knowledge, but there is not enough time in a course to cover all the necessary content. It would also be beneficial for teachers to take a foundational mathematics course where they explore the concepts embedded within mathematical content taught in elementary school grades. For example, Lubinski and Otto (2004) found that a mathematics content course designed to help K-8 preservice teachers develop their mathematical knowledge improved understanding and perceptions of mathematics. School districts need to offer professional development that is focused on mathematical content so that teachers can explore their knowledge and how pupils understand it in greater depth. To ease the multiple subject knowledge demands on elementary school teachers, schools should also consider specialization. There is very little research on elementary school teachers as mathematics specialists. A recent research report discussed the possibility of elementary teachers being prepared to specialize in one subject (Li, 2008). In that report, Li (2008) brought up several important questions about teacher knowledge and preparation by comparing the United States to China. He drew on Liping Ma's (1999) influential study and a recent comparison study where he and other colleagues examined teacher preparation across six school systems in the United States, Mainland China, and South Korea. He found that although mathematics is valued in school systems across all countries, teachers in the two Asian countries were more likely to receive further training in mathematics content and pedagogy. Some school district offer mathematics specialists who support teachers at the elementary school level, while other schools elect a current teacher as a specialist to teach mathematics to a particular grade level (Fennell, 2006). Whatever the existing structure

may be, schools and teacher education programs need to reconsider possible reforms to address teachers' mathematical content knowledge.

*Adopting a Critical Stance.* This study explored how teaching practices reflect a range from traditional to reformed methods. More important, however, is that teachers develop a critical stance towards their own teaching practices (Jaworski, 2006). It is not enough for teachers to be categorized as reform teachers. Classroom practices must be examined in relation to pupil learning and opportunities. It would be ideal for preservice teachers to be placed in classrooms with a model cooperating teacher who espoused teaching practices that develop pupils' conceptual understanding. However, this may not be practical or realistic. Ebby (2000) suggested that traditional field placements can also foster learning when supporting teachers are critical of classroom practices. Some schools of education, including the university in this study, explicitly teach inquiry as a skill and stance (Cochran-Smith & Lytle, 1999), where teachers raise questions about their own classrooms and teaching. To fully prepare preservice teachers for the unexpected, teacher education programs should have a clear mission where professors, directors of field experiences, and supervisors constantly challenge teachers to be reflective and analytical about their own experiences and how they could be effective teachers in a variety of contexts and with a variety of curriculum materials.

*Addressing Classroom Management.* It is important for teacher education programs to address classroom management. If teacher education programs do not require a course on classroom management, strategies to help prepare preservice teachers for classroom management issues must be integrated within a student teaching seminar

and throughout the methods courses. Sonia and Riley both stated that they would have liked a course on classroom management. In Riley's case, her school provided new teachers with professional development focused on a particular classroom management system, which appeared to work well for her classroom. Sonia, who was not provided with additional support, was often overwhelmed by classroom management issues that interfered with instruction. Recently, Pianta, Belsky, Vandergrift, Houts, and Morrison (2008) examined factors that influence pupils' learning trajectories in mathematics and reading. They found that greater exposure to mathematics instruction had an influence on learning. When teachers establish a learning environment with effective classroom management, more time is focused on instruction.

*Curriculum Factors.* Teachers need to be critical of their teaching practices and their use of curricular materials. Although reformed curricula can change teaching practices, ongoing professional development that targets teachers' beliefs is necessary to foster change and sustain reformed teaching practices (Collopy, 2003). Requiring teachers to use reformed curricula does not necessarily mean that they will teach with a reformed approach, nor does it mean that they will help pupils develop a conceptual understanding of mathematics. Teaching and enacting curriculum is clearly a non-linear multi-layered complex process. It is also easy for beginning teachers to fall into a routine; thus, having ongoing professional development that connects to the classroom and raises questions about practices is essential for beginning teachers.

School contexts and curricula are never going to be ideal; therefore, preservice teachers should be prepared to work within the system to improve and change the

conditions. One way of encouraging this behavior is to focus on pupil learning. Teachers are often the best judges of their own pupils' needs. If they strive to improve their own teaching and school conditions while keeping their pupils in mind, teachers can develop a habit of constant learning and growth.

*Pupil Learning.* Assessments need to continually inform teaching practices to meet the learning needs of pupils. Like teaching practices, pupil learning cannot necessarily be predicted based on the use of specific curricula. Although large scale studies suggest that pupils taught with a reformed curricula do just as well or better on standardized tests as pupils who are taught with traditional curricula (Klein et al., 2000; Le et al., 2006; Senk & Thompson, 2003), several of the studies do not directly look at classroom teaching practices. However, the quality of classroom tasks, which are often developed by curricula, can reflect the type of knowledge that is valued in mathematics, whether it be more conceptual or procedural. Several studies that have indirectly analyzed teaching practices by examining teachers' lesson plans, assessment tasks, and pupil work (Newmann, et al, 2001; Stecher et al., 2006) found that analyses of teaching artifacts were valid indicators of teachers' level of reformed teaching practices.

*School Context Matters.* A pervasive finding from the experiences of these teachers illustrated the central role that school demographics, support, and classroom contextual factors play. Specifically, the two cases indicated that the school demographics, mathematics curricula, and classroom management influenced how and what mathematics was taught and learned. Studies have repeatedly shown that resources vary greatly between urban and suburban schools (Berliner, 2005; Ingersoll, 2004).

Teachers in urban schools tend to have less parental support and fewer financial and physical resources. In these cases, Riley had greater access to resources and technology, while Sonia was expected to translate her mathematics curriculum from English to Spanish for her bilingual pupils. Additionally, the populations of students in their classrooms were racially, linguistically, and economically different. Both participants worked diligently to meet the range of learning needs in their classrooms. If Riley and Sonia were offered professional development in mathematics, the teacher educator and/or coordinator would need to take their differing school contexts and student populations into consideration. As Loucks-Horsley, Love, Stiles, Mundry, and Hewson. (2003, p. 53) suggest, “Professional development does not come in one-size-fits-all. It needs to be tailored to fit the context in which teachers teach and their students learn.” On a similar note, no single study has captured every aspect of the process of learning to teach, including this dissertation. In the next section, I discuss limitations of this inquiry.

#### Limitations of Study

In this dissertation, my goal was to implement a comprehensive study with a longitudinal and multiple-method design; nevertheless, there were several limitations in the design. One limitation of the study was the small number of cases, which do not account for a wider range of experiences. Although Riley and Sonia’s experiences have possible implications for beginning teachers in similar urban and suburban settings, findings from the two cases cannot be generalized to all preservice and first-year teachers. In addition, the cases captured participants who were in a one-year master’s level teacher education program and did not account for traditional four-year teacher



education programs at the undergraduate level. Although the depth of the cases provided a rich description of two participants' process of learning to teach mathematics, findings are certainly not definitive.

In addition, it would have been valuable to survey the participants from the mathematics methods course one year later when they were in their first year of teaching. The pre- and post-surveys were confined to one semester long mathematics methods course. Based on the factor analysis, the instrument also had room for improvement, as surveys do not fully capture the variables of interest due to self-reporting and restricted Likert-scales. Thus, it is important to keep these issues in mind when thinking about the implications from the survey results. The sample was also restricted to the mathematics methods courses at one university during one semester. It would have been interesting to replicate the surveys the following year and to compare results over time.

The design could have been strengthened by incorporating pupil interviews and baseline mathematics assessments. This was not possible due to time constraints, IRB related issues, and limited resources. Considering the factors discussed above, the research design was sufficiently comprehensive to address the research questions. As it stands, the corpus of data required considerable time to collect and analyze. The goal was to capture the experiences of the participants and provide insight into the field of mathematics teacher education research. The methodology used in this dissertation afforded that opportunity. However, more research is needed in the field of mathematics teacher education. In the next section, I suggest a variety of methods to expand upon this

research, based on questions arising from the dissertation and remaining gaps in the literature.

### Recommendations for Future Research

The aforementioned sections highlight several areas in which future research on mathematics teacher education can be extended. Findings from this study suggested that school context matters. Much of the literature reviewed in Chapter Two did not account for school context. Whether quantitative or qualitative research methods are employed, it is important for the school context to be incorporated as part of a research design. Quantitative studies can do so by including data on school demographics, which are commonly available on school districts' websites. These data can provide an overview of schools' resources, student population, standardized test scores, and possible teacher information (such as the average years of experience). Qualitative studies can take school context into consideration by including questions related to school context in the interview protocol. To have a better understanding of the school context, studies can include observations of faculty meetings, school routines, and analysis of teacher evaluation procedures and curricular materials. Studies that examine questions pertaining to the teaching or learning of mathematics can be strengthened by taking school context into consideration.

Research can also be improved by designing studies that extend beyond the preservice period or first year of teaching. Nuthall (2004) argued that research has failed to bridge the theory-practice gap due to limited studies that do not continually gather in-depth data that track changes in teaching and pupil learning over time. Furthermore, an

international group of mathematics educators, including Adler, Ball, Drainer, Lin, and Novotna (2005), surveyed the research on mathematics teacher education from 1999 to 2003 and concluded that longitudinal studies were necessary to answer complex questions about teaching and learning mathematics. They found that small-scale qualitative studies dominated the field. Whether data collection procedures include surveys, interviews, or observations, research designs should be extended and repeated to capture change over time and long-term effects.

It is important for research to continue examining the type of teacher knowledge needed to teach mathematics effectively at the elementary school level. Research about teachers' mathematical knowledge needs to connect to teaching practices. Future studies should examine various teacher education and professional development programs that offer more in-depth teacher preparation for both preservice and in-service teachers. In addition to preparation, more studies need to compare school structures that have mathematics specialists that serve as coaches at a school to schools that have grade-level specialists that teach mathematics to all pupils in a particular grade level. Although there are several contextual differences within school systems in the United States and other countries, it is important to examine successful teaching models abroad. Examining our own system with a global view can offer critical insights into possible structural changes.

Few studies of teacher learning and education are longitudinal, and even fewer link teachers' learning with pupils' learning (Lubienski 2005; Wilson, Floden, & Ferrini-Mundy, 2001). It is important that research examine pupil learning with a variety of approaches beyond standardized test scores. Some studies now examine teaching artifacts

and pupil work as a way of investigating pupil learning (King, et al, 2001; Stecher et al., 2006). Although some of these methods seem promising, it is important that large samples of comparable pupil work are analyzed. It is also important for classroom observations to be integrated into studies that examine the influence that teaching practices have on pupil learning. Classroom observations can also be made more systematic by using instruments such as the Reformed Teaching Observation Protocol (RTOP), which measures a teachers' level of reformed practice (Sawada, Piburn, Judson, Turley, Falconer, & Benford, et al., 2002). Researchers must consider a variety of methods to examine specific teaching and learning phenomena in authentic settings.

#### Closing Comments

*Teaching is not a lost art, but the regard for it is a lost tradition.* - Jacques Barzun

When teaching is viewed from a distance, details that go into the daily tasks of teaching can be easily overlooked. The time and effort teachers put into meeting the needs of diverse students can be translated into numbers deemed as underperforming without taking context into account. There is a danger in policymakers viewing teaching from afar. From that perspective, the proposed solution might be higher teaching standards or a scripted curriculum that place more pressure on teachers. However, there is also a danger in viewing teaching through a microscope. Educational researchers typically do not enter classrooms with lab coats; and although there may not be physical barriers between an ethnographer and the classroom, there exist unseen barriers between researchers and practitioners. It is not to say that all research should be participatory action research, but I believe that we need to elevate the teaching profession at all levels.

To do so, part of a researcher's responsibility is to seriously consider teacher and student benefits of the inquiry. Although research attempts to include implications for practice, it is important to provide support for participating teachers in which the need may arise. A question I constantly ask myself is, "where does research end and intervention begin?" If we are learning from teachers' experiences, it is important for us to help them learn and provide incentives in return. There ought to be some level of reflexivity between researchers and practitioners to improve the teaching profession. Valuing teachers and having a deep respect for practice is one step toward elevating the profession. In addition, those who work in educational fields need to be able to consider teaching and learning from multiple perspectives when making decisions. Decisions we make about teacher accountability and how we measure student learning send a message to the public about what we value. If teachers are being rewarded rather than reprimanded for their work, they will take greater pride in their profession and have more motivation to continue working hard.

I do not have a solution for the concerns I have raised about the teaching profession, but I believe it is important for educators at all levels to work together to improve teaching and learning conditions in this nation. I also believe that having a deep respect for teachers and helping the public understand the complex nature of teaching is a good place to start.

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APPENDIX A  
DESCRIPTION OF QUALITATIVE CASE STUDIES (QCS) PROJECT AND  
THE CONCEPTUAL FRAMEWORK

### **Qualitative Case Studies (QCS) Project**

The QCS project is a set of longitudinal case studies examining relationships among preservice teachers' entry characteristics; teacher learning in coursework and fieldwork; developing understandings of teaching, pupil learning, and social justice; teaching practices during student teaching and the first year; pupils' learning; and efforts to teach for social justice. Here "teacher learning" is an amalgam of teachers' knowledge, interpretive frameworks, and practice. "Pupils' learning" is defined as academic achievement (assessed through a variety of other formative and summative means) as well as social and emotional development, critical thinking, and development of democratic skills and values.

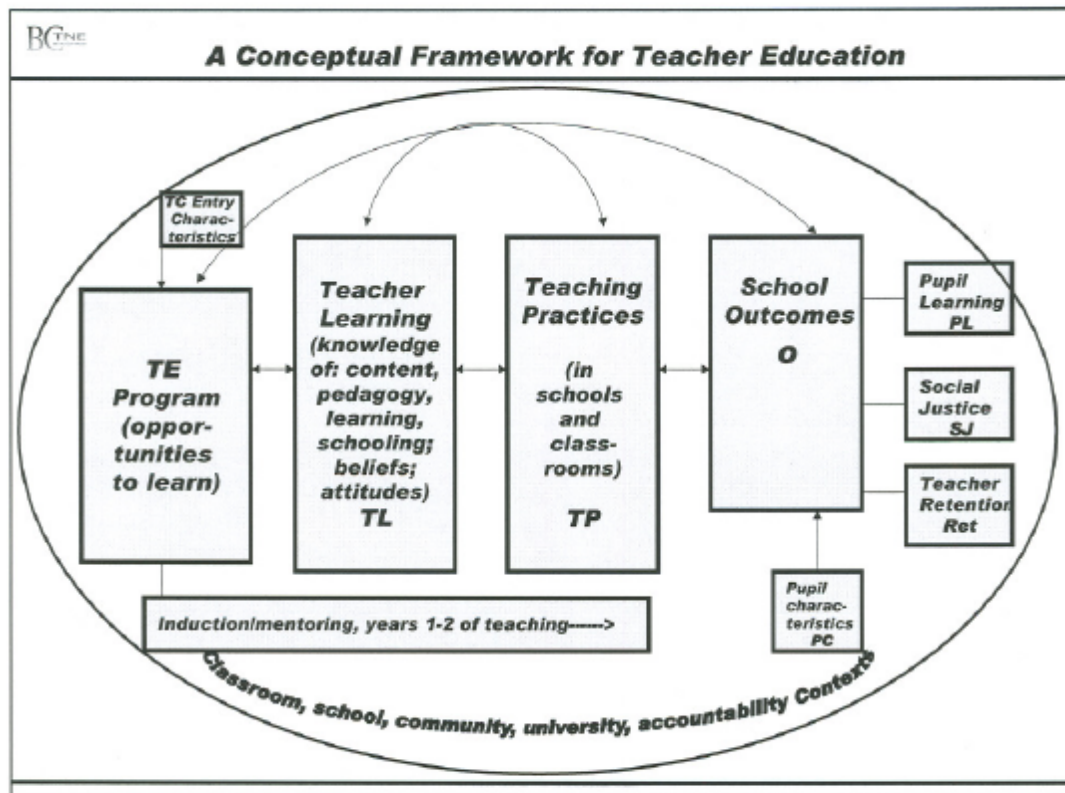
The three-year QCS project uses a staggered research design with the Year 1 design (preservice year) applied to a cohort of 12 preservice teachers across elementary and secondary grades/subjects and repeated with a second cohort of 10 PTs the following year. The Year 2 design (first year teaching) was applied the same way. Data sources for the larger study included interviews, observations in classrooms, and documents and materials representing pupils' and teachers learning.

Data sources for Year 1 included: (a) 6 structured interviews with each preservice teacher; (b) 5 structured observations of PTs' performance during pre-practicum and student teaching, including school demographics and classroom climate, chronology of events, scripting of 2-hour observation blocks, and collection of lesson plans, materials, and samples of pupils' work; (c) interviews with course instructors and supervisors and observations of methods courses; and, (d) collection of PTs' work and program materials.

Data sources for Year 2 include: (a) 3 structured interviews with each new teacher; (b) 4 observations, using the protocol as for Year 1; and, (c) interviews with principals and mentors. In both Year 1 and Year 2, multiple full-class sets of pupil work are collected.

Source:

Cochran-Smith, M., Shakman, K., Jong, C., Terrell, D., and Barnatt, J. (2007, April). *Reclaiming teacher quality : The case for social justice*. Paper presented at American Education Research Association Annual Meeting, 2007. Chicago, IL.



APPENDIX B  
MATHEMATICS EDUCATION SURVEYS

### Mathematics Education Pre-Survey

Using the scale 1=Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree, or 5=Not Applicable (if you absolutely do not know or the item does not apply to you), please respond to the following statements about mathematics.

#### Attitude and Past Experiences

|  | S A | A | D | S D | NA |
|--|-----|---|---|-----|----|
| 1. I like mathematics.   | 1   | 2 | 3 | 4   | 5  |
| 2. I enjoy solving mathematical problems that challenge me to think.   | 1   | 2 | 3 | 4   | 5  |
| 3. I had several positive experiences with mathematics as a K-8 student.   | 1   | 2 | 3 | 4   | 5  |
| 4. I had several positive experiences with mathematics as a 9-12 student.  | 1   | 2 | 3 | 4   | 5  |
| 5. I am proficient in mathematics.   | 1   | 2 | 3 | 4   | 5  |
| 6. Mathematics is one of my favorite subjects.   | 1   | 2 | 3 | 4   | 5  |
| 7. I think mathematics is boring.  | 1   | 2 | 3 | 4   | 5  |
| 8. I have struggled with mathematics as a K-8 student.   | 1   | 2 | 3 | 4   | 5  |
| 9. I have struggled with mathematics as a 9-12 student.  | 1   | 2 | 3 | 4   | 5  |
| 10. I used hands-on materials to learn mathematics in either elementary, middle school, or high school.                    | 1   | 2 | 3 | 4   | 5  |
| 11. The way mathematics is taught today is different from the way I learned it as a K-8 student.                           | 1   | 2 | 3 | 4   | 5  |
| 12. The way mathematics is taught today is different from the way I learned it as a 9-12 student.                          | 1   | 2 | 3 | 4   | 5  |
| 13. As a K-8 student, I mostly learned mathematics in a traditional manner (i.e. textbooks, worksheets, rules, lectures).  | 1   | 2 | 3 | 4   | 5  |
| 14. As a 9-12 student, I mostly learned mathematics in a traditional manner (i.e. textbooks, worksheets, rules, lectures). | 1   | 2 | 3 | 4   | 5  |

#### Teaching and Learning

|   | SA | A | D | SD | N/A |
|---|----|---|---|----|-----|
| 15. I am looking forward to teaching mathematics.   | 1  | 2 | 3 | 4  | 5   |
| 16. It is important to incorporate the use of technologies (e.g. calculators, computers) when teaching mathematics. | 1  | 2 | 3 | 4  | 5   |

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 17. Using mathematics is essential to the every day life of K-12 students.                                | 1 | 2 | 3 | 4 | 5 |
| 18. I want to teach mathematics the same way I learned it.  | 1 | 2 | 3 | 4 | 5 |
| 19. I am confident in my ability to be a good mathematics teacher.  | 1 | 2 | 3 | 4 | 5 |
| 20. I plan to use hands-on materials to help my students learn mathematics and solve problems.            | 1 | 2 | 3 | 4 | 5 |
| 21. Memorizing facts and formulas is essential to learn mathematics.                                      | 1 | 2 | 3 | 4 | 5 |
| 22. I will allow and encourage students to solve mathematical problems in more than one way.              | 1 | 2 | 3 | 4 | 5 |
| 23. I plan on integrating mathematics with different subjects (i.e. science, literature, social studies). | 1 | 2 | 3 | 4 | 5 |
| 24. I am scared of teaching mathematics.  | 1 | 2 | 3 | 4 | 5 |

### Methods course Expectations

| <i>It is important for me to learn...</i>  | SA | A | D | SD | NA |
|--|----|---|---|----|----|
| 25. a variety of instructional strategies.   | 1  | 2 | 3 | 4  | 5  |
| 26. how to use technologies (i.e. calculators, computers) in mathematics classrooms.             | 1  | 2 | 3 | 4  | 5  |
| 27. how students learn mathematics developmentally (i.e. age, grade level).                      | 1  | 2 | 3 | 4  | 5  |
| 28. how to use hands-on materials to teach mathematical concepts.                                | 1  | 2 | 3 | 4  | 5  |
| 29. about national mathematics standards and state frameworks.                                   | 1  | 2 | 3 | 4  | 5  |
| 30. how to teach mathematics to a diverse student population.                                    | 1  | 2 | 3 | 4  | 5  |
| 31. how to assess student learning in mathematics.   | 1  | 2 | 3 | 4  | 5  |
| 32. about the role of standardized tests in mathematics.   | 1  | 2 | 3 | 4  | 5  |
| 33. about different mathematics curriculums used by districts across the nation.                 | 1  | 2 | 3 | 4  | 5  |
| 34. how to manage the mathematics classroom effectively (i.e. behaviors, grouping, transitions). | 1  | 2 | 3 | 4  | 5  |
| 35. how to integrate mathematics with science.   | 1  | 2 | 3 | 4  | 5  |
| 36. how to integrate mathematics with literature.  | 1  | 2 | 3 | 4  | 5  |
| 37. about a variety of mathematics games that can be used in the classroom.                      | 1  | 2 | 3 | 4  | 5  |



### Diverse Learners

|   | SA | A | D | SD | NA |
|---|----|---|---|----|----|
| 38. I am confident in teaching mathematics to high achievers.   | 1  | 2 | 3 | 4  | 5  |
| 39. I am confident in teaching to students who do not have English as their primary language.           | 1  | 2 | 3 | 4  | 5  |
| 40. I am confident in teaching mathematics to students with special needs.                              | 1  | 2 | 3 | 4  | 5  |
| 41. I am confident in teaching mathematics to students of different ethnic/racial/cultural backgrounds. | 1  | 2 | 3 | 4  | 5  |
| 42. Social justice plays an important role in the teaching and learning of mathematics.                 | 1  | 2 | 3 | 4  | 5  |
| 43. Most students (who do not have severe special needs) can be successful at learning mathematics.     | 1  | 2 | 3 | 4  | 5  |
| 44. I am confident in teaching mathematics to students in an Urban school.                              | 1  | 2 | 3 | 4  | 5  |
| 45. I am confident in teaching mathematics to students in a Suburban school.                            | 1  | 2 | 3 | 4  | 5  |
| 46. I am confident in teaching mathematics to students in a Rural school.                               | 1  | 2 | 3 | 4  | 5  |
| 47. Mathematics can help students critically analyze the world.   | 1  | 2 | 3 | 4  | 5  |
| 48. Issues about equity should be addressed in the mathematics classroom.                               | 1  | 2 | 3 | 4  | 5  |

### Background Information

1. Gender: Male \_\_\_\_\_ Female \_\_\_\_\_

2. Degree: \_\_\_\_\_ 3. Current Year:

\_\_\_\_\_

4. Major: \_\_\_\_\_ Minor:

\_\_\_\_\_

5. If you are a Graduate Student, Undergraduate  
Major: \_\_\_\_\_

6. Course Professor: \_\_\_\_\_ Time:

\_\_\_\_\_

7. Number of Math Content Courses Taken at the College Level:

\_\_\_\_\_

8. Future Teaching Plans (check all that apply):

Suburban\_\_\_\_\_ Urban\_\_\_\_\_ Rural\_\_\_\_\_

Public\_\_\_\_\_ Private\_\_\_\_\_ Religious\_\_\_\_\_

Grade(s): \_\_\_\_\_ Subject(s): \_\_\_\_\_

9. Describe your ethnicity.

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10. How long have you (and your family) been in the U.S.A.?

Generation: 1<sup>st</sup> \_\_\_\_\_ 2<sup>nd</sup> \_\_\_\_\_ 3<sup>rd</sup> \_\_\_\_\_ 4+ \_\_\_\_\_

11. Mother's highest level of Education: \_\_\_\_\_

Occupation: \_\_\_\_\_

12. Father's highest level of Education: \_\_\_\_\_

Occupation: \_\_\_\_\_

13. Describe your previous teaching experience (if any).

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*Thank you for completing the survey!!!*

### Mathematics Education Post-Survey

Using the scale 1=Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree, or 5=Not Applicable (if you absolutely do not know or the item does not apply to you), please respond to the following statements about mathematics.

#### Attitude and Practicum Experiences

|  | S A | A | D | S D | NA  |
|--|-----|---|---|-----|-----|
| 1. I like mathematics.   | 1   | 2 | 3 | 4   | n/a |
| 2. I had a positive practicum experience.  | 1   | 2 | 3 | 4   | n/a |
| 3. My cooperating teacher contributed greatly to my knowledge about the teaching and learning of mathematics.    | 1   | 2 | 3 | 4   | n/a |
| 4. My cooperating teacher used a traditional method (i.e. textbooks, lectures, worksheets, rules) to teach math. | 1   | 2 | 3 | 4   | n/a |
| 5. My cooperating teacher used a conceptual method (i.e. problem-solving, open-ended Qs) to teach math.          | 1   | 2 | 3 | 4   | n/a |
| 6. The math curriculum used in my practicum focused on teaching math in a conceptual manner.                     | 1   | 2 | 3 | 4   | n/a |
| 7. The math curriculum used in my practicum focused on teaching math in a traditional manner.                    | 1   | 2 | 3 | 4   | n/a |
| 8. My practicum experience connected to my math methods course.  | 1   | 2 | 3 | 4   | n/a |
| 9. My practicum experience reinforced what I learned in my math methods course.                                  | 1   | 2 | 3 | 4   | n/a |
| 10. My practicum placement had a diverse student population.   | 1   | 2 | 3 | 4   | n/a |
| 11. I think math is boring.  | 1   | 2 | 3 | 4   | n/a |

#### Teaching and Learning

|  | SA | A | D | SD | NA  |
|--|----|---|---|----|-----|
| 12. I am looking forward to teaching mathematics.  | 1  | 2 | 3 | 4  | n/a |
| 13. I plan on incorporating the use of technologies (e.g. calculators, computers, software) when teaching mathematics. | 1  | 2 | 3 | 4  | n/a |
| 14. I plan on teaching math in a procedural way (facts, skills, etc...).   | 1  | 2 | 3 | 4  | n/a |
| 15. I plan on teaching math in a conceptual way (for understanding, problem-solving).                                  | 1  | 2 | 3 | 4  | n/a |
| 16. I am confident in my ability to be a good mathematics teacher.   | 1  | 2 | 3 | 4  | n/a |

|  |   |   |   |   |     |
|--|---|---|---|---|-----|
|  |   |   |   |   |     |
| 17. I plan to use manipulatives (hands-on materials) to help my students learn mathematics and solve problems. | 1 | 2 | 3 | 4 | n/a |
| 18. I will require my students to memorize mathematical facts and formulas.                                    | 1 | 2 | 3 | 4 | n/a |
| 19. I will allow and encourage students to solve math problems in more than one way.                           | 1 | 2 | 3 | 4 | n/a |
| 20. I plan on integrating mathematics with different subjects (i.e. science, literature, social studies).      | 1 | 2 | 3 | 4 | n/a |
| 21. I am scared of teaching mathematics.   | 1 | 2 | 3 | 4 | n/a |
| 22. I am prepared to teach mathematics.  | 1 | 2 | 3 | 4 | n/a |

### Methods Course Evaluation

| <i>The math methods course taught me...</i>  | SA | A | D | SD | NA  |
|--|----|---|---|----|-----|
| 23. a variety of instructional strategies.   | 1  | 2 | 3 | 4  | n/a |
| 24. how to use technologies (i.e. calculators, computers) in mathematics classrooms.             | 1  | 2 | 3 | 4  | n/a |
| 25. how students learn mathematics developmentally (i.e. age, grade level).                      | 1  | 2 | 3 | 4  | n/a |
| 26. how to use manipulatives (hands-on materials) to teach mathematical concepts.                | 1  | 2 | 3 | 4  | n/a |
| 27. about national mathematics standards and state frameworks.                                   | 1  | 2 | 3 | 4  | n/a |
| 28. how to teach mathematics to a diverse student population.                                    | 1  | 2 | 3 | 4  | n/a |
| 29. how to assess student learning in mathematics.   | 1  | 2 | 3 | 4  | n/a |
| 30. about the role of standardized tests in mathematics.   | 1  | 2 | 3 | 4  | n/a |
| 31. about different mathematics curriculums used by districts across the nation.                 | 1  | 2 | 3 | 4  | n/a |
| 32. how to manage the mathematics classroom effectively (i.e. behaviors, grouping, transitions). | 1  | 2 | 3 | 4  | n/a |
| 33. how to integrate mathematics with science.   | 1  | 2 | 3 | 4  | n/a |
| 34. how to integrate mathematics with literature.  | 1  | 2 | 3 | 4  | n/a |
| 35. about a variety of mathematics games that can be used in the classroom.                      | 1  | 2 | 3 | 4  | n/a |
| 36. theories about the teaching and learning of mathematics.                                     | 1  | 2 | 3 | 4  | n/a |

### Diverse Learners

|   | SA | A | D | SD | NA  |
|---|----|---|---|----|-----|
| 37. I am confident in teaching mathematics to high achievers.   | 1  | 2 | 3 | 4  | n/a |
| 38. I am confident in teaching to students who do not have English as their primary language.           | 1  | 2 | 3 | 4  | n/a |
| 39. I am confident in teaching mathematics to students with special needs.                              | 1  | 2 | 3 | 4  | n/a |
| 40. I am confident in teaching mathematics to students of different ethnic/racial/cultural backgrounds. | 1  | 2 | 3 | 4  | n/a |
| 41. I think social justice plays an important role in the teaching and learning of mathematics.         | 1  | 2 | 3 | 4  | n/a |
| 42. I am confident in teaching mathematics to students in an Urban school.                              | 1  | 2 | 3 | 4  | n/a |
| 43. I am confident in teaching mathematics to students in a Suburban school.                            | 1  | 2 | 3 | 4  | n/a |
| 44. I think issues about equity should be addressed in the mathematics classroom.                       | 1  | 2 | 3 | 4  | n/a |

### Future Teaching

*The following will have a major impact on the way I teach mathematics in the future:*

|                                     | SA | A | D | SD | NA  |
|-------------------------------------|----|---|---|----|-----|
| 45. My past K-8 school experiences  | 1  | 2 | 3 | 4  | n/a |
| 46. My past 9-12 school experiences | 1  | 2 | 3 | 4  | n/a |
| 47. Practicum experiences           | 1  | 2 | 3 | 4  | n/a |
| 48. Math methods course             | 1  | 2 | 3 | 4  | n/a |

### Background Information

#### Practicum

1. Grade level: \_\_\_\_\_

Secondary, please specify content area(s) \_\_\_\_\_

2. Setting: Urban \_\_\_\_\_ Suburban \_\_\_\_\_

3. Public \_\_\_\_\_ Private (religious) \_\_\_\_\_ Private (non-religious) \_\_\_\_\_

4. Math Curriculum used by Cooperating Teacher

\_\_\_\_\_

5. Are you a Donovan student? Yes \_\_\_\_\_ No \_\_\_\_\_

*Thank you for completing the survey!!!*

APPENDIX C  
FACTOR ANALYSIS

### Mathematics Education Pre-Survey Factor Analysis

| Survey Items   | Factor Reliability<br>(Cronbach's Alpha) | Factors (7)          |
|--|--|----------------------|
| 1. I like math.<br>2. Enjoy solving math problems, thinking<br>3. Positive experiences with math in K-8<br>4. Positive experiences with math in 9-12<br>5. I am proficient in math.<br>6. Math is one of my favorite subjects.<br>15. I look forward to teaching math.   | .912                                     | Math Attitude        |
| 7. I think math is boring.<br>8. I have struggled with math in K-8.<br>9. I have struggled with math in 9-12.<br>24. I am scared of teaching math.   | .780                                     | Negative Experiences |
| 11. Math today is different from my K-8<br>12. Math today is different from my 9-12<br>13. As a K-8, I learned traditional math<br>14. As a 9-12, I learned traditional math<br>21. Memorizing facts and formulas is essential   | .612                                     | Procedural Math      |
| 16. It's important to use technology w/math<br>17. Math is essential to life of K-12 pupils<br>20. I plan to use hands-on materials<br>22. I will encourage pupils to solve in many ways<br>23. I plan to integrate math w/other subjects  | .662                                     | Conceptual Math      |
| 25. variety of instructional strategies<br>26. how to use technologies<br>27. how pupils learn math developmentally<br>28. how to use hands-on materials<br>29. national math standards & state framework<br>30. how to teach to diverse population<br>31. how to assess pupil learning<br>32. role of standardized tests<br>33. math curriculum used across nation<br>34. math class management<br>35. integrate math with science<br>36. integrate math with literature<br>37. variety of math games | .921                                     | Course Expectations  |
| 19. I am confident in my ability to teach math.<br>38. confident to teach high achievers<br>39. confident to teach ELLs<br>40. confident to teach SPED<br>41. confident, different race/culture<br>44. confident, urban<br>45. confident, suburban<br>46. confident, rural   | .879                                     | Confidence to Teach  |
| 42. social justice important to teach & learn<br>43. most students can be successful in math<br>47. math, help pupils critically analyze world<br>48. equity issues addressed  | .648                                     | Social Justice       |
| 10. I used hands-on materials as K-12<br>18. I want to teach math same way I learned it.   | n/a                                      | n/a                  |



APPENDIX D  
INTERVIEW PROTOCOL

## Interview 1 - Personal History and Education Experience

### **Background: Educational experience**

Let's begin our conversation by talking about what brings you here to BC.

1. Why did you choose BC for graduate school? What do you hope to learn about teaching while you are here?

**Probe:** What are your expectations for the program and learning environment at BC? What do you think the program will offer?

**Probe:** How long has it been since you graduated from undergraduate college? What have you been doing since graduating?

2. Describe your college education? Where did you go? Why? What was your major in college? Why?

**Probe:** What incidents or experiences stand out during your college years? For example, were you active on student organizations or political activities on campus?

**Probe:** Did you work through college and/or did you have financial aid?

3. Describe your past school experiences.

A. Let's start with your secondary school experience.

**Probe** for context—was it a small or large school; an urban or suburban, parochial—single sex? Would you say it was diverse? If so, how?

**Probe:** What was the school like at the time you were there? For example, some people were in school during times of major change, such as during school integration, the merging of two high schools, or witnessing a shift in population in community, leading to increased diversity in the school, OR there were also some local changes such as a new teacher or administrator, a different tracking or grouping system, or a change in courses.

B. Now tell me about your elementary school experience.

**Probe** for context—was it a small or large school; an urban or suburban, parochial—single sex? Would you say it was diverse? If so, how?

**Probe:** Again, what was the school like at the time you were there?

4. How did you experience school as a student?

**Probe** for their experiences as learners-- So if an individual responds about the social aspects of schooling, ask them how they experienced school as learners?

**Probe:** What was your most memorable experience? Were you involved in extracurricular activities? If so, what type of activities were you involved in?

5. Now, I want to switch topics a bit to talk about what brings you to teaching. When did you first start thinking you might want to teach? Why are you interested in teaching?

**Probe:** Did you consider becoming a teacher while you were an undergrad? Why or why not?

**Probe:** for their intellectual interests and the perspective they hold as a student. For instance, many of the elementary candidates mention their love of reading and children. Try also to discover what the person especially enjoys about school or about learning.

6. You're planning to teach \_\_\_\_\_ (elementary or high school) is that right? When you think back to your own experience in \_\_\_\_\_ (elementary or high school), what stands out to you?

**Probe:** for specificity: What do you mean? Can you give me an example of that? Is there anything else you remember?

If the teacher candidate does not mention one of the following: You haven't mentioned (much about) \_\_\_\_\_. Do you remember anything in particular about that?"

- what you learned
- your teachers
- how you felt about different subjects

**Probe (Elementary folks):** How do you think an individual best learns to read or to write?

**Probe (Secondary folks):** How do you think an individual best learns \_\_\_\_\_ (history, English, science, math)?

**Probe:** Do you think you received a good education? Why or why not?

**Background: Beliefs:**

7. A part of our research focuses on individuals' ideas, beliefs and experience as they relate to teaching and learning. At BC, one of the stated purposes is to prepare individuals to teach for social justice. What does that mean to you?

**Probe A:** If teacher candidate says that he/she does not know what teaching for social justice is, move on to question 9.

**Probe B:** If teacher candidate gives an answer to the social justice question, ask: So, how do you think that plays out in \_\_\_\_\_ (reading or math: elementary folks) or (history, English, or science: high school folks)?

8. As you think about your future profession, what do you believe is/are the role(s) of the teacher?

**Probe:** Think of a teacher you have known. Are there things you admired about this teacher? Things you would like to have changed?

**Probe:** From your perspective, what are the top two or three challenges that teachers face today?

**Background: Knowledge**

9. Now, think about the content areas you will be teaching as an elementary or high school teacher. What do you think are your strengths and weaknesses in the content area(s) you might have to teach?

**Probe:** What are you hoping the BC program will provide in terms of your preparation? (**Note:** This can focus on fears and concerns if it hasn't been covered OR it can be skipped if it was thoroughly discussed.)

**Probe:** Now think about the range of things a teacher does. What might be your strengths? What areas might you need support?

**Background: Practice (Future plans)**

10. What are you looking forward to in your Student Teaching Practicum? Is there anything you are concerned about? What challenges do you think you will face?

**Probe:** How will you prepare yourself for these challenges?

11. When you think about next year, where do you see yourself working?  
Where would you like to teach?

**Probe:** Talk to me about what you hope your classroom will be like? How will you teach? What will your relationships with students, faculty, and parents look like?

12. In conclusion, we'd like to get some information about your background, especially your demographics. (**Note:** Make references to prior responses to pull pieces together. Continue probing so we don't receive a mere list.)

**Probe:** For example: your age, race, ethnicity, cultural background, language, religion and political orientation?

**Closing Remarks:**

Is there anything else you'd like to share that we didn't cover?

(Thank the participant!)

## **Interview 2 - Pre-practicum Experience**

The focus of this interview is on your pre-practicum experience. We will meet again in January to talk more about your coursework at BC in the first semester. For this interview, I would like to learn about how your pre-practicum went, what you learned, what you struggled with, what impact the experience has had on your ideas about teaching, etc.

### **Practicum Experiences**

1. Let's talk about your practicum. Describe a typical day at your practicum.

**Probe:** How have you found the structure of the pre-practicum?

**Probe:** What is your role in the classroom?

**Probe:** What is the school environment and community like?

**Probe:** Is the environment different from other places where you've been a student or volunteer/aide?

**Probe:** Do you observe teachers teaching in all subject areas (for elementary)?

2. Tell me about your Cooperating Teacher? (Age, Race, Ethnicity, years teaching, teaching style, etc.) What is the role of the cooperating teacher in shaping your practice and philosophy?

**Probe:** Would you describe a particular lesson you observed that was note worthy? Why?

**Probe:** How do you think your CT knows what to do next?

**Probe:** How do you think your CT knows if the kids are learning?

**Probe:** What types of classroom assessments does your CT use? Formative/summative? In what ways do assessments reflect the instruction?

**Probe:** Every teacher has strengths and weaknesses; can you tell me about those with regard to your Cooperating Teacher? Are there things you have observed and would do/wouldn't do? (specific content areas)

**Probe:** Do you and your Cooperating Teacher have similar teaching philosophies? Explain. (N.B. You want to understand what the teacher candidate's teaching philosophy is—skip if you have gotten at this in Question 2)

**Probe:** Do you think your Cooperating Teacher has the same ideas about teaching and learning as your BC Professors? Why or why not? Do you consider this a problem?

**Probe:** What advice have you gotten from your Cooperating Teacher? How has your Cooperating Teacher helped you in understanding teaching? How has he/she helped your understanding of pupil learning?

**3. OK, let's move from your CT to your Supervisor; tell me about your Supervisor? (Age, Race, Ethnicity, years teaching, teaching style, etc.) What is the role of the Supervisor in shaping your practice and philosophy?**

**Probe:** What advice have you gotten from your Supervisor? How has he/she helped you in understanding teaching? How has he/she helped your understanding of pupil learning?

**Probe:** What would you say are your Supervisor's strengths and weaknesses?

**Probe:** Do you and your Supervisor have similar teaching philosophies? Explain.

**Probe:** Do you think your Supervisor has similar ideas about teaching and learning as your BC Professors? Why or why not? Do you consider this a problem?

**Probe:** So, I understand that all of the pre-pracs in this school meet together with the supervisor at the school once a week? How's that been?

**4. So we've talked about all the grown-ups...the other important people here are the kids. Tell me about the Students in the classroom?**

**Probe:** **What is their role in shaping your practice and philosophy? (Ask about the child study pupil if relevant)**

**Probe:** Diversity (ELLs, SPED, SES, Ethnicity)? How would you describe their experience in school? Do they enjoy it? Why or why not?  
If elementary: How is the weekly read aloud going with your ELL pupil?

**Probe:** Tell me about the lessons you taught. How did they go? What did you learn? (Insert here a question about something you observed in a classroom. For example, a unique method, approach, visual aide).

**Probe:** **Some people say the most important thing about any lesson is whether the kids are learning. What do you think they learned? How do you know?**

**Probe:** **What are you learning about how children learn? How does this influence your perspective on the role of a teacher?**

**Probe:** Can you describe a particular learning moment you observed that was note worthy? Why?

**Probe:** What advice have you gotten from your pupils? How have the pupils helped you in understanding teaching? How have they helped your understanding of pupil learning?

### **Overall Questions**

5. Have you observed examples of teaching for social justice in your pre-practicum experience? Please describe them.

6. Are you making connections between what you're learning at BC and what you're experiencing in your practicum?

7. Based on your pre-prac experience, what would you say are the most important skills and knowledge for teaching?

8. How have your practicum experiences thus far influenced your ideas about teaching?

**Probe:** Based on the practicum, have you changed your plans on where and how you'd like to teach? Explain.



### Interview 3 2005 Summer & Fall Courses

**Please fill table before interview.**

| Methods Courses | Foundations Courses | Content Courses |
|-----------------|---------------------|-----------------|
|                 |                     |                 |
|                 |                     |                 |
|                 |                     |                 |
|                 |                     |                 |
|                 |                     |                 |
|                 |                     |                 |

Last time we met we focused on your pre-practicum experience. Today's topic is your coursework so far at BC.

#### **General Course Experiences**

1. Generally, how have your courses gone so far?

**Probe:** What have you enjoyed about these courses so far?  
Have there been any surprises?"

**Probe:** Can you give me some examples of anything that has been particularly interesting or helpful?

2. Foundations courses are generally used to give people the broad overviews of learning and schooling: broader contexts of children, schooling, and curriculum. Did you find the courses to be valuable in terms of providing that? In what ways? (Specify what courses we are referring to)

**Probe:** Do you think the foundations courses helped you understand the realities of schools today?

3. Methods courses are intended to prepare you to gain strategies to teach specific subjects. What skills and knowledge did you acquire from your methods courses? (Examples?)

**Probe:** Did they meet your expectations? If not, how might they have better met your expectations?

**Probe:** Some people say the most important thing to learn is classroom management. Do you agree?

**Probe:** How did the methods courses help your knowledge of the content?

**Probe:** Often a lesson in a methods class will demonstrate a teaching strategy which also includes content material. Did these "model lessons" increase your understanding about

the content (e.g., looked at content from new perspective, etc)? Were they equally helpful for both strategy and content?

**Elementary**—How did the methods courses relate to each other? (e.g. math, science, literacy, and social studies)

**Secondary**—Have you taken any courses in Arts & Science? Was the course valuable to you in terms of pedagogy, broadening content knowledge, curriculum, and assessment?

**Probe:** What have you learned about bilingual students? Students with special needs?

**4. Now let's talk about the teaching in the methods course? How would you characterize your methods professors' approaches to teaching?**

**Probe** Do you think they modeled the kind of teaching they advocated (practiced what they preached)?

**Probe:** Do you think the faculty structured their courses around the realities of schools today?

**Probe:** Did the methods faculty explicitly address issues of social justice? If so, how?

**Probe:** What did you learn about pupil learning? (ways of learning, etc...)

**Probe:** What did you learn about assessment? (ongoing/formative & high-stakes; pupil learning)

5. You said you were hoping to learn about \_\_\_\_\_, has that been the case? Are there any gaps that remain in your coursework?

### Overall Questions

6. Are you making connections between what you're learning at BC (methods, & foundation courses) and what you experienced in your pre-practicum? How? Examples?

7. When we first talked in the summer, I asked you a question about your definition of teaching for social justice. How do you see it now? Has your definition changed? If so, why?

## **Interview 4 with Participants: Full-Practicum Experience**

### **1. Let's talk about your practicum.**

**Probe:** What's the school environment and community like?

**Probe:** What pressures and issues do teachers face in the school? What pressures do students face? (e.g. test scores, safety, race issues, etc.)

**Probe:** How are student teachers viewed? What's your relationship to other colleagues in the school?

**Probe:** How have things changed from your pre-practicum? (if relevant)

### **2. What's your role in the classroom?**

**Probe:** How much teaching have you done so far? What have you been teaching? What haven't you been teaching?

**Probe:** Do you have any other responsibilities? How much freedom have you had in what and how you teach?

**Probe:** How are you approaching planning? Are you co-planning?

### **Only if the participant has a new CT:**

### **3. Tell me about your cooperating teacher? (race, age, ethnicity, years teaching, teaching style, etc.)**

**Probe:** What are you learning from her/him?

**Probe:** How do you think your cooperating teacher knows students are learning?

**Probe:** What types of assessments does your cooperating teacher use (formative, summative)?

**Probe:** In what ways do assessments reflect the instruction?

**Probe:** Do you and your CT have similar teaching philosophies?

**Probe:** Do you think your CT has the same ideas about teaching and learning as your BC professors? Why/why not? Do you consider this a problem?

**Probe:** Has your CT helped you improve social justice and/or equity in your teaching?

### **4. Tell me about your clinical faculty supervisor? Is s/he different from the person you had for your pre-practicum (race, age, ethnicity, years teaching, teaching style, etc.)?**

**Probe:** What role is your supervisor playing in your practicum experience? (mediator, moral support, academic advice and content support)

**Probe:** What does your supervisor focus on in her observations and feedback? (*if nothing, remember to ask about classroom management?*)

**Probe:** Has s/he helped you provide strong academic content?

**Probe:** How has s/he helped you help pupils to learn?

**Probe:** Has your supervisor helped you improve social justice and/or equity in your teaching?

**Probe:** Do you and your supervisor have the same approach to teaching practices?

**Probe:** Do you think your supervisor has the same ideas about teaching and learning as your BC professors? Why/why not? Do you consider this a problem?

**Probe:** I understand that the BC full practicum students in this school meet as a group with the supervisor once a week. How has that gone? What kinds of issues have you discussed?

**Probe:** What are the other ways that you and your supervisor communicate about the classroom teaching experience? (*ask this if it's not touched on earlier in the interview*)

5. We've talked about the adults; the other important people are the kids. Tell me about the students in your classroom(s).

**Probe:** What are you learning from the students about being a teacher?

**Probe:** What is the diversity in the classroom? (ELLs, SpEd, Ethnicity?) What's that have to do with what and how you teach?

**Probe:** How do you think the kids in your classroom would describe their experience in the school?

**Probe:** How has your relationship changed with the kids over the course of the year?

**Probe:** In general, do you think the kids in the classroom are learning? What evidence do you have that they're learning?

**Probe:** Now, let's talk about your teaching in relation to the students. I noticed that you.... (Insert something here that you noticed from their classroom: about a particular student, a group of students, a unique method, etc.)

6. In your own classroom and in the school, either in what you are doing or what the teachers are doing, do you see examples of teaching for social justice? In your own teaching, how are you addressing issues of equity and justice?

## Interview 5 - Pupil Learning

*NOTE: Teacher Candidate needs to bring three sets of pupil work: a full class set of a cumulative assignment and two examples of tasks that led up to it. TCs also need to pick out one high, one medium, and one low example of pupil performance for the cumulative assignment. Finally, have the teacher candidate bring any rubrics she or he used to score these assignments, as well as any assignment description that the TC gave to the pupils.*

**The purpose of this interview is to see what you are thinking about pupil learning and how it relates to your own instruction. First, I will ask you a series of general questions about the assignments you brought, then we'll get into the specific student examples you have selected as high, medium, and low. Finally, I'll ask you talk about your inquiry project.**

1. First, let's take a look at the assignments you brought. As a way to walk me through this work, it might be helpful for you to start at the end with the cumulative project and work backwards. Or you might want to start with the first task and move chronologically to the end, the cumulative task.

Probe: How does it fit into a larger unit?

Probe: Was this something you devised yourself?

Probe: Was any part of this lesson from a preexisting lesson that you adapted?

Probe: Why did you decide this lesson/assignment/assessment would be appropriate?  
How much autonomy did you have in creating the lesson or assignment?

2. What did you want students to get out of this activity? How do you know whether or not students accomplished what you wanted them to get out of this activity/lesson/unit?

Probe: How did you evaluate these assignments (rubric, scoring, etc.)?

3. Is there anything you would change about this lesson or assignment or unit? What? Why?

4. Let's now look at your examples of a high, a medium, and a low-level response? Why did you choose these three examples? Tell me about the students who did this work (ELL, Special Ed, anything else?).

Probe: How do these samples compare to the overall class? (Is this work representative of the class? Is this what you expected?)

### ***General Pupil Learning Ideas***

5. What do you do to address the range of abilities in your classroom?

6. How do you know if your pupils are learning? What counts as evidence for learning?

7. Of course, teachers are not just interested in their pupils' academic learning; they are also very interested in their social and emotional development. Do you see your students making progress socially and emotionally? Like what?

Probe: How do you know if pupils are making this kind of progress?

8. Are you able maintain high expectations when the pupils have a variety of learning styles and needs? If so, how? If not, why?

### ***The Inquiry Project***

10. What was your Inquiry Question? What did you collect as data for your question?

11. What important insights did you get from your inquiry project concerning pupil learning?

Probe: While doing your inquiry project, what surprised you about students' learning?

Probe: How will the results of your inquiry project influence your practice as a teacher?

12. What would you categorize as social justice insights? Why?

Probe: How will you incorporate these insights into your own teaching?

13. While it is unlikely you would jump right into an inquiry project as you start your first year of teaching, what inquiry skills do you imagine using in your classroom practice?

Probe: Do you see yourself doing a formal inquiry project again in the future?

## **Interview 6 – End of Teacher Education**

**This is our last interview for the year, so it will include an overview of what you have learned through the year and the influences that have been most significant. We will also talk about your future plans and then, at the end of the interview, give you an opportunity to provide us with some feedback about the program.**

**First, we'll talk about the learning overview: Specifically, we'll be looking for information about how you may have changed personally and professionally, your understanding of the role of a teacher, about teaching and learning, and social justice – and the most important influences that have shaped this experience.**

### **I. Learning**

**I'd like to start with a set of questions about what you learned during this year in your teacher education program...**

**1. You've been in schools for almost a year and have finished your full-time student teaching, Some people say they ended up learning as much about themselves as they did about students or teaching methods teaching during this period. What would you say you have you learned about yourself?**

- **As a Teacher?**
- **As a Learner?**

**2. What did you learn about teaching/the activity of teaching? What's the hardest thing? What's the easiest? What most surprised you?**

**3. What has had the greatest impact on this learning?**

**(Probe: What about—depending on their answer—your practicum experience, teacher education courses, A&S courses, your peers?**

**We're going to shift the focus a bit here and talk about some of the themes and concepts that pervade the program:**

**Let's start with the idea of pupil learning.**

**4. What's the most important thing you'd say you've learned about teaching reading/mathematics (for elementary)? \_\_\_\_\_ (specific subject) for secondary)(be specific for secondary)?**



- How/Where/From whom did you learn that? What was the biggest influence on your learning? Who or what played the biggest role? What role did the courses play?
- What have you learned about teaching about literacy in the elementary school? Math?
- What have you learned about teaching bilingual students/ELLs? How/Where/From whom did you learn that?
- Which content areas do you feel the most/least prepared to teach?

All through BC's teacher education program, there's been a lot of talk about social justice. We asked you about this in the first interview, as you might remember...

5. As you complete your teacher education experience, what do you make of this idea of Teaching for Social Justice?
  - Has your definition changed?
  - What impact did your practicum experiences have on your understanding of TSJ?
6. Did you have any strong models of teachers for social justice (either at BC or at your school site)?
  - What made them good models?
7. How do you see yourself teaching for social justice in your own classroom?
8. Can you talk a bit about what you understand is the purpose of schooling? Where has that been highlighted in your program?

## II. Moving Forward/Your future:

Okay, let's look ahead, now. In this section we'd like to talk about your future...

- What are you planning on doing next year (for benefit of the interview transcript)?
  - Do you plan on teaching in the future?
  - How has your experience in the past year impacted your career choice?
9. First, how is your job search going?
    - Will you be around this summer? Do I need to update contact information?
    - Are you planning on taking part in BC's mentoring program?
  10. When you imagine yourself teaching next year, what do you see?
    - What will your classroom be like?
    - What will be the biggest challenges?

- What do you expect to be most prepared for?
- How do you think MCAS and NCLB will influence your teaching?
- Professional goals as a teacher?

**11. Do you think about teaching as a career? What do you see yourself doing in the next five years?**

- Ten years?

### **III. Program Feedback**

**Finally, we'll give you the opportunity to tell us more specifically what you think about the BC program....**

**12. If you could change three things about the program, what would they be?  
Was there anything irrelevant in the program?**

**13. What three things would you keep, that you found especially valuable in the program?**

## **Interview 7 – November of first-year of teaching**

### **Introduction:**

**Now that you've been in the classroom for a few months we're going to ask you some questions that brings us up to date on your school setting and students, how you've settled into teaching, return to a few familiar themes in our research, and then ask just a bit about the future.**

**We'll start with some general questions about your school and schedule.**

**Let's start with a look at the school itself, your students, and the people you work with:**

### **1. Tell me about your school...how would you describe it?**

Probes:

- What kind of resources do they have? Or lack?
- What are the population demographics?
- Are parents involved in the school?
- What kind of goals does the school promote? Is there a mission statement? If so, do both faculty and students buy into it?
- Is there anything major that has happened at the school (AYP problems, new principal, new curriculum they have to use, construction)
- Is this a very different setting from your prac experience(s)?

### **2. Let's shift to your students for a bit. I'd like you to describe them to me. Can you start with some general demographics that describe the pupils in your class(es)?**

Probes:

- Age, ethnicity, language backgrounds, SES
- SPED
- ELL
- Range of abilities across the group(s)
- Did you get some of this information from teachers who had these students previously? Did you have prior experience with any of these pupils?
- How would you describe classroom dynamics? Do you have difficulty with certain students or a particular class?
- What is the biggest challenge you have faced so far this year?

### **3. "At this point in the school year, are you able to identify goals for your students?"**

Probes:

- What do you want them to learn? (consider academic, social, and emotional possibilities, here)

**I'd like to return to a question that has been a theme throughout the interviews:**

**4. We talked about learning to teach for social justice many times last year. We are interested in the realities of how this plays out in practice.**

Probes:

- Do you think about issues of social justice in your classroom?
- In your planning?
- Do you feel that teaching for social justice is an explicit part of your classroom experience at the moment?
- How might this be particular to the context of your school? Classroom?
- How practical is the BC emphasis on social justice for a novice teacher?
- Has your view on teaching for social justice changed over the first few months of fulltime teaching? If so, how and why?

**5. We've talked about this before, but now that you're fully responsible for classes, I'd like to have you think about it again: How do you know your pupils are learning? Be specific about the way you get this kind of information ...**

Probe:

- Has this changed in anyway since your prac? If so, why?
- Has the inquiry played a role in how you look at your classes?

**6. How about the other adults in the school. What kind of relationships have you been able to develop with school faculty & staff?**

Probes:

- Principal, department head, fellow teachers
- Is there a lot of interaction among faculty?
- Do you have the opportunity to co-plan or co-teach?

**7. Do you have an assigned mentor or participate in an induction program? If so, has this been a successful match?**

Probes:

- Are there other people that might be seen as informal mentors or part of your network of support – including friends and family outside of school?
- Did you attend Summer Start? Why or Why not? Describe your experience. Was it valuable? How would you change the program?

**Let's spend a few minutes talking about your immersion into fulltime teaching.**

**8. In general, how do you feel things have gone in the past few months?**

**9. What is your workload like?**

Probes:

- What is your schedule? When do you get in to school? What time do you leave?
- For secondary – number of preps?

- For elementary – breaks?
- Additional school duties (ex: study hall, cafeteria duty, extra-curricular activities?)

**10. Tell me about planning...when do you get to do this? How do you decide what to use? What to teach?**

Probes:

- What resources do you have? Use? Where are they from?
- Are you focusing on day-to-day planning or do you have a long-term plan to work from?
- What strategies/resources have you utilized from your master's program?

**11. How did you plan for this topic that you assessed here (look at the pupil work that the teacher brings to the interview)?**

- Why did you choose to assess your students using this assignment?
- How would you change it if you were to do it again?

**12. Do you see yourself as having a great deal of autonomy in your classroom?  
(If teacher asks what you mean by 'autonomy' can say 'when some people talk about autonomy they refer to the role of standards, district mandated curriculum or exams, whether you feel you have a voice in deciding what is taught in your classroom)**

Probes:

Why/why not?

In what area do you have most/least autonomy?

Who or what influences your decisions in the classroom?

Is MCAS a driving force in what you do?

**Let's look at how well prepared you feel and what you attribute to the BC experience:**

**13. What did you feel prepared for? Not prepared for?**

Probes:

- Is there anything that you feel BC did not prepare you for?
- Is there any one thing that you feel especially well prepared for by the BC program?
- Does your school provide support through PD for what you might not feel prepared for?
- Where might you turn for additional support/knowledge?
- Do you feel prepared to work with the population of students in your classroom? (ELL, SED, etc)

**14. Is teaching what you expected it to be? Have your aspirations for a career in teaching changed?**

- Do you think you'll teach next year?
- In this school? For how long?

**15. Is there anything that we haven't touched on that you feel is especially important to include in this conversation?**

## Interview 8 – February-March of first year of teaching

*NOTE: Teacher needs to bring three sets of pupil work: a full class set of a cumulative assignment and two examples of tasks that led up to it, all from same student. Teacher also needs to pick out one high, one medium, and one low example of pupil performance for the cumulative assignment. Finally, have the teacher bring any rubrics she or he used to score these assignments, as well as any assignment description that the TC gave to the pupils.*

**The purpose of this interview is to see what you are thinking about pupil learning and how it relates to your own instruction. First, I will ask you a series of general questions about the assignments you brought, then we'll get into the specific student examples you have selected as high, medium, and low. Finally, I'll ask you talk about your inquiry project.**

1. First, last time you were struggling with ... (fill in here with something specific to your teacher; e.g. students not completing their homework; the discipline protocol at the school, etc.). How's it going now?

2. OK, let's take a look at the assignments you brought. As a way to walk me through this work, it might be helpful for you to start at the end with the cumulative project and work backwards. Or you might want to start with the first task and move chronologically to the end, the cumulative task.

Probe: How does it fit into a larger unit?

Probe: Was this something you devised yourself?

Probe: Was any part of this lesson from a preexisting lesson that you adapted?

Probe: Why did you decide this lesson/assignment/assessment would be appropriate?  
How much autonomy did you have in creating the lesson or assignment?

3. What did you want students to get out of this activity? How do you know whether or not students accomplished what you wanted them to get out of this activity/lesson/unit?

Probe: How did you evaluate these assignments (rubric, scoring, etc.)?

4. Is there anything you would change about this lesson or assignment or unit? What? Why?

5. Let's now look at your examples of a high, a medium, and a low-level response? Why did you choose these three examples? Tell me about the students who did this work (ELL, Special Ed, anything else?).

Probe: How do these samples compare to the overall class? (Is this work representative of the class? Is this what you expected?)

### ***General Pupil Learning Ideas***

6. What do you do to address the range of abilities in your classroom?

7. You have already talked about how you looked for pupil learning in your cumulative assignment. How in general do you know if your pupils are learning? What counts as evidence for learning? (Connect to question two or it may sound repetitive)

Probe: Has this changed in anyway since your practicum? If so, why?

Probe: Has the inquiry project played a role in how you look at your classes/students?

8. What kind of grading or evaluating system do you use? Are you happy with it?

Probe: To what extent do you have autonomy in this? Are there school or department guidelines about grades?

9. What kind of pupil data does your school district use in developing curriculum & instruction that might impact your class?

Probe: This might include MCAS scores; other standardized test scores; testing coming from, or contributing to IEPs and 504s; Student Success Plans (these are required for students w/o IEP or 504 that don't meet standards on other tests); portfolio or exhibit projects, district benchmark/tests, other?

Probe: Do you have access to this data on an individual or aggregate level to make plans for your classes/pupils?

Probe: Would you be part of the data analysis?



Probe: Do you feel BC has prepared you to be able to use pupil data, both formal, informal, standardized and teacher-developed to make decisions in your classroom? Do you do this?

10. Of course, teachers are not just interested in their pupils' academic learning, they are also very interested in their social and emotional development. Do you see your students making progress socially and emotionally? Like what? (*Note: levels of confidence, enjoyment of learning, engagement in learning, independence in learning, cooperative group work, classroom behavior, interpersonal interactions*)

Probe: How do you know if pupils are making this kind of progress? What evidence do you look for to determine social and emotional growth?

11. What kind of expectations do you have for students? Are you able maintain these expectations when the pupils have a variety of learning styles and needs? If so, how? If not, why?

12. How do you help students develop language abilities? (ELL, SpEd, Writing, Reading)

Probe: Would you call your classroom language-rich? Why or why not?

### ***Experience in Classroom/School***

***Now let's touch base on how the year is going, now that you are about half-way through it.***

13. What kinds of changes, if any, have you made based on your experience in the first half of the year?

Probe: For example, grading, classroom management, differentiated instruction?

Probe: Are there disciplinary or management expectations school-wide? In your teaching team?

Probe: Do you find yourself using any techniques gained from BC? From your practicum?

14. How have you handled classroom management so far?

15. How is the larger school context/culture playing a role in your classroom?

Probe: What contact have you had with the Principal/Dean/Mentor/Coach/etc.? Are you satisfied with the amount and nature of your interactions?

Probe: Have you been observed and evaluated? By whom? What kind of feedback have you received?

Probe: What contact have you had with parents? What role do they play in the school?

16. Are you participating in mentoring/induction? If so, what kind? Is it helping you professionally or personally?

Probe: Are there other people who might be seen as informal mentors or part of your network of support – including friends and family outside of school?

Probe: Are you attending any programs sponsored by BC? Are they valuable? How would you change them?

17. Some people say the first year of teaching is the hardest and find it difficult to find balance. How has your “quality of life” as first year teacher been so far? (Do you have a life?)

18. Do you see yourself working at the same school/in the same job next year?

Probe: If not, ask why. What would it take for you to stay?

Probe: If yes, ask what it is that is keeping them in the position.

## Interview 9 – End of first-year of teaching

**This is our last interview, so it will include an overview of what you have learned, the influences that have been most significant, your thoughts on teaching, and your future plans. We will also talk about pupil work.**

***Remember to print out various charts, etc. before conducting the interview.***

### **Pupil Learning**

1. What's the most important thing you'd say you've learned about teaching reading/mathematics (for elementary)? \_\_\_\_\_ (specific subject for secondary) over the last year?

Probe: How/Where/From whom did you learn that? What was the biggest influence on your learning? Who or what played the biggest role?

Probe: What have you learned about teaching about literacy in the elementary school? Math?

Probe: Which content areas do you feel the most/least prepared to teach? How does this affect your teaching?

Probe: What's the most important thing you'd say you've learned about teaching diverse populations? (ELL, SPED, SES, etc.) – How/Where/From whom did you learn that?

2. OK, let's take a look at the assignments you brought. As a way to walk me through this work, it might be helpful for you to start at the end with the cumulative project and work backwards. Or you might want to start with the first task and move chronologically to the end, the cumulative task.

Probe: How does it fit into a larger unit?

Probe: Was this something you devised yourself?

Probe: Was any part of this lesson from a preexisting lesson that you adapted?

Probe: Why did you decide this lesson/assignment/assessment would be appropriate? How much autonomy did you have in creating the lesson or assignment?

3. What did you want students to get out of this activity? How do you know whether or not students accomplished what you wanted them to get out of this activity/lesson/unit?

Probe: How did you evaluate these assignments (rubric, scoring, etc.)?

4. Is there anything you would change about this lesson or assignment or unit? What? Why?

5. Let's now look at your examples of a high, a medium, and a low-level response? Why did you choose these three examples? Tell me about the students who did this work (ELL, Special Ed, anything else?).

Probe: How do these samples compare to the overall class? (Is this work representative of the class? Is this what you expected?)

6. How do you feel your pupils did overall? Do you feel like they gained skills over the year? What? Were you satisfied/disappointed?

7. Our research group looked carefully at responses from last year's interviews that had to do with pupils' work and your assessments of their learning. We came up with graphic to try to explain what we found. The first box is supposed to represent teacher candidates' experiences during coursework, and the second what happened during student teaching. Overall we found that student teachers created great assessments that showed they had high expectations for pupils and focused on higher-order thinking. (refer to figure) We thought about this as "ownership" —student teachers actively changing strategies, questioning practices, and generally looking for better ways to improve learning in the classroom.

Does that sound to you like what was going on for you during student teaching? How about now, during your first year of teaching?

8. Another thing we found during the interviews when we asked teachers to talk about high-, medium-, and low-, pupil performance on the assessments, was that sometimes there was a kind of distancing. For example, if a pupil performed poorly on a test or a project, sometimes the student teacher attribute this to the pupil's lack of effort or his or her failure to pay attention and follow directions. This made us think a lot about how teachers make

sense of it when pupils don't meet their expectations. Can you talk about this a little bit?

9. Do you think teachers should expect to meet the learning needs of every pupil in the class?

### **Social Justice**

10. All through BC's teacher education program, there's been a lot of talk about social justice. We asked you about this in the first interview, as you might remember...As you are now completing your first year of teaching, what do you make of this idea of Teaching for Social Justice? Is it important to you in your daily work? Do you consider yourself to be teaching for social justice?

11. Show them the 4 categories/28 codes for Social Justice (see end of interview for chart) and ask: We looked at all the responses of participants from the pre-service year and earlier this year about what it means to teach for social justice. Here is the way we grouped responses. What strikes you from this list? What's missing, if anything?

12. Some of the people who define TSJ say it's teaching that improves students' learning and enhances their life chances. They say that part of this is teachers trying to work with others to actively address inequities in the system. We didn't find much talk about activism or addressing inequities in our interviews. Any thoughts on this?

### **School Context/Teacher Roles**

*Now we're going to switch gears and talk about your school.*

13. What opportunities has the school provided you in terms of what and how you teach?

Probe: Have you experienced any constraints? Are there things you've felt you couldn't do this year but wanted to?

Probe: In terms of what you brought with you from the BC program, are there things that were particularly helpful? Were there things that you didn't have an opportunity to implement?

14. What personal factors have made a difference in your teaching (background, education, personal experiences)? (i.e. knowing a second language having an impact on teaching ELLs)?

15. How would you describe the role you played in the school this year (e.g. with pupils, clubs, committees, with other faculty)? Do you see that changing next year?

16. What role have others in the school (colleagues, mentors, etc.) played in your life this year?

### **Inquiry**

17. One of the goals at BC is to develop inquiry as stance – a way of thinking about and questioning what happens in your classroom, collecting data – through pupil work – and making decisions about practice based on that information. Can you give me an example of how you see this occurring in your classroom this year? Is this an important element of your practice?

18. Have you used the strategies you used in your BC inquiry project this year? Why? Why not?

### **Future Plans**

*Dependent on their plans for next year:*

20. Why did you decide to stay at the school?

OR

Why did you decide to leave? What were you looking for in your new school?

AND

What aspects of this first year of teaching encouraged you to stay (or leave)?

21. Do you have any specific goals for next year? Have you thought about what you might keep the same and what you might change in your teaching, your classroom, and in your role in the school?

22. Do you think about teaching as your career? What do you see yourself doing in the next five years? Ten years?

APPENDIX E  
OBSERVATION PROTOCOL

**Observer:** \_\_\_\_\_ **Participant:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Teacher:** \_\_\_\_\_ **Time & Date:** \_\_\_\_\_

**Observer:** \_\_\_\_\_ **Grade & Subject:** \_\_\_\_\_

**Arrangement of Room:**  
 \_\_\_\_\_ Pupils have assigned seats  
 \_\_\_\_\_ Seating appears to be random  
 \_\_\_\_\_ Tables used, not desks

**Add Additional Notes Below:**  
 \_\_\_\_\_ Pupils work on walls  
 \_\_\_\_\_ Comments:

\_\_\_\_\_ Visuals on walls  
 \_\_\_\_\_ Comments:

|              | A | B | H | W | O |
|--------------|---|---|---|---|---|
| F = Female   |   |   |   |   |   |
| M = Male     |   |   |   |   |   |
| A = Asian    |   |   |   |   |   |
| B = Black    |   |   |   |   |   |
| H = Hispanic |   |   |   |   |   |
| W = White    |   |   |   |   |   |
| O = Other    |   |   |   |   |   |
| <b>Total</b> |   |   |   |   |   |

Classroom Climate:

---

Additional Pre-Lesson/Class Observations (including information about host teacher/classroom, if relevant)



Observer: \_\_\_\_\_ Participant: \_\_\_\_\_ Date: \_\_\_\_\_

**Contextual Information on School:**

Name: \_\_\_\_\_ School Setting: \_\_\_\_\_

|          |         |                |
|----------|---------|----------------|
| Urban    | Public  | Enrollment:    |
| Suburban | Charter | Male:          |
| Private  | Pilot   | Female:        |
| Catholic | Magnet  | Grades Served: |

(200\_\_ - 200\_\_)

| Race/Ethnicity   | % of School | Selected Populations       | % of School | Indicators               | School |
|------------------|-------------|----------------------------|-------------|--------------------------|--------|
| African American |             | First Language not English |             | Grade 9-12 Drop-out      |        |
| Asian            |             | Limited English Proficient |             | Attendance Rate          |        |
| Hispanic         |             | Low-income                 |             | Average # of days absent |        |
| Native American  |             | Special Education          |             | In-School Suspension     |        |
| White            |             |                            |             | Rate                     |        |
| Other            |             |                            |             | Retention Rate           |        |
|                  |             |                            |             | Exclusion rate per 1000  |        |

| Teacher Data   | School | Pupil Expenditures         | School |
|--|--------|----------------------------|--------|
| Total # of Teachers  |        | Regular Education          |        |
| % of Teachers Licensed in Teaching Assignment              |        | Special Education          |        |
| Total # of Teachers in Core Academic Areas                 |        | Bilingual Education        |        |
| % of Core Academic Teachers Identified as Highly Qualified |        | Occupational Day Education |        |
| Student/Teacher Ratio                                      |        | All Day Programs           |        |
| Average Salary   |        |                            |        |

Observer: \_\_\_\_\_ Participant: \_\_\_\_\_ Date: \_\_\_\_\_

| MCAS 200 |          | % Advanced | % Proficient | % Needs Improvement | % Warning/Failing | Students Included |
|----------|----------|------------|--------------|---------------------|-------------------|-------------------|
| Grade    | Reading  |            |              |                     |                   |                   |
| Grade    | ELA      |            |              |                     |                   |                   |
| Grade    | Math     |            |              |                     |                   |                   |
| Grade    | Sci/Tech |            |              |                     |                   |                   |

| AYP 200 | ELA Aggt | ELA Sub | Math Aggt | Math Sub |
|---------|----------|---------|-----------|----------|
|         |          |         |           |          |

**Condition of Classroom:**

| 1 = Inadequate<br>Limits opportunities<br>for learning | 2 = Poor         | 3 = Adequate | 4 = Good | 5 = Excellent   |
|--|------------------|--------------|----------|---|
| <b>I. Resources</b>                                    |                  |              |          |   |
| a. Technology works                                    | 1 2 3 4 5        |              |          | 1 2 3 4 5   |
| b. Texts available                                     | 1 2 3 4 5        |              |          | 1 2 3 4 5   |
| c. Usable furnishings (desks and chairs)               | 1 2 3 4 5        |              |          | 1 2 3 4 5   |
| d. Fire/earth boards                                   | 1 2 3 4 5        |              |          | 1 2 3 4 5   |
| e. Teaching materials                                  | 1 2 3 4 5        |              |          | 1 2 3 4 5   |
| <b>II. Environment</b>                                 |                  |              |          |   |
| a. Cleanliness   |                  |              |          | 1 2 3 4 5   |
| b. Climate (temperature)                               |                  |              |          | 1 2 3 4 5   |
| c. Lighting  |                  |              |          | 1 2 3 4 5   |
| d. Adequate Space/storage                              |                  |              |          | 1 2 3 4 5   |
| e. Noise   |                  |              |          | 1 2 3 4 5   |
| f. Postings  |                  |              |          | 1 2 3 4 5   |
| <b>Overall Resource Rating</b>                         | <b>1 2 3 4 5</b> |              |          | <b>Overall Classroom Environment Rating 1 2 3 4 5</b> |
| <b>Final Condition of Classroom Rating:</b>            | <b>1 2 3 4 5</b> |              |          |   |

Summary Notes:

|   |  |  |  |
|---|--|--|--|
| Observer: _____   | Participant: _____   | LAME: _____  |  |
| <b>Condition of School:</b><br>1 = Inadequate Limits opportunities for learning      2 = Poor      3 = Adequate      4 = Good      5 = Excellent  |  |  |  |
| <b>I. Resources</b><br>a. Library/Media Center<br>b. Gymnasium<br>c. Computer Center<br>d. Auditorium<br>e. Playground<br>f. Cafeteria<br>g. Bathrooms and Water fountains<br>h. Teacher's Lounge | 1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5 | <b>II. Environment</b><br>a. Building and Grounds<br>b. Cleanliness<br>c. Appropriate Wall Coverings<br>d. Clear Directives Posted | 1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5<br>1 2 3 4 5 |
| <b>Overall Resource Rating: 1 2 3 4 5</b>   |  | <b>Overall Classroom Environment Rating: 1 2 3 4 5</b>   |  |
| <b>Final Condition of Classroom Rating: 1 2 3 4 5</b>   |  |  |  |
| Summary Notes: _____  |  |  |  |

Observer: \_\_\_\_\_ Participant: \_\_\_\_\_ Date: \_\_\_\_\_

**Chronology of Events**

| Time | Activity/Format | Setting | Participants | Materials |
|------|-----------------|---------|--------------|-----------|
| 1.   |                 |         |              |           |
| 2.   |                 |         |              |           |
| 3.   |                 |         |              |           |
| 4.   |                 |         |              |           |
| 5.   |                 |         |              |           |
| 6.   |                 |         |              |           |
| 7.   |                 |         |              |           |

## Observation Script

|  |
|--|
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity One:</b><br/><b>Time:</b></p>   |
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity Two:</b><br/><b>Time:</b></p>   |
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity Three:</b><br/><b>Time:</b></p> |
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity Four:</b><br/><b>Time:</b></p>  |
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity Five:</b><br/><b>Time:</b></p>  |
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity Six:</b><br/><b>Time:</b></p>   |
| <p><b>Activity Field Notes</b><br/>(Fonts: standard for description; quote what is said; italicize commentary)<br/><b>Activity Seven:</b><br/><b>Time:</b></p> |

## **Annotated Observation Record**

**1. Content (Developmentally appropriate and accurate resources and materials; availability of resources)**

**2. Teacher Pedagogy & Opportunities for Learning (Refers to the activities and strategies in which the teacher/candidate engages as well as the kinds and quality of learning experiences that are offered in the classroom)**

**Activities/Strategies**

**Inquiry**

**Connectedness to the World**

**Levels of Thinking**

**Depth of Knowledge**

**Substantive Conversations**

**Social Supports to Achievement**

**3. Pupil Learning & Assessment(Pupil behavior that suggests engagement and progress in learning skills and content. This may include academic, social and emotional outcomes. Assessment includes any opportunity, formal or informal, in which the teacher/candidate is establishing the skill and knowledge base of students, or ability to utilize information that is being presented.)**

**Formative**

**Summative**

**Pupil Engagement**

**Academic Outcomes**

**Social/Emotional Outcomes**

**Levels of Thinking**

**Connectedness to the World**

**Depth of Knowledge**

**Substantive Conversations**

**4. Social Justice (In keeping with our focus on social justice as an outcome for teacher/candidate and pupils, this topic area explicitly identifies activities/opportunities where teaching for social justice, or social justice issues are apparent in the classroom. Both the Key word list and Newmann's work provide the frame for identifying social justice in the classroom.)**

**Providing rich opportunities and progress for all students**

**Culturally Relevant Content and Pedagogy**

**Diversity as an Asset**

**Social Supports to Achievement**

**Levels of Thinking**

**Connectedness to the World**

**Depth of Knowledge**

**Substantive Conversations**

**5. Relationships & Classroom Management (Interactions in the classroom between and among members of the school community that are represented. This is reviewed as a key to classroom community and context, support for learning, and addressing social/emotional elements of the learning experience, and the organization and routines to support learning)**

**Teacher/Candidate/Pupils**

**Peer-to-Peer**

**Teacher/Other Staff**

**Social Supports to achievement**

**Substantive Conversations**

## Annotated Observation Guidelines

| <b><i>What's going on regarding TEACHING?</i></b>   |  |
|---|--|
| <b><i>The CONTENT</i></b><br><i>What was the content? Was it:</i>   |  |
| <ul style="list-style-type: none"> <li>• DEVELOPMENTALLY APPROPRIATE?</li> <br/> <li>• LINKED TO THE DISCIPLINE AND CURRICULUM STANDARDS</li> <br/> <li>• UTILIZING MULTIPLE AND ALTERNATIVE PERSPECTIVES</li> <br/> <li>• EXPLICITLY INCLUDING ISSUES OF POWER AND EQUITY</li> </ul>   |  |
| <b><i>The PEDAGOGY</i></b><br><i>What pedagogical strategies did you observe?</i><br><i>Did the teacher:</i>  |  |
| <ul style="list-style-type: none"> <li>• RELATE TO PUPILS' CULTURAL, LINGUISTIC, AND EXPERIENTIAL RESOURCES</li> <br/> <li>• LINK PUPILS' KNOWLEDGE TO CONTENT</li> <br/> <li>• UTILIZE KNOWLEDGE OF PUPILS (E.G. BACKGROUND KNOWLEDGE, LEARNING SKILLS, LANGUAGE PROFICIENCY, ETHNICITY, AND GENDER) TO FACILITATE LEARNING</li> <br/> <li>• <b>USE APPROPRIATE TEACHING STRATEGIES AND MATERIALS TO SUPPORT SECOND-LANGUAGE ACQUISITIONS FOR THOSE WHOSE FIRST LANGUAGE IS NOT ENGLISH</b></li> <br/> <li>• <b>MAKE GENERAL CURRICULUM ACCESSIBLE TO STUDENTS WITH SPECIAL NEEDS</b></li> <br/> <li>• VARY INSTRUCTIONAL ACTIVITIES THAT INTEGRATE LESSON SKILLS WITH LANGUAGE PRACTICE OPPORTUNITIES FOR READING,</li> </ul> | <p><b>Organize</b></p> <p>Elaborate, formulate, incorporate, integrate, participate, plan, structure, summarize</p> <p>Cognitive</p> <p>Assess, ask, correct, evaluate, measure, observe, record, track, transcribe</p> <p><b>Teach</b></p> <p><i>Assign, brainstorm, compose, delegate, demonstrate, design, discuss, display, engage, explain, facilitate, lecture, model, observe, plan, present, problem solve, question, repeat, show, tell</i></p> |



|  |  |
|--|--|
| <p>WRITING, LISTENING, AND/OR SPEAKING</p> <ul style="list-style-type: none"> <li>• EMPLOYS VARIOUS SCAFFOLDING TECHNIQUES, QUESTIONING, AND ASSESSMENT STRATEGIES</li> </ul>  | <p><b>Respond</b><br/> <i>Apply, challenge, connect, construct, critique, define, emphasize, focus, inquire, justify, orchestrate, probe, question, recognize, reflect</i></p> <p><b>Adapt</b><br/> <i>Accommodate, adjust, clarify, expand, guide, modify, scaffold, simplify, translate</i></p> <p><b>Emotional</b></p> <p><b>Positive</b><br/> <i>Care, comfort, encourage, feed, listen, meet needs, nurture, provide, respect, support, value, wait/patience</i></p> <p><b>Negative</b><br/> <i>Coerce, criticize, critique, exclude, humiliate, Ignore, racism, reject, ridicule, shame, use sarcasm</i></p> |
| <p><b>EXPECTATIONS/OBJECTIVES</b><br/> <i>What were the pupils asked to do? Did the teacher::</i></p>  | <p>:</p>   |
| <ul style="list-style-type: none"> <li>• USE LEARNING OBJECTIVES THAT COMMUNICATE HIGH STANDARDS AND EXPECTATIONS FOR ALL PUPILS</li> <li>• USE RICH LANGUAGE OPPORTUNITIES THAT ENGAGE ALL PUPILS IN COMPLEX TASKS</li> </ul> | <p><b>Classroom Environment</b><br/> <i>Demand, dismiss, punish, remove, time out</i></p> <p><i>Collaborate, comfort, cooperate, encourage, listen, praise, reward, support</i></p> <p><i>Bargain, cajole, negotiate</i></p>   |

| <b><i>What's going on regarding LEARNING?</i></b>   |   |
|---|---|
| <b>ACADEMIC LEARNING</b><br><i>How were the pupils demonstrating academic skills and learning? Did they:</i>  | <b>ACADEMIC LEARNING</b>  |
| <ul style="list-style-type: none"> <li>• <b>CONNECT NEW CONTENT TO PREVIOUS LEARNING</b></li> <li>• DISPLAY INTEREST IN, AND ENGAGEMENT WITH, CONTENT</li> <li>• ENGAGE IN SUBSTANTIVE CONVERSATION WITH ONE ANOTHER AND WITH THE TEACHER</li> <li>• MANAGE INFORMATION IN A VARIETY OF WAYS (CATEGORIZE, COMBINE, ORGANIZE, SYNTHESIZE)</li> </ul> | <p><u>Cognitive Task Action Words</u> (drawn from Newmann* and SOLO) that might be used to describe pupils engaged in meaningful cognitive tasks:</p> <p><i>Describe; define; explain; summarize; interpret; give examples; construct; apply; compare/contrast; deduce; infer; analyze; categorize; create; support; design; compose; combine; rearrange; judge; debate; critique; recall; formulate; organize; synthesize; evaluate; hypothesize; make models or simulations; construct arguments; invent procedures; apply information; relate information to prior knowledge, personal experience, or perceptions of the world; consider different points of view.</i></p> |
| <b>SOCIAL LEARNING</b><br><i>Did the teacher promote Social Learning that encourages pupils to:</i>   | <b>SOCIAL LEARNING:</b>   |
| <ul style="list-style-type: none"> <li>• SHARE MATERIALS AND IDEAS</li> <li>• LISTEN TO ONE ANOTHER AND TO THE TEACHER</li> <li>• RESPOND IN WAYS THAT CONTRIBUTE TO OTHERS' LEARNING</li> </ul>  | <p><u>Social and Emotional Tasks one might observe:</u> <i>Sharing (materials/ideas); cooperating; listening; self-asserting; showing responsibility; developing relationships with peers; identifying and naming feelings; recognizing danger; empathizing; demonstrating self-control; showing tolerance; being self-motivated; acting independently; show appreciation, anger, and annoyance in appropriate ways; caring; coping; negotiate and accept differences; recognize contributions of others; provide information in constructive manner; solving community problems</i></p>  |

| EMOTIONAL LEARNING   | EMOTIONAL LEARNING                |
|--|-----------------------------------|
| Still need input for this section  | Still need input for this section |
| <b><i>What's going on regarding SOCIAL JUSTICE?</i></b>  |                                   |
| <b><i>CLASSROOM ENVIRONMENT</i></b>  |                                   |
| <i>Did the teacher:</i>  |                                   |
| <ul style="list-style-type: none"> <li>• VARY AND MANAGE CLASSROOM ROUTINES SUCH THAT ALL PUPILS HAVE ACCESS TO LEARNING</li> <li>• ENGAGE ALL PUPILS IN SUBSTANTIVE CONVERSATION THAT SUPPORTS LEARNING</li> <li>• USE INTERACTIONS AMONG PUPILS TO PROMOTE SUBSTANTIVE CONVERSATION AND SHARED UNDERSTANDING ACROSS DIFFERENCES</li> <li>• FACILITATE AN ENVIRONMENT OF COOPERATION, RESPONSIBILITY, TRUST, AND CARE THAT IS ALSO ENACTED BY THE PUPILS</li> <li>• DEMONSTRATE UNDERSTANDING AND EMPATHY SO THAT PUPILS EXHIBIT THIS FOR ONE ANOTHER IN THEIR INTERACTIONS</li> <li>• USE CLASSROOM ACTIVITIES TO MODEL EQUITY?</li> </ul> |                                   |
| <b><i>EQUITY IN LEARNING</i></b>   |                                   |
| <i>Did the teacher:</i>  |                                   |
| <ul style="list-style-type: none"> <li>• ENGAGE PUPILS OF DIFFERENT LANGUAGE BACKGROUNDS IN A WHOLE RANGE OF COGNITIVE AND SOCIAL TASKS</li> <li>• ENGAGE PUPILS AT DIFFERENT SKILL LEVELS, AND STUDENTS WITH SPECIAL NEEDS, IN THE WHOLE RANGE OF COGNITIVE AND SOCIAL TASKS</li> <li>• BUILD CONFIDENCE IN PUPILS' SELF-KNOWLEDGE AS WELL AS KNOWLEDGE</li> </ul>  |                                   |

|   |  |
|---|--|
| OF THE CONTENT  |  |
| <i>EXPOSURE TO SOCIAL JUSTICE</i><br><i>Did the teacher:</i>  |  |
| <ul style="list-style-type: none"> <li>• MAKE POWER, EQUITY, AND ACTIVISM EXPLICIT</li> <br/> <li>• <b>PROVIDE OPPORTUNITIES TO CRITICALLY QUESTION AND ANALYZE EXISTING POWER STRUCTURES IN SOCIETY</b></li> <br/> <li>• <b>HELP PUPILS FEEL POWERFUL IN RESPONSE TO THESE ISSUES</b></li> </ul> |  |

APPENDIX F  
IRB CONSENT FORMS

*CONSENT TO PARTICIPATE IN A RESEARCH STUDY (Pre-Survey)*

Dear Teacher Candidate,

My name is Cindy Jong and I am a doctoral student in Curriculum and Instruction at Boston College. As part of my studies, I will be conducting a mixed-methods research project this semester under the supervision of Dr. Lillie Albert, an experienced educational researcher.

You are being invited to take part in a research study about the impact of mathematics education courses and practicum experiences. Your participation is completely voluntary and will have no impact on your grade for the course. All participants will remain anonymous. No individual participant name will be released in the final report. I have not received any funding for this study, and neither my supervisor nor I expect to receive any extra money from companies because of the results of this study. Please feel free to ask any questions if you need further clarification. My e-mail is [jongc@bc.edu](mailto:jongc@bc.edu) and phone number is (617) 319-1003.

**Purpose:**

The purpose of this survey is to learn of some about the impact your practicum experiences and math education courses have on your learning and teacher preparation. I would also like to learn more about your mathematics content knowledge, past mathematics experiences, and future aspirations for teaching mathematics. I believe your shared experience will help Teachers for a New Era (TNE) learn ways to improve the math methods courses and teacher education program for future teacher candidates.

**You should feel free to skip any questions posed here that you prefer not to answer.**

**Thank you very much.**

I ALLOW my survey to be used for research purposes:

\_\_\_\_\_  
Signature Date

\_\_\_\_\_  
Please print name Date

I DO NOT ALLOW my survey to be used for research purposes:

\_\_\_\_\_  
Signature Date

\_\_\_\_\_  
Please print name Date

*CONSENT TO PARTICIPATE IN A RESEARCH STUDY (Post-Survey)*

Dear Teacher Candidate,

My name is Cindy Jong and I am a doctoral student in Curriculum and Instruction at Boston College. As part of my studies, I will be conducting a mixed-methods research project this semester under the supervision of Dr. Lillie Albert, an experienced educational researcher.

I appreciate the time you took to complete the pre-survey and now you are being invited to continue your participation in the research study about the impact of mathematics education courses and practicum experiences by taking this post-survey. Your participation is completely voluntary and will have no impact on your grade for the course. All participants will remain anonymous. No individual participant name will be released in the final report. I have not received any funding for this study, and neither my supervisor nor I expect to receive any extra money from companies because of the results of this study. Please feel free to ask any questions if you need further clarification. My e-mail is [jongc@bc.edu](mailto:jongc@bc.edu) and phone number is (617) 319-1003.

**Purpose:**

The purpose of this post-survey is to learn about the impact your practicum experiences and math education courses have on your learning and teacher preparation. It will also be used to compare any changes in your attitude towards math in comparison to the pre-survey you filled out earlier in the semester. I believe your shared experience will help Teachers for a New Era (TNE) learn ways to improve the math methods courses and teacher education program for future teacher candidates.

You should feel free to skip any questions posed here that you prefer not to answer.

**Thank you very much.**

I ALLOW my survey to be used for research purposes:

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Signature Date

---

Please print name Date

I DO NOT ALLOW my survey to be used for research purposes:

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Signature Date

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Please print name Date

### **Informed Consent Form for Qualitative Case Studies Research Participants (Year 1)**

You are being invited to participate in a research project that is directed by Dr. Marilyn Cochran-Smith & Dr. Patrick McQuillan of Boston College Lynch School of Education (LSOE) as part of the Teachers for a New Era Project. The study intends to broadly document the experiences and perceptions of learning to teach at Boston College. Hopefully this research will lead to a clearer sense of the relationship between learning to teach and practicing teaching that will lead to positive, professional opportunities for both university faculty and beginning teachers. No individual teacher or faculty member will be the focus of this study.

Your participation will entail several (no fewer than 5) interviews of about 45-60 minutes, and observations in your pre-practicum and practicum classrooms. The interviews will be tape-recorded, with your permission. **The recordings and transcripts of the interviews will be archived in the Teachers for a New Era Evidence Team office. They will be part of a collection of materials that researchers are gathering related to teacher education and teaching.** It is possible that statements you make or ideas you present will be attributable to you. However, as explained below, we will take a number of precautions to protect your identity. Furthermore, our research seeks to highlight strategies that can benefit new teachers.

Your participation in this project is voluntary. You have the right to withdraw your consent or discontinue participation at any time. You are also welcome to ask questions at any time. Further, should we pose a question you would rather not answer; you have no obligation to do so.

We have designed this project to protect your privacy in all published reports or papers resulting from this study. We will assign all participants a code number so that even if someone were to gain access to research data, they would be unable to identify anyone by name. The list of code numbers and the research files will be kept locked in an office at Boston College. Moreover, in publishing any of this research, all contributors will be identified solely by their positions (e.g. high school history teacher) and will be assigned pseudonyms. The public schools involved will also be assigned pseudonyms and will only be identified in a cursory way (e.g. an urban high school in Boston that enrolls so many students, most of whom are from such-and-such racial/ethnic group).

As the report will be shared with administrators, teachers, and faculty, it is possible that statements you make or ideas you present about the program will be attributable to you, and this might engender some measure of professional concern to you. However, we will take a number of precautions to protect your identity, including allowing you to review our final report to remove any sections that seem potentially harmful to you. Furthermore, keep in mind that our research seeks to highlight strategies that can benefit new teachers, not highlight personal disagreements or tensions people may have.



Consequently, in presenting our overall findings, we will never draw on the thoughts of a single participant of this study to make a point.

If you would like a copy of the draft report we produce, you can request one by providing a mailing address. If after reading our draft report, you have any concerns that you wish to discuss, we will be glad to do so. If you find any aspect of the report offensive, inaccurate, or potentially threatening to you in any way, we will remove that section of the report. You are also welcome to a copy of the final report.

With your permission, we would like to save a copy of your interview for future work we hope to do in this area.

We appreciate your willingness to give your time to this project. If you have any questions or concerns regarding your rights as a research participant or with any aspect of this study, you may report them to Dr. Marilyn Cochran-Smith or Dr. Patrick McQuillan, co-investigators of this study, or to Dr Brinton Lykes, acting Associate Dean of the Lynch School of Education. If you have any questions about your rights as a participant in a research study, please call the Office for Human Research Participant Protection at 617-552-4778.

I understand the information above and voluntarily consent to participate in this research.

Signature of Participant \_\_\_\_\_

Date \_\_\_\_\_

Please initial here if we may tape record our interview \_\_\_\_\_

Please write your mailing address in the space provided below if you would like a copy of the draft of our report.

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### Informed Consent Form for Qualitative Case Studies Research Participants (YEAR 2)

You are being invited to participate in a research project that is directed by Dr. Marilyn Cochran-Smith & Dr. Patrick McQuillan of Boston College Lynch School of Education (LSOE) as part of the Teachers for a New Era Project. The study intends to broadly document the experiences and perceptions of learning to teach at Boston College. Hopefully this research will lead to a clearer sense of the relationship between learning to teach and practicing teaching that will lead to positive, professional opportunities for both university faculty and beginning teachers, and should improve our teacher education program. No individual teacher or faculty member will be the focus of this study.

Your participation will entail three interviews of about two hours, and observations in your classrooms. The interviews will be tape-recorded, with your permission. The recordings and transcripts of the interviews will be archived in the Teachers for a New Era Evidence Team office. They will be part of a collection of materials that researchers are gathering related to teacher education and teaching. It is possible that statements you make or ideas you present will be attributable to you. However, as explained below, we will take a number of precautions to protect your identity. Furthermore, our research seeks to highlight strategies that can benefit new teachers, and that may improve BC's program in ways that might impact you positively in the future. In addition, many participants in similar studies have found the opportunity to reflect on their teaching and their personal development as an added benefit for them.

Your participation in this project is voluntary. You have the right to withdraw your consent or discontinue participation at any time. You are also welcome to ask questions at any time. Further, if in the course of an interview we should we pose a question you would rather not answer; you have no obligation to do so.

We have designed this project to protect your privacy in all published reports or papers resulting from this study. No one will be identified specifically in anything we write. For example, you will be referred to as "a male university teacher education student" or given a pseudonym. We will assign all participants a code number that will be attached to all data that we collect from you. Your name will not appear on any interview transcripts or course assignments so that even if someone were to gain access to research data, they would be unable to identify anyone by name. The list of code numbers and the research files will be kept locked in an office at Boston College. Moreover, in publishing any of this research, all contributors will be identified by a pseudonym and a general description that includes grade level, general information about the school, and race, gender and age of participant.. The public schools involved will also be assigned pseudonyms and will only be identified in a cursory way (e.g. an urban high school in Boston that enrolls so many students, most of whom are from such-and-such racial/ethnic group).

As the report will be shared with administrators, teachers, and faculty, it is possible that statements you make or ideas you present about the program will be attributable to you, and this might engender some measure of professional concern to you. However, we will take a number of precautions to protect your identity, as described above. Furthermore, keep in mind that our research seeks to highlight strategies that can benefit new teachers, not highlight personal disagreements or tensions people may have. If you wish, transcribed interviews and descriptive observational data are available for review. In addition, all papers and articles will be made available. Please speak with your researcher regarding access to these materials. In addition, with your permission, we would like to save a copy of your interviews, observations, and other data we collect for future work we hope to do in this area.

We appreciate your willingness to give your time to this project. If you have any questions about this study you may ask one of the co-investigators of the study: Dr. Marilyn Cochran-Smith at (617) 552-0674 or by email at [cochrans@bc.edu](mailto:cochrans@bc.edu), or Dr. Patrick McQuillan, at (617) 552-0676, or at [mcquilpa@bc.edu](mailto:mcquilpa@bc.edu). You may also contact Dr Joseph O'Keefe, Dean of the Lynch School of Education. If you have any questions about your rights as a participant in a research study, please call the Office for Human Research Participant Protection at 617-552-4778.

I understand the information above and voluntarily consent to participate in this research.

Signature of Participant \_\_\_\_\_

Printed Name \_\_\_\_\_

Date \_\_\_\_\_

Please initial here if we may tape record our interviews \_\_\_\_\_

### Principal Consent for School Observations

Boston College  
Lynch School of Education  
Chestnut Hill, MA 02467



Principal  
School Name  
School Address

This is to confirm that *Teacher Candidate*, a BC Grad Pre-prac assigned to School Name this fall, is among a total of 11 graduate students in pre-practicum placements K-12 in our partnership schools, who has agreed to participate in a research project to explore how people learn to teach.

She will be observed by BC PhD Student Researcher, *Cindy Jong*, this fall semester at School Name as part of the research project.

Additional observations of this student teacher may occur during the full practicum experience in Spring, 2006, should she remain at School Name.

Questions about the study may also be addressed by the co-investigators of the study: Dr. Marilyn Cochran-Smith at (617) 552-0674 or by email at [cochrans@bc.edu](mailto:cochrans@bc.edu), or Dr. Patrick McQuillan, at (617) 552-0676, or at [mcquilpa@bc.edu](mailto:mcquilpa@bc.edu).

\_\_\_\_\_  
Signature of Principal

\_\_\_\_\_  
Date

This consent form may be faxed to the BC Practicum office at 617-552-0654.



### **Informed Consent Form for Qualitative Case Studies Research Participants: Faculty**

You are being invited to participate in a research project that is directed by Dr. Marilyn Cochran-Smith & Dr. Patrick McQuillan of Boston College Lynch School of Education (LSOE) as part of the Teachers for a New Era Project. The study intends to broadly document the experiences and perceptions of learning to teach at Boston College. Hopefully this research will lead to a clearer sense of the relationship between learning to teach and practicing teaching that will lead to positive, professional opportunities for both university faculty and beginning teachers, and should improve our teacher education program. No individual teacher or faculty member will be the focus of this study.

Your participation will include one interview of about 45-60 minutes, and observations in your BC courses. The interviews will be tape-recorded, with your permission. **The recordings and transcripts of the interviews will be archived in the Teachers for a New Era Evidence Team office. They will be part of a collection of materials that researchers are gathering related to teacher education and teaching.** It is possible that statements you make or ideas you present will be attributable to you. However, as explained below, we will take a number of precautions to protect your identity. Furthermore, our research seeks to highlight strategies that can benefit new teachers, and that may improve BC's program in ways that might impact you positively in the future.

Your participation in this project is voluntary. You have the right to withdraw your consent or discontinue participation at any time. You are also welcome to ask questions at any time. Further, if in the course of an interview we should we pose a question you would rather not answer, you have no obligation to do so.

We have designed this project to protect your privacy in all published reports or papers resulting from this study. No one will be identified specifically in anything we write. For example, you will be referred to as "a male university teacher education faculty member" or given a pseudonym. We will assign all participants a code number that will be attached to all data that we collect from you. Your name will not appear on any interview transcripts or course assignments so that even if someone were to gain access to research data, they would be unable to identify anyone by name. The list of code numbers and the research files will be kept locked in an office at Boston College. Moreover, in publishing any of this research, all contributors will be identified by a pseudonym and a general description that includes grade level, general information about the school, and race, gender and age of participant.. The public schools involved will also be assigned

pseudonyms and will only be identified in a cursory way (e.g. an urban high school in Boston that enrolls so many students, most of whom are from such-and-such racial/ethnic group.)

As the report will be shared with administrators, teachers, and faculty, it is possible that statements you make or ideas you present about the program will be attributable to you, and this might engender some measure of professional concern to you. However, we will take a number of precautions to protect your identity, as described above. Furthermore, keep in mind that our research seeks to highlight strategies that can benefit new teachers, not highlight personal disagreements or tensions people may have. If you wish, transcribed interviews and descriptive observational data are available for review. In addition, all papers and articles will be made available. Please speak with your researcher regarding access to these materials. In addition, with your permission, we would like to save a copy of your interviews, observations, and other data we collect for future work we hope to do in this area.

We appreciate your willingness to give your time to this project. If you have any questions about this study you may ask one of the co-investigators of the study: Dr. Marilyn Cochran-Smith at (617) 552-0674 or by email at [cochrans@bc.edu](mailto:cochrans@bc.edu), or Dr. Patrick McQuillan,, at (617) 552-0676, or at [mcquilpa@bc.edu](mailto:mcquilpa@bc.edu). You may also contact Dr Brinton Lykes, acting Associate Dean of the Lynch School of Education. If you have any questions about your rights as a participant in a research study, please call the Office for Human Research Participant Protection at 617-552-4778.

I understand the information above and voluntarily consent to participate in this research.

Signature of Participant \_\_\_\_\_

Date \_\_\_\_\_

Please initial here if we may tape record our interview \_\_\_\_\_

## APPENDIX G

RESEARCH INSTITUTE ON SECONDARY EDUCATION REFORM (RISER):  
STANDARDS AND SCORING CRITERIA FOR MATHEMATICS TASKS AND  
PUPIL WORK

Research Institute on Secondary  
Education Reform (RISER)  
*for Youth with Disabilities*

Standards and Scoring Criteria for  
Assessment Tasks and Student Performance

December, 2001



1025 West Johnson Street, Suite 461  
University of Wisconsin-Madison  
Madison, WI 53706  
608-263-0630  
877-866-3382  
608-265-0538 fax



## Standards and Scoring Criteria for Mathematics Tasks

### General Rules

The main point here is to estimate the extent to which successful completion of the task requires the kind of cognitive work indicated by each of the three standards: Construction of Knowledge, Elaborated Written Mathematical Communication, and Connections to Students' Lives. Each standard will be scored according to different rules, but the following apply to all three standards.

- ▶ If a task has different parts that imply different expectations (e.g., worksheet/short answer questions and a question asking for explanations of some conclusions), the score should reflect the teacher's apparent dominant or overall expectations. Overall expectations are indicated by the proportion of time or effort spent on different parts of the task and criteria for evaluation, if stated by the teacher.
- ▶ Take into account what students can reasonably be expected to do at the grade level.
- ▶ When it is difficult to decide between two scores, give the higher score only when a persuasive case can be made that the task meets minimal criteria for the higher score.
- ▶ If the specific wording of the criteria is not helpful in making judgments, base the score on the general intent or spirit of the standard described in the introductory paragraphs of the standard.

### Scoring Criteria

#### **Standard 1: Construction of Knowledge**

The task asks students to organize and interpret information in addressing a mathematical concept, problem, or issue.

Consider the extent to which the task asks the student to organize and interpret information, rather than to retrieve or to reproduce fragments of knowledge or to repeatedly apply previously learned algorithms and procedures.

Possible indicators of mathematical organization are tasks that ask students to decide among algorithms, to chart and graph data, or to solve multi-step problems.

Possible indicators of mathematical interpretation are tasks that ask students to consider alternative solutions or strategies, to create their own mathematical problems, to create a mathematical generalization or abstraction, or to invent their own solution methods.

These indicators can be inferred either through explicit instructions from the teacher or through a task that cannot be successfully completed without students doing these things.

**3** = The task's dominant expectation is for students to interpret, analyze, synthesize, or evaluate information, rather than merely to reproduce information.

**2** = There is some expectation for students to interpret, analyze, synthesize, or evaluate information, rather than merely to reproduce information.

**1** = There is very little or no expectation for students to interpret, analyze, synthesize, or evaluate information. Its dominant expectation is for students to retrieve or reproduce fragments of knowledge or to repeatedly apply previously learned algorithms and procedures.

### **Standard 2: Elaborated Written Communication**

The task asks students to elaborate on their understanding, explanations, or conclusions through extended writing.

Consider the extent to which the task requires students to elaborate on their ideas and conclusions through extended writing in mathematics.

Possible indicators of extended writing are tasks that ask students to generate prose (e.g., write a paragraph), graphs, tables, equations, diagrams, or sketches.

**4** = Analysis / Persuasion / Theory. Explicit call for generalization AND support. The task requires the student to show his/her solution path, AND to explain the solution path with evidence such as models or examples.

**3** = Report / Summary. Call for generalization OR support. The task asks students, using narrative or expository writing, either to draw conclusions or make generalizations or arguments, OR to offer examples, summaries, illustrations, details, or reasons, but not both.

**2** = Short-answer exercises. The task or its parts can be answered with only one or two sentences, clauses, or phrasal fragments that complete a thought. Students may be asked to show some work or give some examples, but this is not emphasized and not much detail is requested.

**1** = Fill-in-the-blank or multiple choice exercises. The task requires no extended writing, only giving mathematical answers or definitions.

### **Standard 3: Connection to Students' Lives**

The task asks students to address a concept, problem or issue that is similar to one that they have encountered or are likely to encounter in daily life outside of school.

Consider the extent to which the task presents students with a mathematical question, issue, or problem that they have actually encountered or are likely to encounter outside of school. Estimating personal budgets would qualify as a real world problem but completing a geometric proof would not.

Certain kinds of school knowledge may be considered valuable in social, civic, or vocational situations beyond the classroom (e.g., knowing basic arithmetic facts or percentages). However, task demands for "basic" knowledge will not be counted here unless the task requires applying such knowledge to

a specific mathematical problem likely to be encountered beyond the classroom.

**3** = The question, issue, or problem clearly resembles one that students have encountered or are likely to encounter in their lives. The task asks students to connect the topic to experiences, observations, feelings, or situations significant in their lives.

**2** = The question, issue, or problem bears some resemblance to one that students have encountered or are likely to encounter in their lives, but the connections are not immediately apparent. The task offers the opportunity for students to connect the topic to experiences, observations, feelings, or situations significant in their lives, but does not explicitly call for them to do so.

**1** = The problem has virtually no resemblance to questions, issues, or problems that students have encountered or are likely to encounter in their lives. The task offers very minimal or no opportunity for students to connect the topic to experiences, observations, feelings, or situations significant in their lives.

## Standards and Scoring Criteria for Student Work in Mathematics

### General Rules

The task is to estimate the extent to which the student's performance illustrates the kind of cognitive work indicated by each of the three standards: Mathematical Analysis, Disciplinary Concepts, and Elaborated Written Mathematical Communication. Each standard will be scored according to different rules, but the following apply to all three standards:

- ▶ Scores should be based only on evidence in the student's performance relevant to the criteria. Do not consider things such as following directions, correct spelling, neatness, etc. unless they are relevant to the criteria.
- ▶ Scores may be limited by tasks which fail to call for mathematical analysis, disciplinary conceptual understanding, or elaborated mathematical written communication, but the scores must be based only upon the work shown.
- ▶ Take into account what students can reasonably be expected to do at the grade level. However, scores should still be assigned according to criteria in the standards, not relative to other papers that have been scored.
- ▶ When it is difficult to decide between two scores, give the higher score only when a persuasive case can be made that the paper meets minimal criteria for the higher score.
- ▶ If the specific wording of the criteria is not helpful in making judgments, base the score on the general intent or spirit of the standard described in the introductory paragraphs of the standard.
- ▶ Completion of the task is not necessary to score high.

### Scoring Criteria

#### **Standard 1: Mathematical Analysis**

Student performance demonstrates thinking about mathematical content by using mathematical analysis.

Consider the extent to which the student demonstrates thinking that goes beyond mechanically recording or reproducing facts, rules, and definitions or mechanically applying algorithms.

Possible indicators of mathematical analysis are organizing, synthesizing, interpreting, hypothesizing, describing patterns, making models or simulations, constructing mathematical arguments, or inventing procedures.

The standard of mathematical analysis calls attention to the fact that the content or focus of the analysis should be mathematics. There are two guiding questions here:

- First, has the student demonstrated mathematical analysis? To answer this, consider whether the student has organized, interpreted, synthesized, hypothesized, invented, etc., or whether the student has only recorded, reproduced, or mechanically applied rules, definitions, algorithms. If work is not shown, correct answers can be taken as an indication of analysis if it is clear that the question would require analysis to answer it correctly.
- Second, how often has the student demonstrated mathematical analysis? To answer this, consider the proportion of the student's work in which mathematical analysis is involved.

To score 3 or 4, there should be no significant mathematical errors in the student's work.

If the student showed only the answer(s) to the task and it is incorrect, score it 1. If the student showed only the answer(s) to the task and it is correct, decide how much analysis is involved to produce a correct answer, and score according to the rules above. It is not necessary for the analysis to be at a high conceptual level to score a 3 or 4.

4 = Mathematical analysis was involved throughout the student's work.

3 = Mathematical analysis was involved in a significant proportion of the student's work.

2 = Mathematical analysis was involved in some portion of the student's work.

1 = Mathematical analysis constituted no part of the student's work.

In scoring analysis, the proportion of work that illustrates analysis is more important than the number of statements indicating analysis.

## **Standard 2: Disciplinary Concepts**

Student performance demonstrates understanding of important mathematical concepts central to the task.

Consider the extent to which the student demonstrates use and understanding of mathematical concepts. Low scores may be due to a task that fails to call for understanding of mathematical concepts.

Possible indicators of understanding important mathematical concepts central to the task are expanding upon definitions, representing concepts in alternate ways or contexts, or making connections to other mathematical concepts, to other disciplines, or to real-world situations.

A guiding question for using this standard is, "Does the student show understanding of the fundamental ideas relevant to the mathematics used in the task?" Correct use of algorithms does not necessarily indicate conceptual understanding of the material.

Even if no work is shown the work may still receive a 3 or 4. Correct answers can be taken as an indication of the level of conceptual understanding if it is clear to the scorer that the task or question requires conceptual understanding in order to be completed successfully. In this case, the scorer must determine the level of understanding and score it appropriately.

The score should not be based on the proportion of student work central to the task that shows conceptual understanding but on the quality of the understanding wherever it occurs in the work.