IMPLEMENTATION OF A MATH WORKSHOP MODEL IN THE ELEMENTARY CLASSROOM: UNDERSTANDING HOW TEACHERS DIFFERENTIATE INSTRUCTION

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Abstract

The purpose of this exploratory case study was to discover the ways in which elementary teachers implement a math workshop model and differentiate math instruction to improve math achievement for elementary students. Constructivist and differentiated learning theories provided a context to explore how elementary teachers implement math workshop and design instruction to meet diverse student needs. The primary research question guiding this study was: *how do elementary teachers use their knowledge and understanding of math workshop in classroom math instruction in a Southeast Massachusetts school district to improve math instruction?* Math workshop was generally defined as teachers strategically selecting appropriate tasks and orchestrating classroom discourse to maximize learning opportunities geared to developing students’ conceptual understanding, fluency with numbers, and problem solving strategies. The analysis of the data indicated that providing teachers with school-based professional development delivered by math specialists with sustained support and follow-up had more influence in changing teachers’ instructional practices than traditional professional development workshops. In addition, the study’s findings highlighted elements that impacted teachers’ implementation of math workshop in their classrooms: student grouping practices, incorporation of differentiated instruction, peer collaboration and support, and teacher autonomy in instructional decision-making.

*Keywords*: math workshop, differentiated instruction, professional development, elementary mathematics instruction, elementary math achievement
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Chapter 1: INTRODUCTION

Overview

American students continue to demonstrate lower math and science achievement than students in other developed countries, ranking ninth on the 2011 Trends in International Mathematics and Science Study (TIMSS). In 2015, average mathematics scores for White, Black, and Hispanic eighth-grade students were lower compared to 2013. Only 40% of fourth graders and 33% of eighth graders reached their grade level proficiency in mathematics on the 2015 National Assessment of Educational Progress (NAEP). Despite efforts to increase K-12 math achievement through increased accountability and development of state standards, achievement gaps among different demographic groups at grades K, 4, and 8 continue to be a critical educational concern (U.S. Department of Education, 2014). The 2013 Program for International Assessment (PISA) report found that students in the United States have weaknesses in performing mathematics tasks with higher cognitive demands, such as interpreting mathematical aspects of real-life problems and translating them into mathematical terms (Organization for Economic Co-operation and Development, 2013).

While national and international math achievement reports paint a rather gloomy picture overall, recent reports have detailed encouraging math assessment data for certain identified subgroups. According to the 2015 NAEP report, White, Black, Hispanic, and Asian/Pacific Islander students—as well as both male and female students—all scored higher in mathematics and reading at both grades 4 and 8 as compared to the early 1990s. However, not all of the same groups made gains from 2011 to 2015. For example, Hispanic students in grade 4 scored higher in mathematics in 2015 than in 2011, but there was no significant change in scores for Black
students in grade 4. In 2015, there was no significant change from 2011 in average math scores for male students in grade 4, but average math scores for female students in the same grade were lower (U.S. Dept. of Education, 2015). While disparities remain across demographic groups, researchers have found evidence that improved pedagogical practices can make a difference for low performing students (OECD, 2012). Darling-Hammond (2000) found that “the effects of well-prepared teachers on student achievement can be stronger than the influences of student background factors, such as poverty, language background, and minority status” (p. 33).

Classroom teaching and instructional methods are the most critical factors in maximizing achievement and engagement of students (Black, 2007). Researchers have encouraged teachers to plan their instruction carefully and to develop a large repertoire of instructional approaches that can be adapted to the diverse needs of students (OECD, 2012, p. 137). Sustained professional development supports may offer teachers an opportunity to reflect and change their teaching strategies (Bonner, 2006).

**Research Problem**

The foundation of a math workshop instructional model requires developing a conceptual understanding of mathematics and in-depth problem solving for all learners through active engagement, flexible grouping, and differentiated lessons; however, the ways in which teachers are implementing the math workshop model in their classrooms remains unclear. If the goal is to improve math education for all students, then there is a critical need to discover the most effective math pedagogies for elementary classrooms. The purpose of this exploratory case study was to discover the ways in which elementary teachers implement a math workshop model and
differentiate math instruction in a Southeast Massachusetts school district to improve math achievement for elementary students.

This study may be of benefit to school district administrators and educators who are responsible for developing and implementing math instruction, as well as to post-secondary educators who design teacher preparation programs. This study will also inform the decision making of the researcher/school principal by providing direction to improve math instruction and increase student learning in the school. Moreover, the research will contribute to the educational literature through the lens of constructivist and differentiated learning theories and within the contexts of instructional methodologies and professional development for teachers. The ultimate goal of this study was to better understand how to improve math instruction and to help close the mathematics achievement gap by providing all learners an equal opportunity to be successful students.

**Justification for the Research Problem**

Young children’s experiences shape their future attitudes toward mathematics (Philippou and Christou, 1998). Children gradually develop an intuitive and practical arithmetic that they use successfully in their daily lives to solve problems confidently (Ginsburg, 1989). There is strong evidence that even very young students are quite capable of exploring problem situations and inventing strategies to solve those problems (Carpenter, Franke, Jacobs, Fennema, & Empson, 1998). Research has shown that students should be taught mathematics in a way that fosters understanding of mathematics concepts, procedures, and problem solving (NCTM, 1991). In addition to making a commitment to problem solving in the mathematics curriculum, teachers need to be strategic in selecting appropriate tasks and orchestrating classroom discourse to maximize learning opportunities. The central purpose of the math workshop model of
instruction is to develop students’ ability to solve problems accurately and efficiently by implementing targeted instruction based on informal assessment. McREL (2010) described effective math pedagogy as “highly interactive as students explore problems, formulate ideas, and check those ideas with peers and with their teacher through discussion and collaboration” (p. 66).

It is imperative that our math instruction transforms in ways that will prepare students to meet 21st century demands and that will advance new innovations in our rapidly changing global society. Science, Technology, Engineering, and Math (STEM) subject areas can no longer be courses of study for a limited number of students. Business leaders, educators, industry experts, and policymakers are rallying around the importance of STEM instruction in education. This is a key issue for K-12 education and a prerequisite for creating the kind of workforce our country needs to meet the demands of business in an increasingly complex and technology driven economy (Bakia, Murphy, Anderson & Trinidad, 2011). Cook, Morse, and Neuhauser (2015) assert in the 2015 U.S. News/Raytheon STEM Index:

There has been little progress made toward decreasing racial and gender disparities for interest and aptitude in STEM. In spite of a range of research projects and education initiatives focused on studying and closing the gaps, certain cultural issues—early bias, discrimination and social expectations—still play a significant role, diverting students from the STEM pipeline, often even before they reach college. (para. 3)

Math instruction needs to change to meet the contemporary learning styles and modern needs of our students. Students with mathematical competence have other critical abilities such
as reasoning, abstraction, pattern/relationship recognition, and conceptual thinking that can be applied in a variety of contexts (U.S. Department of Education, 2008).

**Deficiencies in the Evidence**

While ample research has focused on differentiated learning pedagogy across grade levels, few studies have examined teachers’ implementation of math workshop as an instructional approach to differentiating instruction. Readers’ and writers’ workshop literacy instruction has been studied and refined (Hoffer, 2012), but little research has focused on similar methodologies for math instruction. A large body of research has focused on “hands-on” learning and how to actively engage students during math lessons. “Better than simply offering kinesthetic experiences, we need to ensure that all tasks are minds-on, that is, requiring students to immerse themselves in challenging thinking that culminates in conceptual understanding” (Hoffer, 2012, p. 6). A central goal of the study was to understand how teachers use math workshop to differentiate instruction and engage all students in meaningful differentiated problem solving opportunities where they are encouraged to discuss and justify their problem-solving strategies and solutions (Thornton, Langrall & Jones, 1997).

**Purpose of the Study**

The purpose of this exploratory case study was to discover the ways in which elementary teachers use their knowledge and understanding of math workshop when planning and executing classroom math instruction in a Southeast Massachusetts school district to improve student math achievement. Math workshop is an instructional model in which teachers create and facilitate learning experiences for individuals, partners, and small-groups to cultivate math learners’ deep conceptual understanding, fluency with numbers, and problem solving strategies (Siena, 2009).
More specifically, this study examined the ways in which teachers utilize math workshop instruction to differentiate instruction. Differentiated instruction is an approach to teaching that involves active planning for student differences in classrooms to maximize student growth and individual success (Tomlinson & Allan, 2000).

**Positionality Statement**

In the constructivist paradigm, researchers first acknowledge the importance and influence of their own backgrounds on their perspectives and interpretations (Butin, 2010). Van Dijk (1997) asserted that a researcher who is a member of a group is likely to perceive and represent the group in a way that constructs a social identity that protects and serves the interest of the group. In the proposed study, teacher participants work in the same school district where the researcher is an elementary principal. The researcher conducted this study as a co-participant; however, teachers from the researcher’s school did not participate. The researcher acknowledged her dual roles as principal and researcher so that bias and tension were clearly addressed when conducting the study and drawing conclusions. The researcher was clear in how she presented her intentions and in how she interacted with teacher participants during the research process. In order to protect the validity and credibility of the study, the researcher was extremely cautious in her choice of data-encoding methods to ensure confidentiality so that the participants did not feel threatened in any way about the use of study data.

Since math workshop was a district-supported instructional model, the researcher was careful to not promote a specific agenda, regardless of the input from teachers. The researcher informed participants that she would pass on their questions, concerns, and input to those in charge of decision-making and would provide them with whatever information she was able at
any given time. In order to combat participants potentially finding it difficult to give the researcher negative feedback due to her position as a school principal, the researcher provided a method for participants to give anonymous feedback. The researcher also structured a safe environment for discussion.

The researcher obtained approval for teacher participation from the district Superintendent prior to beginning the research. This permission was especially important due to the possible influence of the research on the school community. Though standardized assessment data is open to public scrutiny, analyzing and discussing student assessment data may have been controversial. The researcher reassured teachers that the goal of the study was to improve lesson planning and instructional strategies and would never be used as part of the teacher evaluation process. Explaining the purpose and likely use of the outcomes of the study to all stakeholders in the school community was essential in designing a fair and ethical study (Mertens, 2014). The researcher also acknowledged that the study could potentially influence math instruction within the district if the researcher discussed the findings with colleagues.

All study participants took part in interviews and some participants provided documents pertaining to math instruction in their classrooms. Three teachers permitted the researcher to conduct a field observation in their classroom during a math workshop lesson at a mutually convenient date and time.

**Research Questions**

Central research question: How do elementary teachers use their knowledge and understanding of math workshop to improve math achievement when planning and executing classroom math instruction in a Southeast Massachusetts school district?
Sub-question 1: How do elementary teachers utilize a math workshop model to differentiate instruction and meet the diverse needs of learners?

Sub-question 2: What support systems need to be in place to ensure that elementary teachers understand and implement a math workshop model when executing classroom math instruction?

Sub-question 3: How do math specialists support teachers in implementing a math workshop model in their classrooms?

**Significance of the Research Problem**

Students often sit through math classes conforming to a persistent curriculum regardless of their individual levels of mastery of previous or prerequisite concepts (Willis, 2010). Students often lose interest in math when lessons repeat what they have already mastered. “The results of analyses of standards, textbooks, and classroom instruction all support the conclusion that the mathematics curriculum in the United States is diffuse and repetitive” (Willis, 2010, p. 233). Through classroom observations, Hiebert, Martin, and Menon (2005) also found a redundancy in math instruction; more than fifty percent of instructional time in each math class was spent on reviewing previously taught material. Students also develop negative attitudes as a result of low self-expectations and as a result of past experiences with math, parental bias against math, inadequate skills to succeed at math learning, failure to engage math through learning strengths, and fear of making mistakes (Willis, 2010). Traditional mathematics instruction expects students to “copy and practice” what the teacher does rather than posing challenging and engaging problems that inspire discussion and passion about the content (Ball, 1995, p. 671). As Ball
envisioned, “The image of a math class inspired by greater connection to the real world and greater personal sense of student ownership seems both reasonable and appealing” (p. 671).

Mathematics assessment data suggest that achievement gaps persist among subgroups of students in the United States, and statistical evidence indicates that this gap may be widening. The 2013 and 2015 National Assessment of Educational Progress (NAEP) showed that Black and Hispanic students continue to trail significantly behind their White peers, scoring an average of 24 test-score points lower on NAEP math assessments at the 4th and 8th grade levels. Many studies document the challenges and lack of differentiation in heterogeneously grouped classes (VanTassel-Baska & Stambaugh, 2005). For example, Westberg, Archambault, Dobyns, and Salvin (1993) found that there was a lack of differentiation in instruction and curriculum in 84% of the learning experiences in third- and fourth-grade classrooms. Higher achieving gifted students may receive less differentiation than their peers due to a cultural belief that these students will succeed without sustained teacher adaptations (Brighton, Hertberg, Callahan, Tomlinson, & Moon, 2005). Rubenstein, Gilson, Bruce-Davis, and Gubbins (2015) found that “many teachers are able to differentiate if provided appropriate support and materials” (p. 159).

In a math workshop model, the teacher differentiates instruction to foster a deep understanding of rich, rigorous mathematics that is attainable by all students. The successful implementation of math workshop in the classroom is dependent on effective lesson planning, and so exploring the ways teachers plan lessons to meet students’ needs, readiness, and interests will impact delivery of classroom instruction (Leonard & Austin, 2012). The role of the teacher is to revise, select, and develop tasks likely to foster the development of understanding and mastery of procedures in a way that will also promote the development of abilities to solve problems, reason, and communicate mathematically (NCTM, 1991).
Theoretical Framework

Theory provides the framework for interpreting facts and making decisions. Kepner (2008) contended that teachers of mathematics make hundreds of instructional, management, and assessment decisions every day, and that these decisions are the foundations of effective teaching. “Being familiar with the arguments of theorists enables the practitioner to deploy a wide range of experience and understanding in resolving the problems of today” (Bush, 2003, p. 24). Teachers sometimes explain their decision-making as just “common sense.” However, most practical decisions are based on implicit theories. “Theorizing is taking place without it being acknowledged as such” (Hughes, 1985, p. 31). Bush (2003) asserted that the “ultimate test of theory is whether it improves practice” (p. 194).

The intended outcome of this study was to better understand how teachers implement a math workshop model after participating in district-provided professional development. This study was framed by differentiated learning theory, which is grounded in constructivism, in order to better grasp how the math workshop model of instruction can be used to design instruction to meet the diverse needs of students. Differentiated instruction emphasizes the active participation of students in a learning process in which the construction of knowledge emerges due to the interactions between students and their environment. Constructivist theory originates from the field of cognitive science, particularly from the later work of Jean Piaget, the sociocultural theory of Lev Vygotsky, and the cognitive psychology of Jerome Bruner.

Constructivist Theory. Bruner (1994) suggested that there are three stages of learning: enactive, iconic, and symbolic. In the enactive stage, learners begin to develop an understanding of the environment through active manipulation of materials to understand how they work. In
the iconic stage, learners make mental images of the materials and no longer require objects to manipulate, as they are now able to visualize concrete information. Finally, at the symbolic stage, learners are able to use abstract ideas to represent the world. According to Bruner (1994), effective teachers must provide assistance and guidance through the three stages of learning by scaffolding. Wood, Bruner, and Ross (1976) introduced the term scaffolding to describe “those elements of the task that are initially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence” (p. 90). Effective scaffolding bridges the novice’s current knowledge with new knowledge via “prompts, clues, modeling, explanation, leading questions, discussion, joint participation, encouragement, and control of the child’s attention” (Miller, 2011, p. 175).

For scaffolding to be effective, Piaget’s (1952) stages of cognitive development, in which he described intelligence as not being fully developed until late adolescence or early adulthood, need to be considered. Bruner (1994) and Piaget (1952) concluded that learning is a process in which students construct new ideas based on current or past experiences and that those experiences determine the level of processing for each stage. Implicit instruction occurs as the adult and child form shared understandings through their interactions. “Instruction is what happens in those intermediate stages between total teacher responsibility (modeling) and total student responsibility (practice or application)” (Pearson, 1985, p. 731). Graves and Fitzgerald (2003) concurred: “It is through this process of gradually assuming more and more responsibility for their learning that students become more competent, independent learners” (p. 98). With this in mind, the best pedagogical practices take into account students’ cognitive development, where teachers plan instruction based on the developmental levels of their students. When teachers set up the learning environment to include authentic learning experiences and social interactions,
students are able to construct their own meanings on which they build a foundation for more advanced mathematical understanding.

**Zone of proximal development.** Sociocultural theorists see learning as a social construct in which the student-teacher relationship is collaborative, with the learning experience becoming reciprocal (Shambaugh & Magliaro, 2001). In the 1920’s, Lev Vygotsky established the foundation for studying how children’s development is influenced by their social experiences. He theorized that learning and development are dependent on the social context in which they occur. He advocated for an approach focused on the process of development rather than on the product. For example, in the context of a classroom math lesson, the teacher would focus on how the student applies problem-solving strategies to arrive at an answer rather than attending to the final answer as being either correct or incorrect. Vygotsky (1978) defined the “distance between a child’s actual developmental level as determined by independent problem solving” and the “potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (p. 86) as the zone of proximal development (ZPD). Vygotsky believed that learning is a social experience involving a more knowledgeable other (MKO) who has a better understanding or higher ability level than the learner. In the view of Vygotsky, the ZPD is different for each child (Miller, 2011). Children develop at different rates and in different ways.

Wells (1999) expanded on this theory by asserting that ZPD applies to “any situation in which, while participating in an activity, individuals are in the process of developing mastery of a practice or understanding a topic” (p. 333). The ZPD focuses on the learner’s potential and/or readiness to learn. “It is within this zone that a person’s potential for new learning is strongest” (Fabes & Martin, 2001, p. 42). Rogoff (1990) viewed the ZPD “as a dynamic region of
sensitivity to learning the skills of culture, in which children develop through participation in problem solving with more experienced members of a group” (p. 90). This guided participation involves children and others in a collaborative process of “building bridges” from children’s present understanding and skills to reach new understandings and skills that requires “the arranging and structuring of children’s participation in activities” (Rogoff, 1990, p. 8). Cole (1985) argued that within the ZPD, culture and cognition create each other. Differentiated learning theory extends sociocultural learning theory into classroom practice to match the learning needs of individual children with the appropriate instructional methods.

**Differentiated Learning Theory.** Guba and Lincoln (1989) emphasized the limitations and weaknesses of traditional knowledge-and content-oriented instructional practices. Differentiated learning theory developed in response to the need to transform math instruction and to increase math achievement for all students. Ineffectiveness has been one of the main problems plaguing modern educational systems. Previous research revealed that educational systems fail to meet the challenge of providing quality and equity, leading to achievement gaps among different groups of students (OECD, 2012). Narrowing achievement gaps has been the main objective of recent educational reforms. Although many curriculum reforms and policies were created based on providing and promoting equity and increasing the quality of education, the results have not been as successful as anticipated. It is the failure of schools to provide education appropriate to different needs that leads students to fail (Faubert, 2012). Traditional and undifferentiated instruction that does not meet the needs of all learners is seen as one of the main causes of this problem (Valiande & Koutselini, 2010).

Supporters of differentiation and its effectiveness state that it is the only way to successfully address the learning needs of all students in mixed-ability classrooms (Tomlinson,
Differentiation guides planning and instruction in mixed-ability classrooms based on students and their individual needs. Differentiation can be defined as the instructive approach by which teachers modify the curriculum, their teaching methods, educational materials, learning activities, and assessments according to students’ varied needs to maximize learning opportunities for every student (Bearne, 1996). Differentiated instruction, first proposed as a teaching practice by Tomlinson (1999), is seen as adjusting the teaching process to accommodate the broad span of students’ differences in mixed-ability classrooms, such as student readiness, interests, and learning styles (Tomlinson 1999, 2001).

Contemporary student populations are becoming increasingly academically diverse (Hall, 2002; Tomlinson, 2004). Learning within the inclusive classroom is influenced by a student’s gender, culture, experiences, aptitudes, and interests and by the teaching approaches employed (Stronge, Tucker & Hindman, 2004; Tomlinson, 2004). It is necessary to take into account the vast differences among students in a classroom, acknowledging each student’s strengths while accommodating their limitations (Tomlinson, 2002). The main principle of differentiated instruction is that teaching approaches should vary and be adapted in relation to individual students and their diversity of needs. The teacher is challenged to facilitate learning for students of different readiness levels, interests, and learning profiles (Tomlinson, 2003). The model of differentiated instruction requires teachers to be flexible and to adjust their curriculum and presentation of information (Tomlinson, 2001). Koutselini & Gagatsis (2003) described differentiated teaching as a process in which students are facilitated to construct their knowledge by maximizing motivation for cognitive and metacognitive growth that will eventually improve academic outcomes for all students.
Student-centered instruction is rooted in constructivism. Using constructivist theory as a contextual lens is consistent with the foundation of the workshop model of instruction: students constructing meaning through purposeful activities that are designed to respond to their level of understanding and skill through scaffolded instruction. Additionally, differentiated learning theory, derived from the work of constructivists, provided a context in which to explore the ways in which teachers tailor instruction to maximize learning based on their knowledge of students’ individual strengths and needs.

Research Context

In the current study, beginning in the 2014-2015 school year, the district-wide expectation was for teachers to follow the school district’s math curriculum by incorporating new program materials within a math workshop instructional model. While reading and writing workshops had been the standard methods of instruction in the district for many years, math instruction had more traditionally consisted of whole group instruction accompanied by some small-group intervention support with published math program materials.

As a precursor to the math workshop initiative, a new district math curriculum aligned with the 2011 Massachusetts Math Curriculum Framework (merging the Common Core State Standards (CCSS) for Mathematics with additional Massachusetts standards and other features) was developed by a team of teachers and administrators. Beginning in 2012, teachers received two years of professional development in standards-based math instruction. Teachers worked with a math consultant to develop standards-based lessons and activities for each grade level. Based on teacher feedback and a need for consistency across the district’s six elementary schools, the enVisionMATH program was purchased that addressed the CCSS. School district administrators determined that math instruction needed to be aligned with current literacy
instruction practices to promote differentiated instruction, close achievement gaps, and challenge high-achieving students.

Teachers received professional development from product representatives focused on introducing the print and online components at the beginning of the 2014-2015 school year, with a follow-up training session later the school year. Math specialists in each elementary school provided support for teachers by modeling instruction, co-teaching math lessons, designing assessments, and assisting in lesson planning.

Professional development focused on student learning and helping teachers develop pedagogical skills to teach specific content has strong positive effects on practice (Wenglinsky, 2000). The most useful professional development emphasizes active teaching, assessment, observation, and reflection rather than abstract discussions (Darling-Hammond & McLaughlin, 1995). Cerit (2013) asserted that “Teachers’ efficacy beliefs for student engagement and instructional strategies have an important effect on their willingness to implement the curriculum reform” (p. 263).

This case study explored the ways in which elementary teachers implement a math workshop model and differentiate instruction. The inquiry-based workshop model provides a menu of multilevel math tasks within the daily math block that focus on similar mathematical content. Math workshop promotes a culture of engagement and individualization that gives mathematical access to every learner in the classroom community. Leonard and Austin (2012) described the math workshop as students working in the “zone of proximal development” (Vygotsky, 1978, p. 86). Fisher and Frey (2008) suggested increasing student independence through a “gradual release of responsibility model” in which learners have opportunities to
practice and engage with strategies “before they’re expected to use them on their own” (p. 19). Willis (2010) concluded, “Teachers who use strategies to differentiate and adapt the curriculum according to the foundational knowledge of their students, increase the likelihood of successfully meeting those students’ varying needs” (p. 24). A wide range of instructional literature discusses the importance of teachers planning and adjusting their methods to address the wide variety of student readiness levels, interests, and learning profiles to allow all learners to achieve.

Summary

This chapter introduced the research problem, the purpose of study, a positionality statement, research questions, an overview of the theoretical framework, and the significance of the research problem. The constructivist and differentiated learning theoretical frameworks helped to draw meaning within the broader context of educational research and provided a paradigm to examine tensions in the literature. The theoretical context informed the research in three ways. First, understanding the ways in which students construct meaning from the learning experiences implemented by teachers helped explain the tensions that underlie the problem of practice. Second, the theoretical frameworks informed the setting and participants in the study: a school district where elementary teachers worked to understand and implement math workshop instruction. Finally, differentiated learning theory provided the lens through which to explore how teachers adapt classroom instruction to meet the diverse needs of their students. The remainder of this thesis contains four chapters: literature review, research design, report of research findings, and discussion of findings and implications of practice.
Chapter 2: LITERATURE REVIEW

Purpose Statement and Research Questions

The purpose of this exploratory case study was to discover the ways in which elementary teachers use their knowledge and understanding of math workshop when planning and executing classroom math instruction in a Southeast Massachusetts school district to improve math achievement. Based on the intellectual goals, theoretical framework, and qualitative methodology of this study, one central research question and three sub-questions were developed as a foundation for investigation:

Central research question: How do elementary teachers use their knowledge and understanding of math workshop to improve math achievement when planning and executing classroom math instruction in a Southeast Massachusetts school district?

Sub-question 1: How do elementary teachers utilize a math workshop model to differentiate instruction and meet the diverse needs of learners?

Sub-question 2: What support systems need to be in place to ensure that elementary teachers understand and implement a math workshop model when executing classroom math instruction?

Sub-question 3: How do math specialists support teachers in implementing a math workshop model in their classrooms?

Introduction

Effective elementary mathematics instruction is significant within a local context and is also part of a larger conversation about improving student achievement. In addition to research
identifying which instructional practices have the most beneficial impact on learning, studies have shown that the quality of implementation of a teaching practice also greatly influences its impact (Grouws, 2004). Constructivist and differentiation instruction theories provide the conceptual framework to explore the ways in which elementary teachers use their knowledge and understanding of the math workshop model to plan and execute classroom math instruction. This case study provided a context-specific perspective on how elementary teachers use their knowledge and understanding of math workshop when planning and executing classroom math instruction. This knowledge may help school administrators and teachers design and implement effective classroom math instruction, and it may also prove valuable to this researcher and other school administrators in providing effective and sustained professional development and support systems for teachers in mathematics pedagogy.

This literature review examines four interrelated bodies of literature: elementary math instruction, math workshop, differentiated instruction, and professional development. The review begins by exploring elementary math instruction from a broad perspective first to develop a thorough understanding of the problem of practice; next, the focus concentrates on how teachers differentiate instruction to meet a wide range of students’ skill levels and needs in the classroom. The third theme investigates the constructs and instructional methodologies that constitute a math workshop model. Lastly, the review examines effective professional development approaches and considers support systems that teachers may need to implement and sustain novel instructional models. Limitations in the literature are identified, and the potential contributions of the proposed study are discussed. Key literature themes and findings, as well as next steps in the study, are reviewed in the chapter summary.

Elementary Math Instruction
Elementary math instruction can be defined as the construction of math knowledge through connections made to prior experiences, schema already developed, and values and beliefs (Jamarillo, 1996). This section of the literature review begins with the question: how is the theme of elementary math instruction reflected in current discussions of math pedagogy in elementary education?

In 1989, the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards for School Mathematics* as a response to the nationwide problem of lack of achievement in mathematics. The goal of this document was to illustrate what it means to be mathematically competent and to “create a set of standards to guide the revision of the school mathematics curriculum” (NCTM, 1989, p. 1). The *Standards* set forth a guide on how teachers could change instructional techniques to encompass the newly publicized research on cognition and learning. Traditional math education is based on a teacher-centered classroom in which teachers used whole-group instruction and in which assessments were based on recall of memorized facts (Cuban, 2001). The *Standards* place emphasis on depth of understanding rather than on basic skill knowledge and memorization of facts (NCTM, 1989, 2000). Teachers are encouraged to move away from teacher-centered classrooms to a more student-centered learning environment grounded in the research on cognition (Bransford, Brown, & Cocking, 1999). Student-centered math instruction is based on the characteristics of a constructivist classroom where students are at the center of idea sharing, discussion, and problem-based learning (Rust, O’Donovan, & Price, 2005). This emphasis indicates a strong alignment with the constructivist theory and constituted a major reform in mathematics education.

**Math Curriculum**
Research-based knowledge about effective math instruction has increased in recent years. Educators can look to a solid base of information to identify the mathematics skills students need and the instructional strategies that best support their development (Protheroe, 2007). In response to research comparing math instruction in the United States and other countries, standards-based math curriculum systems were implemented across the U.S. that included long lists of standards developed to cover vast amounts of math material at each grade level (Hoffer, 2012). Many states’ math standards and textbooks are comprised of topics arbitrarily placed throughout grade levels and lacking a logical progression of focused skills and concepts (Schmidt, 2004). Reys, Lindquist, and Suydam (1999) agree that math topics should be presented in a sequence and manner appropriate for the developmental level of students.

In top achieving countries, the number of topics that children are expected to learn at a given grade level is relatively small, permitting a thorough and deep coverage of each topic. In contrast, U.S. schools expect teachers to cover up to twice as many mathematical topics. As a result, the U.S. math curriculum has been characterized as “a mile wide and an inch deep” (Protheroe, 2007). Vinson (2001) argues that too many students in the United States have only a moderate level of procedural knowledge of mathematics, and an even lower level of conceptual knowledge. In 2006, the National Council of Teachers of Mathematics (NCTM) developed *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics* to address the need for a focused, coherent mathematics curriculum in which topics are explored “in depth, in the context of related content and connected applications, thus developing more robust mathematical understandings (NCTM, 2006). The *Curriculum Focal Points* identified and described the most significant mathematical concepts and skills at each grade level (Number and Operations, Geometry, Measurement, Algebra) to build students’ strength in the use of mathematical
processes which incorporate problem solving, reasoning, communication, making connections, and designing and analyzing representations.

The *Massachusetts Mathematics Curriculum Framework for Mathematics*, developed by the Massachusetts Department of Elementary and Secondary Education (DESE) in 2011, incorporates the *Common Core State Standards (CCSS)* based on research concluding that the mathematics curriculum in the United States must become substantially more focused and coherent in order to improve mathematics achievement. Two highlights of the 2011 *Math Framework* include revised *Guiding Principles for Mathematics Programs and new Standards for Mathematical Practice*. The six *Guiding Principles* are designed to steer the construction and evaluation of mathematics programs in the schools: learning, teaching, technology, equity, literacy across the content areas, and assessment. In addition, the *Guiding Principles* provide direction for student-centered math instruction:

To achieve mathematical understanding, students should have a balance of mathematical procedures and conceptual understanding. Students should be actively engaged in doing meaningful mathematics, discussing mathematical ideas, and applying mathematics in interesting, thought-provoking situations. Student understanding is further developed through ongoing reflection about cognitively demanding and worthwhile tasks (MA DESE, 2011).

Additionally, the *Standards for Mathematical Practice* describe varieties of expertise that mathematics teachers should seek to nurture in their students based on the NCTM process standards: problem solving, reasoning, proof, communication, representation, and connections. The next section of the literature review examines research-based teaching practices that integrate NCTM and Math Framework recommendations.
Effective Teaching Practices

Effective mathematics instruction begins with effective teaching. Grouws (2004) discusses how the quality of implementation of teaching practices impacts student learning. He provides the following example: “…small-group instruction will benefit students only if the teacher knows when and how to use this teaching practice” (p. 8). The complex demands of teaching mathematics requires teachers to have a deep understanding of the mathematical knowledge they are expected to teach (Ball, Thames, & Phelps, 2008). Math teachers also need a clear vision of how student learning develops and progresses across grades (Sztajn, Confrey, Wilson, & Edgington, 2012). Ball and Forzani (2011) agree that student learning of mathematics “depends fundamentally on what happens inside the classroom as teachers and learners interact over the curriculum” (p. 17). In 2014, NCTM published Principles to Actions, which connected the following research-based teaching practices to classroom instruction necessary to promote students’ deep learning of mathematics:

- Establish mathematics goals to focus learning.
- Implement tasks that promote reasoning and problem solving.
- Use and connect mathematical representations.
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning mathematics.
- Elicit and use evidence of student thinking.

Two teaching approaches are prominent in the literature about how math should be taught. In the first approach, skills-based instruction focuses on developing computational skills
and recall of facts. In the second approach, teachers encourage students to consider more than one way of solving a problem and to explain how they arrive at solutions (Protheroe, 2007). Grouws and Cebulla (2000) discuss the importance of teachers finding a balance between the two approaches: “Skills can be developed on an as-needed basis, or their development can be supplemented through the use of technology… if students are initially drilled too much on isolated skills, they have a harder time making sense of them later” (p. 3). Shellard and Moyer (2002) expand on how to incorporate skill development within a holistic math approach, identifying three critical components of effective math instruction: teaching for conceptual understanding, developing children’s procedural literacy, and promoting strategic competence through meaningful problem-solving investigations. Additionally, Rosenshine (2001) found three important structural tools in her summary of instruction-focused research from the last four decades: (a) the need to help students develop background knowledge, (b) the importance of student processing, and (c) the importance of organizers. Rosenshine delved further into the literature to suggest how research can be applied in the classroom to help students acquire these structures: (1) present new material in small steps, (2) help students develop an organization system for new material, (3) guide students’ practice by supporting them during initial practice sessions and by providing extensive student processing, (4) suggest cognitive strategies when teaching higher level tasks, (5) model the use of procedural prompts, and (6) provide for extensive student practice (Rosenshine, 1995, p. 267). The following subsections of the literature review are guided by the preceding six researched-based instructional practices.

**Present new information in small steps.** Teachers sometimes assume that if they cover more material, students will retain the important information with only extraneous material being forgotten. In reality, when working memory is overloaded, students typically retain less
information than they would if a more limited amount of information had been introduced. Instructional approaches that present a small amount of information and then provide time for students to actively process that information will be more successful with students struggling to master mathematics (Geary, 2003). Some students learn new content quickly, while other students need help forming connections and may need additional practice to retain content. Introducing new content too soon disrupts the consolidation of previous learning (Wolfe, 2001). Students who struggle with math need their instruction broken-down into smaller steps to remain engaged in learning and to develop the sense of self-efficacy that is crucial to attempting more challenging problems (Hunter, 2004).

While general educators have moved toward an inquiry approach that emphasizes conceptual understanding and real-life problem solving rather than memorizing facts and teaching a particular algorithm, special education teachers are often taught to use a direct instruction model (Frobringer & Fuchs, 2014, p. 28). Extensive research has documented the importance of this type of explicit instruction—i.e., breaking skills into small steps and explicitly teaching algorithms for solving each type of problem—for students with disabilities and other struggling leaners (Vaughn, Gersten, & Chard, 2000). Direct instruction is built around problems with clear, correct answers that can be learned quickly. By contrast, in student-centered instruction the teacher facilitates students’ own learning by allowing them work through problems on their own before demonstrating problem solving strategies (OECD, 2012). While there is tension in the literature about which approach is more effective, an over-reliance on either approach is not recommended, and both direct and student-centered instruction should be utilized (OECD, 2008b). An integrated approach is also recommended in the 2008 National Mathematics Advisory Panel’s (NMAP) final report, which concluded that core curriculum and
classroom instruction should balance conceptual understanding, computational and procedural fluency, and problem solving.

**Organization system for new material.** A prevalent theme in the instructional literature advances a major goal of education: to help students “develop a well-connected body of accessible knowledge” (Rosenshine, 1995, p. 262). Large bodies of research focus on the importance of cognitive processing—how information is stored and retrieved—and the resulting implications for teaching. Rosenshine explained, “Well-connected and elaborate knowledge structures are important because (a) they allow for easier retrieval of old material, (b) they permit more information to be carried in a single chunk, and (c) they facilitate the understanding and integration of new information” (p. 262). Additionally, Dewey’s (1964) seminal work provides a foundation for understanding the importance of helping students develop, organize, strengthen, and expand their knowledge within a course of study. He termed the process of “moving from the child’s present experience” toward the organized and accepted content—and of striking a balance between the logical and the psychological—as “psychologizing” the subject matter (p. 351). Dewey (1964) asserted that the instruction of organized content must be based upon experience:

> Abandon the notion of subject-matter as something fixed and ready-made in itself, outside the child’s experience; cease thinking of the child’s experience as also something hard and fast; see it as something fluent, embryonic, vital; and we realize that the child and the curriculum are simply two limits which define a single process… It is continuous reconstruction, moving from the child’s present experience out into that represented by the organized bodies of truth that we call studies (p. 344).
**Graphic organizers as instructional tools.** Graphic organizers are visual and spatial displays that make relationships between facts and concepts more apparent (Kim, Vaughn, Wanzek, &Wei, 2004). Studies established the effectiveness of utilizing graphic organizers as visual methods for teaching routine and concept vocabulary terms. Graphic organizers are intended to promote more meaningful learning and to facilitate understanding and retention of new material by making abstract concepts more concrete and by connecting new information with prior knowledge. Ellis and Howard (2007) described graphic organizers as visual devices that depict information in a variety of ways. Most commonly, teachers use graphic organizers to help students represent knowledge as imagery. These nonlinguistic representations are powerful because they connect to “students’ natural predisposition for visual-image processing, helping them to better recall new information later” (Goodwin, 2011, p. 29). Graphic organizers also provide visual prompts designed to facilitate communication and understanding of information by demonstrating how essential information is organized (Ellis & Howard, 2007).

Though there is limited research addressing the use of graphic organizers in mathematics instruction (Monroe & Pendergrass, 1997), there is evidence that graphic organizers help students learn vocabulary in informational text. Braselton and Decker (1994) found that graphic organizers helped students with mathematical problem solving in addition to developing critical thinking skills; however, Dunston (1992) argued that the effectiveness of graphic organizers is limited by its dependence on a student’s background knowledge of a concept. In a study designed by Monroe and Pendergrass (1997), as soon as students had experience with a math concept, the teacher’s use of a
graphic organizer to coach vocabulary helped students access and organize newly acquired knowledge.

Zollamn (2012) designed a classroom action research project to study a problem-solving instructional approach in which students used graphic organizers to answer open-response math problems. The teachers found the use of graphic organizers in mathematical problem solving to be very efficient and effective for all levels of students. Teachers saw that their lower-ability students wrote partial solutions where typically they would not have attempted the problem at all. The use of graphic organizers appeared to help average-ability students organize their thinking strategies and high-ability students improve their problem-solving communication skills (Zollman, 2012).

In summary, graphic organizers have been found effective in helping students learn math vocabulary, organize what they learn, and improve recall of information when used in combination with meaningful context and direct teaching.

Guided practice. The concept of guided practice was developed by Hunter (1982), first appearing in an experimental study of teacher effects by Good and Grouws (1979). In this study, the least effective teachers would present a lesson and then tell the students to work on problems on worksheets, resulting in student confusion and error. The most effective teachers—the teachers whose classes made the greatest gains—presented only some of the material at a time, teaching it in small steps, and then guiding student practice. The teacher solved a few problems at the board while talking through the procedural steps, thus modeling for students, before asking students to come to the board to work on problems and discuss their procedures.

Guided practice took the form of dialogue among teacher and students—reciprocal teaching (Palincsar & Brown, 1984)—with students and teachers rotating the role of instructor.
This role shifting gave students the opportunity to internalize cognitive strategies and receive feedback and assistance from the teacher. Collaborative social dialogue was practiced in Schoenfeld’s (1985) study of students participating in small-group mathematical problem solving. As students work in small groups, the teacher has the opportunity to assess students’ progress and provide support as they engage in problem solving, articulate their knowledge and reasoning for choosing alternative solutions, and practice collaboration, while students who are insecure about their problem solving skills are able to observe more capable peers struggle over difficult problems (Rosenshine and Meister, 1992). Guided practice after teaching small amounts of new material and then checking for student understanding is a way to reduce errors and correct misconceptions (Rosenshine, 1995). Thus, the responsibility for learning shifts from the teacher to the student; the teacher gradually reduces supports and develops student independence (Rosenshine & Meister, 1992).

Cognitive strategies. The term cognitive strategies can be defined as the use of the mind (cognition) to solve a problem or complete a task. Cognitive strategies may also be referred to as procedural prompts (Rosenshine, 1995) or scaffolds (Palincsar & Brown, 1984). A related term is metacognition, the self-reflection or “thinking about thinking” necessary for students to learn effectively (Baker, Gersten, & Scanlon, 2002). Wong, Harris, Graham, and Butler (2003) defined cognitive strategies as “processes that the learner intentionally performs to influence learning” (p. 383). A cognitive strategy serves to support the learner as he/she develops internal procedures that enable him/her to perform tasks that are complex (Rosenshine, 1997). For example, in a classroom where cognitive strategies are used, the teacher bridges the gap between student and the content/skill to be learned. In this role, the teacher understands the task to be
completed, as well as knowledge of an approach to the task that he/she can communicate to the student.

According to constructivist theory, knowledge is neither passively received nor mechanically reinforced; instead, learning occurs by an active process of sense making (Shephard, 2000). Vygotsky’s social constructivist theory can be used as a lens to interpret current discussions of cognitive strategies instruction. Vygotsky understood that all learning is social. He noticed that children solve problems as they talk to guide their own thinking processes, hypothesizing that this speech process is the basis for learning that eventually becomes internalized as part of our repertoire of strategies for problem solving (Hammond & Gibbons, 2001). Vygotsky suggested that language helps children be strategic rather than purely impulsive in their approach to complex problems, and it helps them gain control over their own thinking and behavior (Vygotsky, 1978). Tharp, Estrada, Dalton, and Yamauchi (2000) referred to this “instructional conversation” as learning through exchange and discussion with a specific academic goal (p. 33). The teacher or a more expert peer is essential to this learning process, as a child’s development takes place in the context of activities modeled or assisted by this more skilled person. Research has shown that interactions between a child and a more competent peer or adult in which everyone is actively engaged tend to produce higher student achievement (Darling-Hammond & Bransford, 2005). Teachers can help students learn by consciously teaching within their zone of proximal development and providing support, or by having other students provide assistance in that social context (Hammond & Gibbons, 2001).

Bulgren, Deshler, and Schumaker (1997) described the importance of the teacher’s knowledge of what the students should learn (the product of learning) and of the teacher modeling how (the process of learning) as content enhancement:
1. Teachers evaluate the content they cover.

2. Teachers determine the necessary approach to learning for student success.

3. Teachers teach with routines and instructional supports that assist students as they apply appropriate techniques and strategies.

These instructional supports used to teach students to develop and apply cognitive strategies have also been called scaffolds by Palincsar and Brown (1984) and “cognitive apprenticeship” by Collins, Brown, and Newman (1989). It is necessary to understand the developmental status of students’ thinking and reasoning to improve student learning. The more information teachers obtain about what students know and think, the more opportunities they create for student success (Darling-Hammond, 1994). The literature reflected that teachers’ knowledge of students’ thinking has a substantial impact on their classroom instruction and on student learning (Gardner, 1999). If students are routinely asked to explain their thinking or to clarify terms, then eventually these habits are internalized and become part of their thinking process as well as a social norm in the classroom (Hogan & Pressley, 1997).

**Modeling.** Rosenshine (1995) provided examples of scaffolds that teachers can provide to students: “modeling, thinking aloud, completing some of the steps for the students, teaching in small steps, anticipating errors and providing feedback…” (p. 267). When teachers and proficient students “think aloud” to demonstrate their thought process while solving problems, learners are able to observe the “expert thinking” and unlock hidden strategies they can use to solve higher order tasks (Collins et al., 1989). In a mathematics study by Schoenfeld (1985), the teacher identified and labeled the problem-solving procedures he was using as he went through the steps in solving math problems. Schoenfeld maintained that thinking aloud may provide labels that student can use to call up the same processes in their own thinking.
**Extensive student practice.** Rosenshine (1995) found that the most effective teachers provided for extensive and successful practice after sufficient guided practice so students were not rehearsing errors and misconceptions. Brown and Campione (1986) wrote, “Understanding is more likely to occur when a child is required to explain, elaborate, or defend his position to others; the burden of explanation is often the push needed to make him or her evaluate, integrate and elaborate knowledge in new ways” (p. 123). There is a close relationship between truly understanding a concept and being able to transfer that knowledge and use it in new situations. Research has demonstrated that learning is more likely to transfer if students have the opportunity to practice with a variety of applications while learning (Bransford, 1979). To support generalization and ensure transfer of skills to new contexts, effective instruction utilizes current understandings as a foundation for learning new concepts, applying skills, and making new connections (Shepard, 2000).

Hiebert and Grouws (2007) used the term *productive struggle* to refer to the “effort to make sense of mathematics, to figure something out that is not immediately apparent.” Teaching methods that embrace and employ productive struggle lead to long-term benefits, with more students able to apply their learning to new problems and situations (Kapur, 2014). It is important for teachers to accept the fact that struggle is important in learning mathematics, convey this message to students, and allow time for them to work through uncertainties when solving a problem.

The school district in the proposed study utilized the *enVisionMATH* program in grades K-5. *The enVisionMATH* program incorporates the teaching approaches described above. The program pacing allows teachers to explore concepts in depth and teach for understanding. Problem-based lessons move from concrete to pictorial to abstract. Bar diagram models are used
to help students make sense of the problem and demonstrate mathematical reasoning. The *enVisionMATH* program provides three tiers of instructional lesson plans and resources to support and challenge students. Each lesson guide supports mathematical practices through interactive exploration and problem-based learning. Step-by-step visual models and manipulatives develop conceptual understanding. Guided practice provides support to scaffold instruction and reteach skills and concepts. The program includes independent student practice through daily problems, reteaching and enrichment resources, review exercises, center activities, games, and homework.

In their attempts to tie effective math instruction to increased student learning, each of the authors in the above section of the literature review brought us valuable information about strengths and weaknesses of various instructional strategies. Detailed information about students’ mathematical thinking and problem solving can help us understand how mathematics is taught and can identify the most effective ways to improve students’ learning (Bradburn & Gilford, 1990). The following section of the literature review surveys how differentiated instruction is designed to meet the diverse needs of students in the classroom.

**Differentiated Instruction**

Differentiated instruction can be defined as an approach to teaching that involves active planning for student differences in classrooms to maximize student growth and individual success (Tomlinson and Allan, 2000). This section of the literature review begins with the question: how is the theme of differentiated instruction reflected in studies of elementary teaching models?

To make a commitment to equal opportunity for diverse learners, educators need to provide genuine opportunities for high-quality instruction and access to academic curricula
Differentiated instruction benefits students at all levels of education (Lightweis, 2013). When differentiation is implemented with fidelity, students are able to explore concepts and ideas in greater depth than they can with a more traditional approach to teaching (Archambault et al., 1993).

Differentiation is more than a set of specific instructional methods; it is a philosophical approach to teaching that structures the entire classroom environment. According to Tomlinson and Imbeau (2010), “Learning to differentiate instruction well requires rethinking one’s classroom practice and results from an ongoing process of trial, reflection, and adjustment in the classroom itself” (p. 13). Teachers must continually focus on how they will design instruction to increase achievement for all learners. Teaching quality, which includes strategies that teachers employ to improve student learning, has more bearing upon student achievement than any other factor (e.g., teaching experience and class size; Park, 2005). Teachers who plan engaging educational experiences based on students’ skill levels maximize learning in the classroom by preventing behavior disruptions from students who may be bored with the subject matter (Bender, 2007). Differentiated instruction takes time, expertise, and dedication to understanding students’ readiness levels on a daily basis, where readiness refers to the “current knowledge, understanding, and skill level a student has related to a particular sequence of learning” (Tomlinson & Strickland, 2005, p. 6). Drawing on Vygotsky’s zone of proximal development, Tomlinson and Strickland (2005) contended, “The goal of readiness differentiation is first to make the work a little too difficult for students at a given point in their growth—and then to provide the support they need to succeed at the new level of challenge” (p. 6).

Tomlinson (1999, 2000) described four necessary components for classrooms to be considered differentiated learning communities. These four elements take into account students’
levels of understanding, interests, and learning profiles and include the following definitions: (a) content, or the information students need to know and how it is delivered; (b) process, or the learning experiences provided to the student to convey the intended message; (c) product, or the performance assessments that require students to demonstrate mastery over what was learned; and (d) learning environment, or the aesthetic qualities of the classroom and its comforting appeal. The following subsections of the literature review expand on these four components, using them as themes to survey the literature on differentiated instruction. Figure 1. presents a concept map for understanding and planning effective differentiation in the classroom.

**Content.** A student’s readiness level is dependent upon information regarding a certain topic that has been previously understood, practiced, and conceptualized (Tomlinson, 2005). Readiness levels can differ depending upon the topics and subject areas being taught. “Diverse classrooms pose many challenges and require teachers to develop a variety of activities to help students understand key concepts and make connections to their learning” (Keck & Kinney, 2005, p. 15). Teachers who structure learning experiences that utilize varied instructional techniques increase the motivation of learners (Yuen & Hau, 2006). A case study by Yuen & Hau (2006) compared the time required to teach content through constructivist teaching and teacher-centered instruction methods and found that even though more content could be covered in a shorter time in the teacher-centered approach, students retained more material with constructivist teaching. Students were more deeply involved in processing the content with active student-centered instruction. Formulating and implementing student-centered lesson plans are, of course, complex undertakings for teachers, but Lappan and Friel (1993) emphasized the importance of teachers’ lesson planning:
Figure 1. A concept map for differentiating instruction.

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No other decision that teachers make has greater impact on students’ opportunity to learn and on their perceptions about what mathematics is than the selection or creation of the tasks with which the teacher engages the students in studying mathematics. Here the teacher is the architect, the designer of the curriculum (p. 524).

**Process.** Archambault (1993) conducted a national survey with third and fourth-grade teachers to see to what extent the teachers differentiated instruction for gifted learners. The analysis of answers from nearly 4,000 participants revealed a startling reality: very little modification was made to accommodate the needs of advanced learners (Archambault, 1993). Differentiated math lessons are designed to utilize a variety of instructional strategies. Tomlinson (1999) identified six differentiated instructional strategies that teachers can use to meet students’ readiness levels, interests, and modes of learning: tiered assignments, compacting, interest centers or interest groups, flexible grouping, learning contracts, and choice boards.

Tiered assignments involve several tasks of varying degrees of challenge and support designed to meet students’ levels of readiness for the topic at hand, while curriculum compacting is “a flexible, research-supported instructional technique that can benefit any student who displays strengths or high levels of interest in one or more content areas” (Reis & Renzulli, 1992, p. 51). With a compacting strategy, teachers utilize assessments to determine the specific skills students need to master, enabling some students to skip work they already know and to substitute more challenging or appropriate content (Reis & Renzulli, 1992). Curriculum compacting is designed to make appropriate adjustments for students in any curricular area and at any grade level.

Interest centers and interest groups reflect students’ readiness levels in that students are able to choose activities they are eager to study. Teachers plan instruction so that students work with a variety of peers based on flexible grouping practices; students work with like-readiness
peers, mixed-readiness peers, students with similar interests, and students with different interests. Flexible grouping allows students to see themselves in a variety of contexts and aids the teacher in “auditioning” students in different settings and with different kinds of work (Tomlinson, 1999).

A learning contract is an agreement between a teacher and student that specifies in writing the work the student will complete in a given amount of time and allows the teacher to differentiate the curriculum based on the student’s readiness level or learning profile, while choice boards give students multiple ways of processing information and rehearsing content and skills (Gregory & Chapman, 2012). Students work alone or with peers to accomplish tasks they choose from a variety of activities planned by their teachers.

**Product.** Differentiated learning experiences are designed to target “student engagement plus student understanding” (Tomlinson, 1999). The use of pre-assessments and formative assessments are important factors in the design of differentiated lessons. Meaningful assessment naturally leads to functional and successful differentiation, informing teachers’ planning to provide a menu of choices to meet the varying needs, interests, and abilities that exist in classrooms (Tomlinson, 2001). Heacox (2001) suggested that if the primary purpose of assessment is to give students feedback about their work, then criteria should be determined and described for each task so that students’ products are evaluated fairly.

**Learning Environment.** In a differentiated classroom, students gain access to the content being taught in individualized ways. Hillocks (1995) asserted that teachers can and should possess specialized knowledge of students, of particular content and tasks, and of how to represent and teach this knowledge. Hillocks added that context and situation are also essential to learning. Students need to be engaged in real everyday activities that have purpose and
meaning for them. Brown, Collins, and Duguid (1989) argued, “Classroom activity very much takes place within the culture of schools, although it is attributed to the culture of readers, writers, mathematicians, historians, economists, geographers, and so forth. Many of the activities students undertake are simply not the activities of practitioners and would not make sense or be endorsed by the cultures to which they are attributed” (p. 7). The authors also supported the idea of cognitive apprenticeship, in which learning is supported by enabling students to acquire, develop, and use cognitive tools in authentic domain activity (Brown et al., 1989).

Tomlinson (2000) provided examples of a differentiated learning environment at the elementary level, including:

- room for students to work quietly and collaborate without distraction;
- materials that reflect a variety of cultures and home settings;
- clear guidelines for independent work that match individual needs;
- routines that allow students to get help when teachers are busy with other students;
- classroom rules that recognize that some learners need to move around to learn, while others do better sitting quietly.

In summary, differentiated instruction bridges theory and pedagogy to provide educators with a framework to attend to students’ individual learning styles, interests, and skill levels in the classroom.

**Math Workshop**

Math workshop can be defined as an instructional model in which teachers create and facilitate learning experiences for individuals, partners, and small-groups to cultivate math
learners’ deep conceptual understanding, fluency with numbers, and problem solving strategies (Siena, 2009). This section of the literature review begins with the question: how is the theme of math workshop reflected in current studies of elementary math instruction?

The 2000 NCTM Principles and Standards for School Mathematics offers the following Vision for School Mathematics:

Imagine a classroom…where all students have access to high-quality, engaging mathematics instruction. There are ambitious expectations for all, with accommodations for those who need it…. The curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts, skills and procedures with understanding…. Students confidently engage in complex mathematical tasks chosen carefully by teachers. Teachers help students make, refine, and explore conjectures on the basis of evidence and use a variety of reasoning and proof techniques to confirm or disprove those conjectures. Students are flexible and resourceful problem solvers. Alone or in groups and with access to technology, they work productively and reflectively, with the skilled guidance of their teachers. Orally and in writing, students communicate their ideas and results effectively. They value mathematics and engage actively in learning it (p. 3).

The workshop model of instruction cultivates all learners’ mathematical abilities by creating and facilitating learning experiences that provide opportunities for students to construct deep conceptual understanding, as well as develop fluency with numbers (Hoffer, 2012). The workshop model of instruction draws on Vygotsky’s theory of a zone of proximal development—the notion that with the support of a community, learners can meet more strenuous challenges than they might succeed at meeting on their own (Vygotsky, 1978). The
math workshop model developed from the success of readers’ and writers’ workshop models in elementary classrooms (Hoffer, 2012), and it differs from traditional teacher-centered math instruction in that the teacher’s role is one of facilitator more than of direct instructor. Because students are self-directed and engaged in working on activities individually and in groups, teachers are able to spend time “observing, questioning, and communicating with students” (Heuser, 2000, p. 292). While traditional approaches to teaching mathematics can be limited in their efficacy by teacher-oriented instruction and by the “ready-made” mathematical knowledge presented to students who are not receptive to the ideas (Shoenfeld, 1988), in a math workshop model, students learn mathematical procedures through a deep conceptual understanding by engaging in differentiated lesson components individually and with peers.

**Mini-Lesson.** Math workshop can take a variety of forms, but the math class period is typically divided into three distinct components: mini-lesson/launch, activity/exploration, and student reflection/summary (Bennett 2007). “The mini-lesson is designed to orient students to the purpose of the day’s work, then introduce or revisit concepts and strategies that will be useful during independent work time” (Hoffer, 2012, p. 10). The teacher gathers data on what students already know about a specific mathematical concept during this brief inquiry-based period (Learner and Johns, 2011), accomplishing this by posing a mathematical representation, problem, or math task that invites students’ understanding and investigation into the mathematical goals of the lesson, which in turn activates students’ background knowledge (Learner and Johns, 2011).

Chazan and Ball (1995) argued that the teacher’s role in classroom discourse is more involved than the teacher simply presenting a problem and waiting for students to discuss and solve it. The teacher’s instructional role is to increase participation and conceptual
understanding through cognitive and motivational discourse (Chazen & Ball, 1995). Cognitive discourse refers to what the teacher says to promote conceptual understanding of the mathematics itself. Kazemi and Stipek (2001) found that some inquiry-based classrooms, which they described as “low-press,” are not effective in facilitating student discourse because they focus on explanations of procedure and do not provide links to a conceptual understanding of mathematics. By contrast, in “high-press” classrooms teachers encourage students to link the strategies and procedures used to the underlying concepts and help students learn from their individual mistakes, thus fostering accountability and engagement. Effective teachers convey a sense that they enjoy working with students and that students are valued; consequently, students work harder for teachers who they perceive as being honest with them about their abilities (Haberman, 1995).

Motivational discourse refers to the supportive and non-supportive statements teachers make that encourage or discourage participation in mathematics classroom discussions. Turner et al. (2002) found that when teachers used supportive motivational discourse in addition to pressing for conceptual understanding, the reported levels of non-participation in discourse decreased. The researchers contended that students’ lack of participation in classroom discussion is often a result of students avoiding risk-taking and/or failure. Other students may avoid expressing their disagreement with a discussion point rather than making a mathematical argument (Lampert, 1990).

Activity/Exploration. The second section of the math workshop, activity/exploration, is grounded in educational research on how children learn by constructing meaning through active engagement in understanding mathematical procedures and strategies. Math workshop is much more complex than providing students with “hands-on” activities. As Hoffer (2012) asserted,
“Better than simply offering kinesthetic experiences, we need to ensure that all tasks are minds-on, that is, requiring students to immerse themselves in challenging thinking that culminates in conceptual understanding” (p. 6). Activity time is the longest section of the math workshop lesson and can be structured in a variety of ways. Teachers often pose a challenging problem that students conceptualize and solve individually or in small groups based on the objective targeted during the mini-lesson. Students articulate and document their thinking in discussions with peers or in writing. Children can learn more when they share their work with others or work collaboratively (Zemelman, Daniels, & Hyde, 1993). However, Phillips (1995) found that students benefit from working independently when learning developmental skills such as classifying, ordering, sequencing, and counting.

During the activity portion of the lesson, students complete tasks at work stations individually or in small groups. They may work at single station for the entire activity period or rotate through a variety of stations designed by the teacher to provide practice in applying specific skills and concepts. “Teachers then use work time as an opportunity to differentiate instruction by offering a range of challenge levels in a task, a variety of supports, and an array of tools for students to use” (Hoffer, 2012, p. 11). Teachers also use this work time to confer with learners about their mathematical thinking, trying to understand “what and how students are thinking about their own problem solving, nudge them along, and encourage independence” (Hoffer, 2012, p. 11). Research suggested that once students have memorized and practiced procedures that they do not understand, they have less motivation to understand their meaning or the reasoning behind them (Hiebert, 1999). Therefore, the development of students’ conceptual understanding of procedures should precede and coincide with instruction on procedures. Students need to have a deep and flexible knowledge of a variety of procedures, along with an
ability to make critical judgments about which procedures or strategies are appropriate for use in particular situations (NCTM, 2014). “Students need opportunities to justify both informal strategies and commonly used procedures mathematically, to support and justify their choices of appropriate procedures and to strengthen their understanding and skill through distributed practice” (NCTM, 2014). Practice should be brief, engaging, purposeful, and distributed (Rohrer, 2009). Too much practice too soon can be ineffective or lead to math anxiety (Isaacs & Carroll, 1999).

**Reflection/Summary.** The final component of math workshop is the reflection or summary section. At the close of the workshop lesson, the teacher asks students to come back together as a group to talk about solutions, how they found them, difficulties they may have encountered, and “how they are thinking about themselves as mathematicians” (Hoffer, 2102, p. 12). The reflection/summary allows the teacher and students to evaluate the effectiveness of the lesson and encourages the use of mathematical vocabulary. Students also evaluate how they spent their time thinking like a mathematician (Heuser, 2000). Evaluating the quality of their work, their thinking, and their efforts supports students’ in developing self-regulated learning skills. Students’ ability to engage collaboratively in classroom discourse and to have conversations about their learning is a key strength of the workshop model. “Discourse is a life skill, and math classes are wonderful learning grounds for the listening, critical thinking, and cooperation that discourse requires” (Hoffer, 2012 p. 7). Participating in a mathematical community through discourse is as much a part of learning mathematics as the conceptual understanding of the mathematics itself (Stein, 2007). Students can also reflect in writing, which serves as an informal assessment tool for teachers to inform instruction for the next day. Young children learn more when they reflect on their work and on themselves as learners (Zemelman,
Daniels, & Hyde, 1993). Students need time to process and organize new knowledge and to make connections to previous learning. Effective teachers also reflect on the lesson, making sure it met students’ needs, was paced appropriately to allow students to learn the material, and included methods for assessing whether students understood the content (Stronge et al., 2004).

In summary, the math workshop model combines research-based instructional practices into a lesson framework that actively engages all students in increasing their math achievement. Math workshop “requires challenging tasks, collaboration, community, and conferring within the context of a specific organization of time that maximizes opportunities for student thinking” (Hoffer, 2012, p. 16). Through informal assessment and lesson planning, teachers utilize workshop model components (mini-lesson, activity/exploration, and reflection/summary) to meet the needs and ability levels of all learners through tiered instruction and differentiated activities focused on the same learning objective. Effective teachers spend a great deal of time deciding how they will teach, as they know that well-constructed lesson plans typically yield better student engagement (Shellard & Protheoe, 2000). The complex structure of the workshop model requires teachers to understand and apply research-based practices to meet the diverse needs of their students. Effective teachers use a variety of instructional strategies, and Stronge, Tucker and Hindman (2004) asserted that when educators participate in professional development related to the content area or the students they teach, their effectiveness increases, resulting in higher levels of student academic success. The following section of the literature review examines research on productive professional development approaches.

**Professional Development**

Professional development can be defined as “…a comprehensive, sustained and intensive approach to improving teachers’ and principals’ effectiveness in raising student achievement …”
(Hirsh, 2009). This section of the literature review begins with the question, how is the theme of professional development reflected in current research?

Teaching quality, which includes the things teachers do to improve student learning, has more bearing on student achievement than any other factor (e.g., teaching experience and class size; Park, 2005). In order to fully implement differentiated instruction within a learning community, teachers should be properly trained so that they understand the scope of this phenomenon and its propositions (Polk, 2006). The 2008 National Mathematics Advisory Panel discussed research confirming the importance of the relationship between teachers’ mathematical knowledge and student achievement. The panel cited the limitations of existing research, calling for more precise measures with which to examine the relationships among elementary and middle school teachers’ mathematical knowledge, instructional skills needed for effective teaching, and students’ learning. A critical recommendation of the panel was that teachers must be given ample opportunities to learn mathematics for teaching through professional development in math content knowledge (p. xxi). Tomlinson (1999) contended, “…teachers need time and opportunity to make sense of new ideas” (p. 112). Educational leaders need to form specific implementation plans that are structured to provide teachers with time to reflect on new information about a topic in mathematics. Tomlinson (1999) also emphasized the importance of professional development, including the following methods for sustaining support over time: providing time to plan differentiated lessons; creating differentiated curriculum when curriculum guides are revised; providing opportunities to visit differentiated classrooms; giving access to a wide range of learner materials; making teachers feel safe in trying a new approach; giving meaningful, targeted feedback about their work; providing a network of mutual support
and encouragement; and expressing clear appreciation when they have done a good job or have taken a risk that was less than successful (pp. 113-114).

Professional development activities that promote student achievement are directly related to teacher effectiveness. Ongoing embedded professional development that works toward increasing both the quality of pedagogy and achievement has a profound impact on teachers and on students (Darling-Hammond & McLaughlin, 1995). In the early 1980’s, Joyce and Showers (1982) introduced a peer-coaching training design which included “modeling, practice under simulated conditions, and practice in the classroom, combined with feedback” (p. 384). Their studies found that teachers in peer coaching relationships “practiced new skills and strategies more frequently and applied them more appropriately than did their counterparts who worked alone to expand their repertoires” (Baker and Showers, 1984, p. 5). The following section reviews literature focuses on how job-embedded math coaches provide targeted professional development to support teacher efficacy in the classroom.

Math Specialists

Following the recommendation of NCTM, many school districts are hiring math coaches and math specialists to provide sustained embedded professional development during the school day. Hull, Balka, and Miles (2009) defined a math coach as “an individual who is well versed in mathematics content and pedagogy and who works directly with classroom teachers to improve student learning of mathematics” (p. 3). Several researchers contended that the most important task of a math coach is to foster change in the classroom to enhance student learning and improve teacher practices. Fennell (2011) stressed the significance of hiring math specialists at the elementary level: “Mathematics specialists at the elementary school level are becoming increasingly important as we acknowledge the complexities of elementary teaching and learning”
The Principles and Standards for School Mathematics (NCTM, 2000) suggest that specialist-related models, including mathematics teacher leaders and mathematics specialists, be considered a way to ensure the mathematical expertise of those responsible for knowing and teaching the content and process standards contained within the Principles and Standards, and to thereby strengthen and deepen mathematics learning for all students.

Chval et al. (2010) asserted that the rise in the use of mathematics specialists and coaches in the U. S. grew out of the need for professional development to occur within teachers’ contracted work day to increase teacher participation in training sessions. The authors also argued that elementary teachers view professional development as irrelevant to their practice. Math coaches have the potential to address both problems because they embed training in relevant pedagogy and content within teachers’ classrooms during their contracted work day (Chval et al., 2010).

Typically, coaches work with teachers for the purpose of improving instructional practices and student learning within a particular curricular area such as literacy or mathematics (Neufeld & Roper, 2003a). Hull, Balka, and Miles (2009) described the role of effective math coaches as: collaborating with teachers to implement curriculum that positively impacts student learning and achievement; building trust and rapport with resistant teachers; developing collegial partnerships for planning, analyzing, and reflecting on instruction; and supporting individual and school change.

Researchers, however, have also identified several challenges related to establishing and implementing a successful and sustainable coaching model. These challenges include the high cost of implementing the model, time and scheduling constraints imposed on coaches, lack of administrative support and direction to carry out the work of coaching, teacher resistance to
coaching support, inconsistent messages from districts and schools regarding expectations,
limited ways to assess the quality and impact of the coach, and, most notably, role confusion and
conflicting responsibilities (Neufeld & Roper, 2003). Chval et al. (2010) found that the coaches
in their study experienced isolation in their buildings that differed from the isolation they felt as
teachers, noting the need for a support system tailored specifically to coaches. The National
Mathematics Advisory Panel report (2008) recommended that “research be conducted on the use
of full-time mathematics teachers in elementary schools” (page xxii). This recommendation was
based on the panel’s findings about the importance of teacher content knowledge and the
recognition that most preservice teacher education programs for elementary teachers do not
address mathematics in sufficient depth (Fennell, 2011).

Chapter Summary

This literature review focused on effective math instruction strategies that teachers can
implement in the classroom. Prior studies have identified components that comprise
differentiated instruction; other educational literature has identified elements of the math
workshop instructional model. There is still a huge unmet need, however, for information about
how elementary teachers use their knowledge and understanding of math workshop when
planning and executing classroom math instruction. Further research is needed to explore how
elementary teachers differentiate math instruction when utilizing a workshop model and to
identify support systems that teachers need to sustain its effective implementation.
Chapter 3: RESEARCH DESIGN

Purpose of Study

The purpose of this study was to explore the ways in which elementary teachers use their knowledge and understanding of math workshop when planning and executing classroom math instruction in a Southeast Massachusetts school district to improve math achievement. More specifically, this study examined the ways in which teachers utilize math workshop instruction to differentiate instruction. Differentiated instruction is an approach to teaching that involves active planning for student differences in classrooms to maximize student growth and individual success (Tomlinson & Allan, 2000).

Research Problem Statement

Implementation of a math workshop instructional model requires development of a conceptual understanding of mathematics and in-depth problem-solving for all learners through active engagement, flexible grouping, and differentiated lessons, but the ways in which teachers are implementing the math workshop model in their classrooms remain largely unknown. The goal of this research was to improve math education for all students by discovering effective math pedagogy for elementary classrooms.

Research Questions

Central research question: How do elementary teachers use their knowledge and understanding of math workshop to improve math achievement when planning and executing classroom math instruction in a Southeast Massachusetts school district?

Sub-question 1: How do elementary teachers utilize a math workshop model to differentiate instruction and meet the diverse needs of learners?
Sub-question 2: What support systems need to be in place to ensure that elementary teachers understand and implement a math workshop model when executing classroom math instruction?

Sub-question 3: How do math specialists support teachers in implementing a math workshop model in their classrooms?

**Research Design**

The strategy of inquiry for this study was modeled after other qualitative studies in the literature to explore the nuances and interpersonal exchanges that lead to effective lesson planning and classroom instruction (Harwell, D'Amico, Stein, & Gatti, 2000).

The design of a qualitative study depends on the purpose of the inquiry, what information will be most useful, and what information will have the most credibility. “Qualitative studies typically employ multiple forms of evidence...[and] there is no statistical test of significance to determine if results ‘count’” (Eisner, 1991, p. 39). Judgments about usefulness and credibility are left to the researcher and the reader. Lincoln and Guba (1985) suggested that a researcher must do three things before conducting a qualitative study. First, the researcher must adopt the stance suggested by the characteristics of the naturalist paradigm. Second, the researcher must develop the skills needed to collect and interpret data. Third, the researcher must adopt a research design that utilizes accepted strategies for naturalistic inquiry (Lincoln and Guba, 1985).

Qualitative research guided this researcher’s discovery of elementary teachers’ understandings of math workshop implementation and the ways in which a workshop model is used to differentiate instruction. Qualitative research design is emergent in nature. The researcher was able to observe and interpret meanings in context through the exploration of
primary questions and data collection planning (Patton, 1990). Creswell (2007) proposed the following important components of qualitative research: involving emerging and ongoing questions and procedures, collecting data in the participants’ setting, making interpretations about the meaning of data, writing reports with a flexible structure, and placing importance on situational complexity. According to Stake (1995), qualitative research is best suited to cases in which researchers seek to understand the complexities of relationships by constructing knowledge (p. 37).

Strauss and Corbin (1990) claimed that qualitative methods can be used to better understand any phenomenon about which little is known. A qualitative approach can also be used to gain new perspectives on things about which much is already known, or to gain more in-depth information that may be difficult to convey quantitatively. Because a goal of this study was to provide insight into how teachers make instructional decisions, consideration of the viewpoints of the researcher and readers was important to the research design. “If you want people to understand better than they otherwise might, provide them information in the form in which they usually experience it” (Lincoln and Guba, 1985, p. 120). “The ability of qualitative data to fully describe a phenomenon is an important consideration not only from the researcher’s perspective, but from the reader’s perspective as well” (Hoepfl, 1997, p. 49).

**Research Tradition**

“The particular design of a qualitative study depends on the purpose of the research question, what information will be most useful, and what information will have the most credibility” (Hoepfl, 1997, p.50). Stake (1995) and Yin (2003) propose a case study based on a constructivist paradigm. This paradigm “recognizes the importance of the subjective human
creation of meaning, but doesn’t reject outright some notion of objectivity” (Crabtree & Miller, 1999, p. 10). Ponterotto (2005) described,

Thus a distinguishing characteristic of constructivism is the centrality of the interaction between the investigator and the object of investigation. Only through this interaction can deeper meaning be uncovered. The researcher and her or his participants jointly create (co-construct) findings from their interactive dialogue and interpretation. (p. 129)

According to Yin (2003), a case study design should be considered when: (a) the focus of the study is to answer “how” and “why” questions; (b) you cannot manipulate the behavior of those involved in the study; (c) you want to cover contextual conditions because you believe they are relevant to the phenomenon under study; and d) the boundaries are not clear between the phenomenon and context. Case studies allow the researcher to explore individuals and organizations, interventions, relationships, communities, or programs (Yin, 2003) and to describe a phenomenon in context using a variety of data sources (Baxter & Jack, 2008, p. 1).

The proposed research utilized an exploratory case study method to establish an in-depth understanding of the perceptions and experiences of elementary teachers when they planned and implemented a math workshop instructional model after participating in professional development focused on math curriculum and instruction. Yin (2003) described how multiple case studies can be used to either “(a) predict similar results (a literal replication) or (b) predict contrasting results but for predictable reasons (a theoretical replication)” (p. 47).

This study facilitated the exploration of phenomena in context using the following data sources: Interviews with elementary teachers and math specialists, classroom observations, filed notes, and review of documents. These data sources ensured that the issue was explored through a variety of lenses allowing for multiple facets of the phenomenon to be revealed and understood
(Baxter & Jack, 2008). Stake (1995) suggested that researchers who have a genuine interest in the case should use a case study approach when the intent is to better understand it. Because this researcher had an intrinsic interest in improving math achievement within the context of the school district of study, the case itself, with all its “particularity and ordinariness”, called for a case study approach (Stake, 1994, p. 237).

**Research Procedures**

**Participants.** Purposeful sampling was used to select participants for this case study. The participants—elementary teachers and math specialists in a Southeast Massachusetts public school district—were selected to participate in the study group on a voluntary basis. Creswell (2007) asserted, “It is typical in qualitative research to study a few individuals” (p. 209). Patton (1990) agreed “selecting a small sample of much diversity, the data collection and analysis will yield… high-quality, detailed descriptions of each case, which are useful for documenting uniqueness…” (p. 172).

Four classroom teachers and two math specialists were selected as research participants based on their participation in the district math professional development during the 2012-2014 school years. Purposeful sampling was used in the initial stages to select participants. Teachers and math specialists across grade levels K-5 who implement math workshop in their classrooms were asked to participate in the study. They were provided with the parameters of participation (i.e., time involved, purpose of the study, use of audio-tape to record sessions, and interview dates). Selected participants were given further information regarding the purpose and scope of the study. The relatively small sample size allowed for an in-depth exploration into the minds of elementary teachers in a Southeast Massachusetts public school district. Creswell (2013) suggested that qualitative research should study and “collect extensive details about” a few
individuals (p. 157). “The validity, meaningfulness, and insights generated from qualitative inquiry have more to do with the information-richness of the cases selected and the observational/analytical capabilities of the researcher than with sample size” (Patton, 1990, p. 185).

Purposeful sampling seeks information-rich cases that can be studied in depth (Patton, 1990). Teachers had the opportunity to “participate in defining and exploring the problem or service under investigation” (Stringer, 2007, p. 44). The construct of “collective participation” in Garet et al.’s (2001) research referred to professional development in which teachers participate alongside colleagues from their school and district. A large body of research focusing on the importance of teachers’ professional communities supports the notion that this might be an effective strategy for teacher learning (Desimone, Porter, Garet, Yoon, & Birman 2002).

In Patton’s view (1990), all types of sampling in qualitative research may be encompassed under the broader term of purposeful sampling. He states that “qualitative inquiry typically focuses in depth on relatively small samples, even single cases, selected purposefully” (p. 169). The underlying principle common to purposeful sampling strategies is selecting information-rich cases, that is, cases that are selected purposefully to fit the study. Morse (1991) suggested that “when obtaining a purposeful (or theoretical) sample, the researcher selects a participant according to the needs of the study” (p. 129). This researcher chose to “interview informants with a broad general knowledge of the topic or those who have undergone the experience and whose experience is considered typical” (Morse 1991, p. 129).

Due to the nature of the research design, the study is limited in its generalizability. In addition, the time frame of study was not prolonged; participants were interviewed over the
course of a few weeks. While the limited scope of the study is not generalizable to schools in other settings, one goal of this research was to offer insights for educators into how teachers understand, plan, and implement instruction in their classrooms, “The researcher cannot specify the transferability of findings; he or she can only provide sufficient information that can then be used by the reader to determine whether the findings are applicable to the new situation” (Lincoln and Guba, 1985). Eisner (1991) suggested that transferability is a form of “retrospective generalization” that can allow us to understand our past (and future) experiences in a new way (p. 205).

**Recruitment and Access.** The main ethical consideration in case study research is protecting the confidentiality and anonymity of participants. Stake (1995) asserted, “Qualitative researchers are guests in the private spaces of the world. Their manners should be good and their code of ethics strict” (p. 154). He suggested that researchers maintain active dialogue with the research participants, provide feedback, and “listen well for signs of concern” (p. 154). Lofland and Lofland (1984) believed that naturalistic researchers are more likely to gain successful access to situations if they are respectful of participants’ time, treat respondents with courtesy, and provide respondents with a clear description of the goals of the research. Approval for teacher participation in the study was obtained from the school district superintendent (Appendix A). A recruitment email was sent to potential participants inviting them to learn more about participating in a study that will explore how teachers understand and use a math workshop model of instruction (Appendix C). Those who were interested were invited to a meeting to learn more about the study (in an elementary classroom in the school district), and the researcher received approval from the school principal (Appendix B) prior to setting up the meeting location. At this meeting, potential participants were invited to review consent forms before
deciding whether or not they would like to participate in the study (Appendix D). The consent forms included the option to choose not to participate in the study and a notice that the participant may choose to opt out at any time. The researcher scheduled interviews at a place and time convenient to each participant who decided to participate in the study.

Qualitative research and data collection in particular involve creating a qualitative sampling strategy and developing means for recording, while also gaining permission and anticipating the ethical issues that may arise (Creswell, 2013). It is important to note that the researcher in this case is a principal in the same school district of the participants. The researcher explained that the participants should in no way feel pressured to participate in the study or to answer questions with which they are uncomfortable. The subjects in this study shared their personal feelings about district-provided professional development and their own classroom instruction. Interviews were completed in a way that avoided any potential judgment or deception. Participants were assured that their participation in the study would have no bearing on the evaluation of their job performance. Participants were not monetarily compensated for their time.

Protection of Human Subjects

Anytime in which research is performed that involved humans participants, it is of the utmost importance that the researcher ensures that none of the participants are harmed as a result of their participation in the study. The Belmont Report established three essential considerations to be observed by those conducting research: respect for persons, beneficence, and justice (Seidman, 2006). All requirements set forth by the Northeastern University Institutional Review Board for the protection of human subjects were met in this study. The researcher ensured that
all federal, state and local regulations and codes were strictly adhered to. The participants were made aware that their participation in the study was voluntary and that they could withdraw from the study at any time without negative consequences (Creswell, 2012). To protect the identities of the participants, the researcher assigned each participant a pseudonym. The researcher reviewed the Informed Consent Form (Appendix D) with each participant.

**Data Collection**

A case study research methodology relies on multiple sources of evidence to add breadth and depth to data collection, to assist in bringing a richness of data together in an apex of understanding through triangulation, and to contribute to the validity of the research (Yin, 2003). In order to uphold the traditions of case study design and to ensure that the context of the research problem is understood, multiple sources of data were collected. This added to the trustworthiness of the information gathered, providing understanding through triangulation of several data sources. The researcher conducted semi-structured interviews, completed field observations, wrote field notes and analyzed documents.

**Semi-Structured Interview.** Participants were asked a series of oral interview questions that were digitally recorded using two recording devices. Interviews were conducted in secure, private locations of the participants’ choice where participants had the opportunity to share their views and experiences. Interview sessions lasted no more than 60 minutes. The researcher utilized interview protocols (Appendix E, Appendix F) to probe and explore within predetermined inquiry areas based on the research questions. Semi-structured interview questions allowed participants to “best voice their experiences unconstrained” (Creswell, 2012, p. 218). In keeping with the flexible nature of qualitative research designs, interview protocols were modified over time to focus attention on areas of particular importance, or to exclude
questions the researcher found to be unproductive for the research goals (Lofland and Lofland, 1984).

Interview participants were asked to share their perspectives about the math professional development in which they participated during the 2012-2014 school years, differentiated instruction, and how they implement math workshop in their classrooms. Each interview began with an initial question, followed by corollary questions in a flexible, non-confrontational manner. At the conclusion of the interview sessions the digital recordings were transcribed by a professional transcription service. Study participants were asked to review their specific section of the transcription for verification and correction to ensure trust and increase validity. The credibility of a qualitative research report relies heavily on the confidence readers have in the researcher’s ability to be sensitive to the data and to make appropriate decisions in the field (Eisner, 1991; Patton, 1990).

Field Observation. Each teacher was asked to consider allowing the researcher to conduct a field observation in her classroom during a math workshop lesson. The researcher conducted three classroom observations as a nonparticipant observer and took notes without direct involvement in the classroom activity (Creswell, 2013). Classroom observations were conducted utilizing the observation protocol developed by the researcher (Appendix G) that included “both descriptive and reflective notes” (Creswell, 2013, p. 167).

Documentation. Three participants provided documents to the researcher that elaborated upon their experiences in implementing math workshop their classroom, e.g., lesson plans, student work samples, student grouping list. These documents added important information to the qualitative research which augmented data collected through interviews. “Documents of all
types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problem” (Merriam, 1988, p. 118). Hoepfl (1997), in her study of closure of technology teacher education programs, used newspaper reports, university policy documents, and department self-evaluation data whenever available to supplement data gained through interviews.

Data Storage. Protection of confidentiality was essential. Recordings and notes taken during interviews were collected and stored in a locked file cabinet in the researcher’s home office. Information was only gathered during research specific times and not during other points of contact throughout the study. The original recordings and notes were destroyed after the final transcription process was verified by the participants. Transcriptions were saved on a password protected hard drive. For the purpose of confidentiality, the participants’ assigned pseudonyms were used to collect and maintain data.

Data Analysis. The perceptions and understandings of participants were explored and an inductive analysis was employed through a constructivist paradigm. Strauss and Corbin (1990) discussed the concept of theoretical sensitivity that refers to the researcher’s insight and ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't (Strauss and Corbin, 1990). Brown (1996) contended:

People and their interactions are more than a collection of objective, measurable facts; they are seen and interpreted through the researcher’s frame—that is, how she or he organizes the details of an interaction, attributes meaning to them, and decides (consciously or unconsciously) what is important and what is of secondary importance or irrelevant (p. 16).
Creswell (2012) described data collection, data analysis, and report writing as a “spiral” process where “one enters with data…and exits with an account or a narrative” (p. 182). Creswell described several aspects of data analysis and suggested a nonlinear approach: organize and categorize collected data, describe and code to develop categories and form themes, interpret data to find “larger meaning”, and validate the findings to ensure accuracy as shown in Figure 2.

Interviews, field observation notes, and documents provided by participants were transcribed and read several times, notes were taken, which ultimately led to the coding of various themes and identifying relationships. Each theme was defined and included rich, thick descriptions of contexts and findings (Creswell, 2007). Codes are defined by Saldaña (2009) as a “word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data” (p. 3). The codes used for this study were based on themes, topics, keywords, and ideas within the theoretical framework, as well as the literature review and teacher interviews. Three cycles of coding were conducted to extract the themes present in the data. Descriptive coding in the first cycle summarized what had been discovered from the teacher interviews. Pattern coding was utilized in the second cycle to categorize and analyze the data to make meaning from the interrelationship of themes and rich descriptions (Miles & Huberman, 1994). Finally, overarching themes were identified through analysis of the “study as a whole” (King & Horrocks, 2010, p. 158). The constant comparative method was employed to check for consistencies and contradictions among categories (Creswell, 2007).
Figure 2: Data Analysis in Qualitative Research

Trustworthiness

Trustworthiness allows qualitative researchers the freedom to conduct rigorous studies without having to fit their research into a quantitative model (Given & Saumure, 2008). Many different perspectives and terms are used when discussing qualitative trustworthiness—also referred to in the literature as validity (Seidman, 2006). Creswell (2013) considered validation “an attempt to assess the “accuracy” of the findings, as best described by the researcher and the participants” (p. 250). With this in mind, potential threats to validity as well as the steps taken to
minimize these threats were identified. Immersed in the school and classroom culture, the researcher worked to build trust with study participants and understood the dynamics of the elementary classroom due to years of teaching experience. This relationship helped to maintain a natural discourse during interview sessions.

The researcher attempted to limit bias as much as possible by utilizing reflexive journaling (Ahern, 1999) and peer debriefing (Lincoln & Guba, 1985). The researcher was forthcoming about any personal bias toward participants. The researcher participated in debriefing with a disinterested peer to uncover perspectives and assumptions on the researcher’s par to overcome areas of vulnerability (Lincoln and Guba, 1985).

This study was designed using data source triangulation to determine if the elements of the case remained consistent throughout the study. Multiple sources of data were obtained (including interviews, classroom observations, and documents) to ensure saturation. Member checking was also used as a strategy to ensure the accuracy of transcripts. Lincoln and Guba (1985) suggested “… making segments of the raw data available for others to analyze and using member checks in which respondents are asked to corroborate findings” (p. 313). Creswell (2007) contended that member checking is an important strategy to identify biases and misunderstandings and to eliminate misinterpretation of data. The researcher met with participants to provide an opportunity for them to review interview transcripts and documents to determine whether an authentic representation was made of what they intended to convey during the interview. Findings were revised based on participant feedback. At the end of the study, results were shared with participants, providing them with an opportunity to analyze and comment on the findings (Creswell, 2007).
Chapter Summary

This chapter offered a description of the case study research design, research procedures, and data collection methods. The qualitative case study methodology utilized in this research aligned with other research on the implementation of pedagogy and curriculum initiatives. Multiple forms of data were collected in context and contributed to a rich description of how teachers used their knowledge and understanding of math workshop when planning and teaching math lessons. An inductive data analysis was employed to discover and categorize themes in perceptions of participants and to make meaning from the interrelationships between themes and rich descriptions. Specific steps were enacted to ensure the validity of the findings.
Chapter 4: REPORT OF RESEARCH FINDINGS

“Mrs. D., math is finally fun again.”

Chapter 4 presents the data collected for this qualitative case study. The research purpose was to explore the ways in which elementary teachers in a suburban Massachusetts school district use their knowledge and understanding of math workshop to improve math achievement when planning and executing classroom instruction, and in particular how they employ the math workshop model to differentiate instruction. Collected data included semi-structured interviews of four elementary teachers and two math specialists, classroom observations, field notes, and relevant documents provided by the participants. Several themes and sub-themes emerged from the qualitative coding and analysis processes. Three primary themes included: a) math workshop, b) professional development, and c) collaboration. These three themes were further divided into sub-themes for clarity.

After presenting the research questions driving this study, chapter 4 provides a brief history of professional development and math curriculum initiatives in the school district, followed by a description of each teacher’s classroom and a discussion of the study findings. The research site will be referred to as “Keenstone School District.” School names are fictitious, and participants in the study have been given pseudonyms.

Research Questions

The following questions guided this qualitative case study:

Central research question: How do elementary teachers use their knowledge and understanding of math workshop to improve math achievement when planning and executing classroom math instruction in a suburban Massachusetts school district?
Sub-question 1: How do elementary teachers utilize a math workshop model to differentiate instruction and meet the diverse needs of learners?

Sub-question 2: What support systems need to be in place to ensure that elementary teachers understand and implement a math workshop model when executing classroom math instruction?

Sub-question 3: How do math specialists support teachers in implementing a math workshop model in their classrooms?

Data Collection and Analysis

To develop a thorough understanding of how elementary teachers use their knowledge and understanding of math workshop to improve achievement, the following forms of data were collected and analyzed over a five-week period: semi-structured interviews, classroom observations, field notes, and a review of documents provided by participants. The researcher also kept a reflexive journal throughout the research process.

The terms “math coaches” and “math specialists” are often used interchangeably in the literature and within the Keenstone School District. In the next two chapters, the term “math specialist” is used to refer to terminology used by study participants. Campbell and Malkus (2014) clarify the intended role of this professional position:

The role of the mathematics specialist or coach is to support the improvement of mathematics teaching and learning in schools by targeting teachers’ understanding and action. The assumptions are that the specialist or coach is a knowledgeable colleague who has pedagogical expertise and an understanding of mathematics and of how students learn
and that this person is qualified and capable of serving as an on-site resource and leader for teachers, providing school-based and content-specific professional development. (p. 214)

**Teacher interviews.** The interviews for this study took place in three elementary schools located within the same public school district in a suburban community in Southeastern Massachusetts. Each school serves students in grades kindergarten through five and employs a full-time math specialist. A brief description of participant demographics is given in Table 1.

<table>
<thead>
<tr>
<th>Participants (Pseudonyms)</th>
<th>Teacher’s Grade</th>
<th>Years of Teaching Experience</th>
<th>School (Fictitious Names)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diana</td>
<td>Kindergarten</td>
<td>8 Years</td>
<td>Meadowbrook School</td>
</tr>
<tr>
<td>Mary</td>
<td>First Grade</td>
<td>4 years</td>
<td>Riverview School</td>
</tr>
<tr>
<td>Brooke</td>
<td>First Grade</td>
<td>5 Years</td>
<td>Meadowbrook School</td>
</tr>
<tr>
<td>Lynn</td>
<td>Fourth Grade</td>
<td>25 years</td>
<td>Riverview School</td>
</tr>
<tr>
<td>Cara</td>
<td>Math Specialist Grades K-5</td>
<td>3 years as a Math Specialist</td>
<td>Riverview School</td>
</tr>
<tr>
<td>Pam</td>
<td>Math Specialist Grades K-5</td>
<td>8 years as a Math Specialist</td>
<td>Woodville School</td>
</tr>
</tbody>
</table>

Table 1: Demographics of Study Participants

The researcher interviewed five teachers and two math specialists using a semi-structured interview format. Five interviews were conducted either before or after school in participants’ classrooms at the request and convenience of individual contributors. Two participants requested that interviews be conducted during their regularly scheduled planning period. The researcher drew from a total of 27 questions from interview protocols (Appendix E, Appendix F), and the interviews lasted approximately 45 minutes. When participants pointed to specific
items during the interview, the researcher made note of their use in the classroom, thus augmenting the interview data.

**Classroom Observations.** Four participants agreed to have the researcher conduct a classroom observation during a math workshop lesson. The researcher used the observation protocol (Appendix G) to record teacher-student interactions, instructional methods, activities, materials, and visual displays in the classroom environment. Additional field notes were recorded in a paper journal during participant interviews. The researcher used that field journal to record hand-written notes during interviews, along with relevant information about the participants.

**Documents.** Four participants provided documents relative to math instruction in their classrooms, such as completed lesson planning forms, student grouping templates, math game boards, written math assignments, and parent information letters. These documents augmented and clarified data collected during interviews.

**Data Analysis.** Interview recordings were professionally transcribed. The researcher read all transcripts closely, becoming well-versed in the data. When completed, member checking was employed. All participants were provided copies of their interview transcripts to review and check for accuracy. As soon as all participants expressed satisfaction with the content of their interview transcripts, the researcher coded and analyzed the data to identify categories, organizing the categories by research question. This process provided insight into how the data aligned with the research questions framing this study. Once coding was completed, the researcher conducted a preliminary analysis of the condensed categories, interpreted the categories, and developed the themes that emerged from the coding process.
Classroom Descriptions

This section includes a brief description of each teacher’s physical teaching space. Describing the classroom environment helps us understand how teachers design lessons and organize student activities given available space and resources.

**Classroom one: Diana.** Diana is a kindergarten teacher. She co-teaches with a special education teacher who works full time in their classroom. The classroom is inviting and organized. Instructional materials such as large ten-frame cards filled in with circles, a word wall of sight words, number lines, and number grids are posted on bulletin boards. A system for organizing math workshop materials is comprised of small plastic bins housed under the windows. Bins are labeled by math workshop center activity and contain materials and math tools needed for each center. Student tables, each seating four students, are arranged around the classroom. There are two tables on opposite sides of the room for small group instruction.

There are a total of 17 kindergarteners in the class. Three students have individual educational plans. All of their special education services take place within the kindergarten classroom.

**Classroom two: Mary.** Mary is a first grade teacher. Her classroom is bright and energetic. You immediately feel a positive and productive atmosphere when you view her students’ work and the colorful educational materials covering all four walls. The classroom is filled with neatly organized materials on shelves. Bins of math games and problem-solving activities are easily accessible for her young students. Mary arranges student desks into groups of four. There is one round child-sized table with four chairs for small-group activities. She uses another table for small-group instruction. Four computers are arranged back-to-back in the
corner of the room. Mary’s computer is connected to an interactive white board, which (as she reports) is frequently used for visual displays, videos, and demonstrating online math games.

There are 17 first graders in her class. A special education teacher is present in the classroom for a portion of the day to provide instruction for two students with individual educational plans. Some students receive pull-out services that take place in the special educator’s classroom.

**Classroom three: Brooke.** Brooke is a first grade teacher. Her classroom is bright and neatly organized. Bins of manipulatives and school supplies are situated around the classroom. A poster listing math problem solving strategies hangs on the white board in front of the room as a reference tool. Brooke arranges her student desks in a large u-shape with four student desks in the middle section. Labeled bins of math manipulatives are kept near the front of the room for students to access. Students also have their own counters which are kept inside of pencil cases kept inside their desks. Brooke uses a small table near the front of the room for small group instruction. There are a total of 20 first graders in the class. Two of the students receive special education services with a special education teacher who provides pull-out math instruction in her own classroom.

**Classroom four: Lynn.** Lynn is a fourth grade teacher. Nearly all of her wall space is covered with academic topics and stimulating learning materials. Teacher and student written information is displayed on chart paper hanging on the walls. Organized math tools and games are stored in drawers and bins. An organized book corner with an abundance of student literature and a small table fill one corner of the classroom. She arranges student desks in groups of four. There are two standing desks at the back of the classroom for student use. Lynn uses another
small table near the windows for small-group instruction. She reports that she frequently uses the interactive whiteboard to display her lesson objectives, agenda, videos, and lesson content. Bins of small white boards and markers are easily accessible to students during lessons and independent work. A cart of Chromebooks is in another corner of the classroom for student use.

Lynn has 18 fourth graders in her class this year. Five students have individual education plans. She and another fourth grade teacher work with a special education teacher as a team to plan instruction for their students. Lynn is certified both as an elementary and as a special education teacher. The three teachers divide students from both classes into three heterogeneous groups for math and literacy lessons. The special education teacher’s classroom is set up with 12 desks so that students can be divided equally among the three classrooms.

Findings

The three questions directing this research guided the development of the semi-structured, open-ended interviews and observations. The questions were designed to elicit meaningful data that could be used to answer the research questions. The rich data gathered from documents provided by participants, field notes, and the researcher’s reflexive journal were also analyzed through the lens of the research questions.

Three primary themes emerged from the qualitative analysis: (a) math workshop, (b) professional development, and (c) collaboration. Sub-themes related to each primary theme are reported under sub-headings. There is considerable overlap among themes, and participants’ responses often addressed more than one theme. In these cases, interview data are included in the theme under which they fit most logically.

Theme 1: Math Workshop
The major purpose of this research was to learn how elementary teachers differentiate instruction within a workshop model to meet the diverse needs of their students. A significant amount of literature cited in this study refers to math workshop—specifically, how teachers design math lessons and utilize particular structures and resources with their students on a daily basis. Three sub-themes were identified within the primary theme of math workshop: (a) lesson structure, (b) differentiated instruction, and (c) impact on students.

**Lesson Structure.** All participants discussed how they have experimented with different math workshop structures over the past two years to find the best way to integrate workshop components into 60-75 minute math period. Most participants reflected on how they utilize the basic workshop structure of warm-up, focus lesson, rotation of activity centers, and small group instruction, culminating in the class coming back together for a whole group sharing or reflection session at the end of the period. Some participants discussed how small groups rotate through a variety of math activities and small group instruction opportunities during each math lesson. Mary described how she experiments with different workshop structures to meet the diverse needs of her students each year:

> It was really challenging at first, because there are so many different approaches to take and I was trying to figure out which one worked for me and in the particular class. What worked for my second grade class two years ago was doing stations. Last year was probably the most challenging for me because I had very a difficult student who had a lot of behavior problems. He couldn’t handle the stations, so it made me really think about, ‘How can I make this work for everybody?’ So my approach last year completely changed.
Diana explained her workshop design this way: “We do it in centers. My co-teacher will take a small group and I’ll take a small group… and then other groups are working on center activities, typically like game-based activities that focus on whatever the skill was for that day…and then we just rotate.” During an observation in Lynn’s classroom, the researcher noted a math workshop agenda written on the white board: “1) Warm-up, 2) PBIL team 3) Lesson, 4) Teamwork, 5) Game 2-9”. Adjacent to the agenda, three math practice standards were listed: persevere, model, and be precise. Students were observed checking the agenda to determine what to do after completing the Problem Based Interactive Learning activity in their enVisionMATH textbook. One pair of boys discussed how they would get materials they needed to play board game 12-9.

During an observation in Mary’s class, when three first graders were finished with the written math assignment, they came to the front of the class to carefully examine the chart on the white board to find out what they should do next. After a little discussion, they appeared excited to play the math facts game with dice called “Let’s Talk 10,” a colorful game with a Valentine’s Day theme.

Brooke described that she typically begins each math workshop lesson with a five to ten minute introduction of the lesson where she introduces the learning objective. Next, she shows a lesson video from the EnVisionMATH program, pausing periodically to discuss the math content with her first graders.

Two participants described the approach they used to launch the math workshop model effectively at the beginning of the year—essential groundwork to keep the workshop running smoothly for the rest of the year as new and more complex activities are introduced. Teachers
reported that they taught students how to locate and use math manipulatives efficiently and appropriately. They also shared how they provided opportunities for students to practice working cooperatively when playing math games and engaging in hands-on math activities before having students work in centers independently.

Mary discussed how she used interactive modeling at the beginning of the year to help her first graders learn routines, find materials independently, and work cooperatively in center groups: “I wanted to get them circulating around the room and knowing where things are, so I would put out pattern blocks and the first week was just explore materials, but at a certain time I’ll ring a chime to move.”

Each participant used a different method to determine when students should move to different activities. During one observation, the teacher displayed a digital timer counting down minutes on the interactive white board. Diana noted that she sets a timer for 12 minutes. When the timer rings, her students move as a group to the next math center. She adds, “We would do that three times. When we have our more struggling group ... It might take a little more time and we just go over and add some minutes to it [timer]. So those two independent groups might be working on their activity or their game a little longer.”

This year, Mary decided not to place time limits on her center group rotation. Instead of having students rotate through centers as a group at specific time, each student completes the task at their own pace before they move on to the next center. Mary explains, “I like it, because they get it [assignment] done at their pace for differentiating...When I think about how to group them, and how to strategically do it, I don’t want the special education kids always coming to the
teacher first, because I don’t want them to get a complex of, ‘I always have to work with the teacher.’”

Similarly, Lynn explained that her students complete assignments and activities in the order listed on the board at their own pace:

My instruction has always been lesson, practice, games and teacher review at the same time. I require everybody to participate in that teamwork time. I also have a teacher table; sometimes it’s mandatory, sometimes it’s voluntary, depending on the day and the kids and how they feel about what they’re doing.

Lynn reported how she provides closure to her math workshop: “When the rest of my class finishes working, they go into games and I do groups. It’s a little teamwork, then it’s games, then we come back and regroup.” Diana described how she ends each math workshop: “Whenever we’re finished with our center activities, we always do meet back on the carpet. I think that’s a great time when we can hear what the children learned or what might have been a challenge for them.”

**Grouping practices.** Participants described their approaches to determine how to group students for instruction and center activities. Some teachers used a combination of heterogeneous and homogeneous grouping strategies, sometimes using both methods in a single lesson depending on a variety of factors such as lesson content, activity type, skill levels of students, and number of staff working in the classroom. Other teachers preferred to place students in mixed-ability groups. Lynn explained that she determines students’ math groups on a monthly basis according to assessments and teacher observations: “This year, we’re exploring a co-teaching model. We have thirty-six kids between two fourth grade classes. We have ten students
on IEPs. We have a resource teacher who takes twelve students, I take twelve students and the other fourth grade teacher takes twelve students. We have them divided up heterogeneously. The special education teacher does not take all of the kids on IEPs. We each have some high, middle, low, because I feel very strongly about heterogeneous grouping.”

Lynn provided an example of how she utilizes homogeneous grouping to teach focused small-group lessons:

Sometimes at the teacher table, especially if my lower group doesn’t need some more teaching, I’ll pull the higher kids over to introduce a project…. My teams are heterogeneous except for when I might put a few students to work with them individually or in groups.

Brooke and another first grade teacher divide the students from both of their classes into two groups for math instruction. The special education teacher takes six students with pull-out math services to her own classroom during math lessons. Brooke explained that they change math groups between the two classrooms after each math benchmark assessment which are administered approximately four times a year, “Even after that second benchmark, our groups didn’t change that much… We kind of do our own thing in the flexible groups knowing that we are working towards the same objective, but get there however we need to.” Brooke explained her lesson structure, “Once the students come into my room, I'll just review, "This is what you're learning today." Then, we'll do a whole group lesson because it's just such a big group. Then they'll do a lot of partner work.” Brooke reported that she provides small group instruction while the remainder of the class is working on independently or in pairs.
A few participants discussed the challenges they face in determining how to meet the needs of students with a wide range of math skills when they are the only teacher in the classroom. Cara recounted how she helped a third grade teacher set up math workshop in her inclusion classroom for the first time:

There was a third grade teacher who needed lots of help with the workshop. She said, ‘I need help getting this up and running.’ We sat and grouped her kids. What was so overwhelming to her was that she has probably five kids with special needs that are really, really struggling with math. Then she has six kids that are low because of executive functioning issues. She was having a hard time managing those eleven kids and then getting to the other kids in the class. We grouped them strategically…in ability groups…She has her low group go to her, and the special educator, or the aide, takes the four or five really low kids. She actually doesn’t meet with the special needs kids, which is kind of a flaw, I think in the model.

This approach differed starkly from the co-teaching model in Diana’s classroom, where the special education teacher works full time in the general education classroom alongside the classroom teacher. In the co-taught classroom, the two teachers work collaboratively to share the responsibility of teaching all students in the class. Diana explains, “My co-teacher is not always working with her students. I’ll work with them just as much as she does, which is great so that we both have eyes on all of the kids. And they see us both as their teacher for sure.”

While the majority of participants discussed how they typically group students for math workshop based on assessment data, Diana explains that she and her co-teacher group students in their inclusion classroom based on teacher observation:
We have the purple group ... These are our more struggling learners ... That’s how we have them grouped, by shape and color. So we’ll just say, ‘Purple group is going to work with Miss N. first.’ We don’t necessarily always use enVisions assessments to go off of. It’s more like teacher observation than anything. The groups might even change topic to topic as well, depending on what it is that we’re doing.... For the most part, you might only see one or two kids move into another group. They’ve stayed pretty consistent.

Later in the interview, Diana discussed how she and her co-teacher form homogeneous groups based on benchmark assessment data: “We just sit down and when we do our center groups, we group the children homogeneously. That can be a challenge, because then when they’re at an independent center, we don’t always know that they’re performing their best or being on task, because they need a lot of adult assistance.” Diana explained that when students are grouped by ability, then “we can really make sure that we’re teaching them exactly what they need and giving them what they need. So I guess there are pros and cons.”

An observation in Diana’s kindergarten classroom validated her concern that her students had difficulty working independently at center activities. The researcher observed that students were assigned to homogeneous groups by math skill level. Two groups of students worked with the co-teachers at the teacher center tables. Three other small groups of students worked at three different center activities focused on listing numbers in a series and on using a number chart. Prior to the start of center activities, the special education teacher explained the directions and demonstrated how to complete each activity. Approximately half of the students had a difficult time getting started on the activity without teacher support. During the 15 minute workshop period, a few students walked over to a teacher with their papers to ask for assistance. Each teacher also left their group twice to check in with students at each center to clarify directions
and model how to complete a section of the activity. Four of the students did not complete any part of the activity. Many students had recorded inaccurate answers on their papers. At the end of the observation, Diana commented to the researcher that these particular activities were all new to the students and that it is difficult to manage the independent centers with only two teachers.

During an observation in Mary’s classroom, Mary commented on why she paired two girls together to work on a written assignment: “I put them together because she is good at explaining her thinking.” The observer noted that the stronger student was talking through her own math reasoning as she worked to fill in missing numbers on a number grid. Mary noted that she employs an assessment method she learned about during a professional development workshop facilitated by the school’s math specialist to inform her decision-making around grouping students: “The groups, we figure out who gets what from pre-assessing. It could be through a number talk. It could be through games. Just informal assessments, but figuring out how to group them, it’s usually mixed ability grouping.”

Teachers described how they communicated with students about which groups they would be working with during the math workshop period. A few teachers had their students’ names written on cards, which were then attached with Velcro to posters under categories such as the “purple group.” In Mary’s classroom, each student had an assigned number, and the numbers were listed by groups on “frog shapes” displayed on a hanging pocket chart. In other classes, student groups and center activities for the day were displayed in chart form on the interactive white board.

**Differentiated instruction.** Participants discussed strategies they utilize to assess students’ knowledge and skills to determine how to provide meaningful instruction at an
individual student’s level or zone of proximal development. They described how they adapt lessons so that all students can access the grade-level curriculum through tiered assignments and materials prepared at varying levels of difficulty. They also shared how individual and small-group instruction enables them to individualize instruction and content through the use of guided practice with immediate feedback, manipulatives, and modified assignments. When asked what differentiated instruction means to her, Lynn replied, “That means everybody gets what they need and if somebody is struggling to get remediation, if someone is high, they get some enriching.” Pam expressed a similar sentiment, “Differentiation is meeting students’ needs where they are.” She described how teachers design math workshop in a variety of ways and the importance of differentiating within the workshop model:

The workshop…looks just so different in many different grades, and in many different classrooms…I try to talk about math workshop as differentiating instruction…because I think that sometimes teachers think it has to be students moving from center to center to center…In the upper grades, it’s just a completely different ball game, and I think that with these heavy common core standards, and with what we have to accomplish…teachers need to get through a lot of content, so a workshop model where they’re rotating might not be the best idea. However, I think differentiating and pulling small groups, and having that be something that’s done daily is a good thing. That’s what’s happening more…What I do say is, ‘We need to meet the needs of all the students and all the learners in your classroom.’

**Assessment.** Teachers shared how they use formative assessment measures such as student work, anecdotal notes, and teacher observations to determine which differentiation techniques to employ to meet their students’ needs. Teachers also described the summative
assessments they gave, such as *enVisionMATH* topic tests and district benchmark assessments. Mary explained how she implemented an assessment method she learned during a professional development workshop presented by her school’s math specialist:

This is something huge I took away from this professional development. We noticed that their number sense wasn’t strong when they came into first grade and it really bothered us, because first grade’s such a crucial year to get a strong foundation, so our math specialist told us about a screening assessment, so we did that…. It baffled my mind how many of them did not know their parts of five…. I jumped right into it and I’m very big in differentiating instruction, because of how differently they learn and how different they are as learners.

Pam described that teachers have requested that she provide pull-out enrichment lessons for students based on their math benchmark assessment data:

From our common planning times, teachers have said, ‘Could you do an enrichment group for second grade?’ I have enrichment groups in the morning where I’m pulling kids, and we’re doing above grade-level problem solving…I also have intervention groups…

During an observation in Lynn’s classroom, she asked her students to complete an “exit ticket” at the end of the math workshop to determine their level of understanding about the fraction problems they had worked together to solve. She directed her students this way: “Close your eyes. Put your hand up if you are feeling good about it…. Put your hand up if you are worried about homework tonight.” Lynn used this method to assess which students needed additional instruction or practice in subtracting fractions. She then asked her students to work as a group to
produce a quick written assessment of their understanding of the lesson concepts. “This is your ticket to leave math. What is one thing you have to remember when subtracting mixed numbers? Talk with your group and come up with one answer from the group to share.” Lynn asked each group to share their reminder with the class out loud. She then asked for a student from each group to write their collective reminders on the chart paper on an easel at the front of the classroom. One representative wrote, “Convert the fraction if possible.”

Pam explained how she utilized an informal assessment strategy when teaching a model lesson in a fifth grade classroom which differed from a traditional workshop structure:

When I model a lesson, I will teach a whole class lesson, and then I will pull a flexible group. I’ll put a star on six [students’] papers. If you have a star, you’re coming over to me because I noticed that you’re struggling. I think that’s more powerful than that idea of a workshop model. Then there should be definitely prescribed activities that students are doing, they should be working independently or in partners. There could be games involved, but I just feel like the idea of differentiation is the piece that’s the most important.

Cara described her perception that teachers have varied skill levels in using different types of assessments to inform their instruction. “It’s the lack of understanding of the several different purposes of an assessment…that prevents them from using the benchmark data in a way that it could be really meaningful to them. With that said, they’re so good at anecdotal observations. They’re so good with doing quick checks. Honestly…I would rather teachers be dip-sticking all day long and have a good handle on where every single child is in their
classroom instead of waiting for the benchmark assessment to understand it…. They know their kids so well.”

**Strategies.** Participants discussed strategies they use to differentiate instruction, such as small-group instruction, project-based learning, tiered instruction, and modification of instructional materials. Some teachers described how they scaffold instruction (defined as providing support to students as they gain progressively stronger understanding and greater independence in learning and skill acquisition). During one observation, Lynn scaffolded instruction for two students by using plastic fraction tiles to model how to subtract mixed numbers, while the remainder of the class worked in groups to complete the math assignment. Lynn periodically circulated around the room checking on her students’ progress, posing questions, and providing prompts such as, “Have you tried to draw a picture of the fraction? That might help you explain it better.”

Cara described how she works with teachers to tailor differentiated instruction to a wide range of skill levels in their classes.

I always try to make sure that their lessons are expandable and retractable so they have a fitting challenge for the kids who are going to finish, while the other kids are still working. For the struggling learners, I try to help them figure out which problems are most essential.

Lynn implements project-based learning activities for students who are ready for more challenging assignments. She described a project her students are working on during teamwork time: “Three kids make up our high group and for the fraction unit…I got a unit from Teachers Pay Teachers, which is project-based. I purchased a project about owning a bakery and creating a
bakery.” The researcher also observed this type of tiered instruction in Mary’s class. Her first graders were involved in a center activity in which they were making a number line by placing number cards with digits 85-120 in sequential order on the rug. Mary differentiated the project by making a variety of activity sets in plastic bags containing number cards of different spans of digits. Some students had 85-120, while others had 80-100. Mary noted, “I made the bags different. I tell them, ‘I want you to be using the blue bag and I want you to be using the pink bag.’ Some of the numbers are higher and some are lower. They don’t know they are differentiated. The activity is always differentiated.”

Diana spoke about how she also differentiates math games for centers so that her students do not realize where they’ve been benchmarked:

“Right now we’re doing teen numbers, but we still have children who are not solid in their numbers one through ten. One of the games was Top It with the numbers one through ten….and we had students who were playing Top It with the numbers 11 through 20. So we differentiate in that way. So they’re playing the same game but with different materials.

Cara describes how she helps teachers scaffold instruction to improve students’ listening and discussion skills when having conversations about math problem solving:

I think the first step is drawing those conclusions between reading workshop and how you get kids to talk to each other in reading workshop. I think the second step is teaching strategies to promote talk. Teaching kids how to listen to each other and repeat back what they heard instead of having the teacher repeat it back. I think sentence starters are great
for the younger grades and modeling. Then, eventually you build that into your routine so you have your turn and talk during your mini lesson.

While all participants shared that they differentiate math instruction, a few discussed the challenges of differentiation and the comprehensive planning required for workshop to be effective. One participant recounted, “I was struggling with the teacher stations, I had students who were really struggling and I did not feel comfortable letting them go to another station…. I just need more time with them.” She reported that she and the math specialist discussed those concerns, and the specialist suggested that she plan her group rotations so that more independent learners come to the teacher center after the struggling learners so that she can spend more in-depth time with them as needed.

Mary also shared some of the challenges of meeting a wide range of student needs in her classroom:

That’s something we are struggling with…we focus so much on the kids who are struggling and not enough on the kids that need enrichment. That’s why I love the workshop model, because I do it two ways. We look at the units ahead of time. We pre-assess to figure out who gets what. It could be through a number talk. It could be through games. Just informal assessments, but figuring out how to group them, it’s usually mixed ability grouping…I find differentiating is really easy with math because I know their working number. I have some kids that are already at ten and I have some kids that are at six.

Cara shared her ideas about how to improve teachers’ capacity to differentiate instruction:
The thing that would be really helpful to have, extra personnel to cover teacher’s classes and give them the opportunity to go across the district to see different grade level teachers that have… mastered the art of the differentiation in the math workshop… and that it can look very different…I think would be the most helpful because it’s a very personal thing, math workshop and with what works for you and what works for your kids. I also feel like you learn so much when you go into someone else’s classroom.

Mary extends her math differentiation into homework practice by creating “fluency bags” that each student takes home on Mondays and returns to school on Fridays. These bags contain a ten-sided die, a game board, and game sheets to fill in as an “accountability component.” Mary provided the researcher with a copy of the letter she sends home to families explaining the activities. The bags are differentiated for individual students and contain game boards that match their “working number.” She explained that each student’s “working number” is determined by assessing their knowledge of number combinations up to ten. Her constructivist approach to homework has resulted in strong participation and positive feedback from parents regarding this fun style of homework, and consequently her students’ number fluency has been improving.

**Impact on students.** The sub-theme “Impact on students” was pervasive throughout the interview data, classroom observations, documents, and researcher’s notes. Teachers spoke passionately about how math workshop has affected their math instruction in encouraging ways. They reported that their ability to engage students at their individual skill levels has increased, resulting in improved math achievement.

**Student engagement.** Students’ excitement for math was evident during an observation in Mary’s classroom. Her first graders were actively engaged in all parts of the workshop lesson.
Mary’s enthusiasm for teaching math was contagious, as she described center activities in fun and purposeful ways. She posed open-ended questions to engage students in higher-level thinking, such as, “What do you notice about the number grid? Turn and talk at your table.” A few students eagerly responded, “I noticed it goes up to 120.” Another student responded, “I noticed the top row goes one, two, three, four, five, all the way up to 10.” Mary led the class in counting animatedly to 10 while she pointed to the numbers on a grid projected on the white board. Another student noticed that the number 11 did not have a zero. Mary queried, “Who can say it another way?”

Mary attributed her first graders’ increased engagement in “math talk” or math discourse to opportunities for problem-solving discussions during small-group work and during the whole-group “share time” at the end of the workshop. She described an example of how she engages students in explaining their mathematical reasoning during a focus lesson by writing each of their answers on the white board without offering a response. Explaining how this approach helps students focus on math problem solving rather than on her reaction to an answer, she stated, “I take their answers and I just write, I try to be very monotone, and then I say ‘Okay, who would like to defend their answer?’” Pam described how she supports teachers in fostering active learning and students’ engagement during math discussions:

I said, ‘Who’s doing the heavy lifting? Who’s working the hardest in there? Because it should be the kids, and that you should hear their voices the most.’ That’s what I love. It’s when I get to go into the rooms and it’s so much less teacher-driven, and it’s more kid-driven. They’re partnering up. They’re talking about a problem. They’re working through something together. That’s like the most beautiful thing.
Pam reported that some teachers find it challenging to incorporate student-led discussions into their math lessons. She described that she plans to work with teachers to foster more active student participation in math discussions:

I think the real easy thing to fall back on sometimes is teacher-led [discussion] because that just easier to manage. It’s less chaotic and it sounds quiet…That’s something that I think we need to keep talking about and keep evolving, but this whole idea of rich tasks really lends itself to more teacher hands off and more student dialogue and student discussion…That’s way more important…than the teacher standing up and being the one who’s just delivering the knowledge…They [students] have to be able to construct it themselves.

Lynn explained that the teamwork part of her math workshop increases her students’ math reasoning and math discourse:

I give them a task to do and I have them solve it as a team. I tell them that it’s their responsibility to make sure everybody on their team can answer the question…. It helps my higher kids feel like they have to take a minute, and it helps my lower kids not be so passive.

Lynn described her role as one of facilitator during group work. She actively listens to students’ math conversations and problem solving. She might give a “quick hint” and then move away so that the focus stays on the students talking to each other and not on her. She then circles back to check on their progress, perhaps posing an open-ended question. Lynn shared that the biggest change to her outcomes since implementing math workshop is her students’ increased ability to work as a team and have math conversations:
I think what’s different with the workshop model is that kids are modeling for each other more so than what I had done before…I do think that that has raised the abilities of my high kids. If you can teach somebody something, it’s different from just knowing it yourself. I feel like the lower kids have really risen to the responsibilities.

Diana echoed this sentiment that math workshop has a positive impact on her students’ math achievement:

I think that we’re getting the chance to meet with small groups more than we ever were before. I felt like small groups was something we did in reading and writing and it wasn’t something we did in math. So that’s exciting…I’m definitely seeing much more growth in students … In the way they’re talking about math is incredible. We are always asking them, ‘How can we prove that?’ And it’s so fun hearing them try to explain their thinking… I don’t think we ever did that before in our old curriculum.

Participants found that their students are actively engaged during all parts of the workshop period. In two math workshop observations, the researcher noted that active learning and on-task behavior was consistent throughout the period. In particular, the researcher observed a high level of participation in discussions, productive written problem solving, and teacher and student enthusiasm. One especially encouraging instance in Lynn’s class involved students maintaining attention to subtracting fractions with mixed numbers. As students worked in small groups, they discussed their problem-solving strategies with peers, explained problem-solving steps when a peer asked for clarification, drew visual models, and utilized manipulatives without teacher intervention.
Diana spoke of her kindergarteners’ interests and how they guide her instruction, leading to increased engagement in math:

We had pulled away from doing our centers for a topic. The children were making shapes with geoboards, and one of my students said, ‘Mrs. D., Math is finally fun again.’ And it broke my heart when he said that...My co-teacher and I realized we didn’t do centers that whole unit...we know that they all really love the hands-on activities...they love centers; they love working in small groups.

In contrast, Brooke described her concern about the effectiveness of the independent math games component of the math workshop for her first graders:

The hardest part is for them is being able to slow down to their partner's pace, just to elaborate on a problem on their own, to think, ‘How can we keep talking about this and stretch this?’...They just don't apply that independently...Often times, I do think, ‘Is this the best use of their time?’ They're getting their work done and they're playing games that reinforce the skill, but I'd much rather have them in a group of six back here [small group instruction table].

**Theme 2: Professional Development**

The second main theme emerging from the data analysis was professional development. Professional development is defined as an approach to improving teachers’ effectiveness in raising student achievement, and it can take the form of courses and workshops, coaching and mentoring, or collaborative planning and teaching. Participants discussed the professional development workshops and follow-up sessions provided by the district during the 2012-2014
school years. They also reported on their experiences with more recent professional development opportunities provided by math specialists in their schools. The three sub-themes found within the primary theme of professional development were (a) relevance for classroom practice, (b) communication, and (c) expectations.

Relevance for classroom practice. Most participants discussed how they were unclear on the purpose of the district-provided professional development with a math consultant during the 2012-2014 school years. Several participants reported that even though the actual content and focus of the professional development were different from what they expected, they still learned relevant information about the curriculum for their grade level.

Brooke explained that she thought the primary purpose of the professional development “was to help us make materials when we didn't have a math program; and materials that obviously supported the Common Core, and our Massachusetts Math Standards as well.” She reported that she utilized the information she learned during the professional development to develop lessons and incorporated the games she learned about into her math instruction. Mary explained her perception of the purpose of the professional development sessions:

I thought the primary purpose was to teach us about math workshop…That’s not what I got out of it… I think the most I got out of it was more materials we could use and supplemental things when we were using no program at all.

Lynn also thought there was a disparity between the intended purpose of the professional development and what she learned, stating:
I think that the message was that it was going to be about unpacking the Standards and learning some strategies for math workshop. I think the actual thing was unpacking the Standards and learning some math games. I think that the discussions afterward were along the lines of how to teach the Standards broadly and deeply.

Cara echoed this confusion about the purpose of the professional development. She considered the primary goal of the training to be “getting familiar with the new content standards and the math practices” and reported, “She [math consultant] touched on math workshop but, to me, that was not a focus in these workshops because teachers so desperately needed the actual content in the new standards.” Cara also discussed how she thought the professional development was overwhelming to some teachers because the district was transitioning away from the current math program. She reflected on how teachers were worried about “completely switching what they were doing and go to the new Content Standards.”

Diana conveyed a more positive perception of the content and relevance of the professional development to her teaching:

I think it was just like a really quick overview of ways we can supplement what we had already been doing, because we didn’t have a math program at the time…It was a lot of creating…We looked at the Standards and then created what we wanted to make. She [math consultant] gave us some really great ideas and they were all really hands-on, which I think is so important in kindergarten…we actually participated in all of the center activities. I thought that was really great. We took back a lot of information and a lot of things we could use right away…. The next day I could put it out for my kids.
By contrast, Lynn expressed that she did not feel that the professional development affected her math instruction. She shared that she felt the most valuable part of the professional development was being able to attend sessions with her grade-level team. “Having time to talk about the changes was definitely valuable. That allowed us to adjust our practice…I felt like I didn’t grow as much as I would have liked with the amount of time that we spent.”

**Communication.** Some participants attributed their uncertainty about the purpose of those professional development sessions to a lack of adequate communication ahead of time. The training took place over a two-year period and was delivered in stages by grade level. Some teachers reported that at least some of their uncertainty was due to the district’s moving away from the Everyday Math program, which had been the primary elementary math program in the district for many years. Teachers relied heavily on the Everyday Math program materials, and being suddenly expected to design their own units and lessons was unsettling. A few participants shared the fact that administrators had informed them that the district was moving toward a math workshop model of instruction while also trying to align with the new curriculum, causing some teachers to be apprehensive about the changes.

Diana shared her thoughts about how implementation of a new curriculum and instructional model was communicated by administrators over the last two years:

I think finally we’re getting a clearer message of what’s expected. I think we were getting the message before ... at least we were interpreting that we had to stick with enVisions and do enVisions the way it was handed to us. And now, we’re getting the message that enVisions is a resource and that we can supplement it with anything that we’re finding that we need.
Teachers reported that once the district had adopted the *enVisionMATH* program, there was some confusion about how closely teachers were supposed to follow the program. Lynn shared her concerns about moving to a new math program after the teachers had worked for two years to develop their own units with the assistance of the math consultant:

> We were literally writing units and gathering materials from a bunch of sources. That was our first challenge. The second challenge was when were given EnVisions... We had done two years of instruction using the workshop model and the new standards. Then last year, all of our units were sort of pushed aside to do EnVisions and I felt that EnVisions wasn’t as rigorous as the stuff we had developed. This year, I think our message was more, ‘Use EnVisions and here’s your trajectory.’... Then, after meeting with our math specialist and our principal, our message became, ‘EnVisions should be your first go to tool, but it’s not your only tool.’

Mary observed that collaborating with the math specialist helped to clarify her understanding of how the new math program was expected to be implemented: “Our math specialist told us you can supplement EnVisions and we did. We didn’t follow it with fidelity, because when we noticed this isn’t going to help them reach the Standard we did what we needed to do to get it better.”

Lesson observations revealed that students were working with *enVisionMATH* program materials such as work mats, textbooks, and homework sheets within the workshop structure. Some resources produced by other publishers were also being used, as were many teacher-created materials such as games, worksheets, posters, activities, and problem-solving projects.
**Expectations.** All participants expressed strong feelings about using supplemental resources to strengthen areas they found to be lacking in the new math program. Teachers reported that they wanted to be able to use their professional judgement to modify or eliminate specific *enVisionMATH* lessons based on their students’ needs. Some participants felt strongly that the lessons they had created in the past were effective for students, and they felt a sense of relief at being told that the district’s expectation was that *enVisionMATH* should be seen as a resource and not as the total math program to be used lockstep. As Lynn expressed it, “Personally, I don’t think EnVisions is rigorous enough. We are definitely adding our own things. I use some videos and lessons from *LearnZillion* and *EngageNY.*” She reported that her team asked the math specialist about an assessment they wanted to use instead of the enVisions test: “We asked, ‘Do we have to give them?’ As a team, we celebrated and said, ‘Okay, we’re going to pull out our fraction assessment that we made.’”

Mary stated that she has a better understanding now of the district’s expectations for math instruction than she did when the change in math program was initiated:

> The standards are very rigorous. Our expectations of these kids are really high, not that they weren’t before, but I’m starting to get more comfortable with the new standards, and starting to get comfortable with Envisions... I’m teaching to standards, not to a program.”

Cara related the feeling that implementation of the math curriculum and workshop model could have been smoother. “It was a very drastic message to completely switch what you were doing and go to the new content standards. I don’t think enough of a connection was made between what you’re already doing and how to tweak it in a manageable way… in a gradual release kind of way.”
Mary described how she and the special education teacher collaborated to adapt *enVisionMATH* materials to plan differentiated lessons:

We just dug apart the enVisions manual and the standards…It made no sense the way enVisions ordered the lessons and the way they were teaching them…we always go above the standards and further, but some of the enVisions stuff, I feel sometimes it’s not developmentally appropriate.

**Theme 3: Collaboration**

The final theme emerged from participants’ recognition of the need for ongoing collaboration with their peers, math specialists, and administrators in order to design and implement effective math workshop lessons aligned to the curriculum. There were three sub-themes within the primary theme of collaboration: (a) math specialists, (b) peer support, and (c) teacher autonomy.

**Math specialists.** The majority of participants reported that collaborating with the math specialist has helped them implement changes to their math instruction, resulting in increased student learning. Teachers described the ways in which the math specialist impacted their ability to plan effective workshop lessons, assess students’ math understanding and skills, and meet a wide range of students needs in their classrooms.

**A resource.** Some teachers reported that they viewed their math specialist as an important resource and an “expert.” For example, Diana stated:
Our math specialist here is wonderful. She’s so hands-on with helping us, coaching us in anything that we need. We’ve been using our common planning time with her to plan for the upcoming topic, which has been great…we talk about what topic we’re working on, what’s coming next, and then she actually really pulls a lot of activities…and she’ll get those ready for us.

Diana reported that the math specialist collates the benchmark data and assists teachers in analyzing the results during common planning time. She explained how the kindergarten teachers use the data to plan intervention groups: “We’ve been using the benchmark data that we’re getting from the math specialist... we are using our educational assistant to work with those students who are really struggling in areas.”

Mary described how she applied information she learned during a professional development training facilitated by the math specialists:

The first one they did was working number in fluency, the three stages of fluency, and because of that, we took it ... I think that’s how I am with PD, I take it and run with it…They’re giving it to us for a reason and I want to use all the knowledge they have. They’re the experts, so I want to take what they have and try it out.

Mary also spoke of how she was more engaged in the embedded professional development with the math specialists than she had been during the earlier training with the math consultant “because now it has more purpose.”

Mary described how the math specialist had helped her during her second year of teaching when she had a student in her class with challenging behaviors. “The math specialist
came in, I relied heavily on her and she actually set me up right away with a workshop model…It was really challenging at first, because there’s so many different approaches to take and I was trying to figure out which one worked for me and in that particular class.” In contrast, one participant explained that while she saw the math specialist as a valuable resource for the school, she felt that the specialist had not impacted math instruction in her classroom yet. In particular, she thought math specialists were important in supporting new teachers to develop their content and pedagogy knowledge.

Cara shared an example of how she provides resources to teachers when they asked her for assistance:

I’ve supplied them PowerPoint templates so they can project their objective, their groups and the task…I think that’s really helped…it becomes a very interactive tool. I still use PowerPoint if teachers need help with specific content lessons…to guide them with questions and visual modeling. That really helps a ton. They’ve actually gotten good at making their own… and sharing it with each other too, which is awesome.

In her role as a math specialist, Pam described how she embeds professional development into common planning meetings with teachers at each grade level to discuss the content and pacing of upcoming math units:

We take a look at…the focus standards for this grade level… ‘What games or activities can we use that address what we’ve talked about?’ We try to talk about the standards as much as possible. I’ll help them make a scope and sequence. ‘Here’s what enVisions
tells us to do, but what do we need to supplement it with? What sort of math models do we need to really make sure students are aware of?’

**Roles and relationships.** Cara spoke about how the role of the math specialist is unclear to many educators in the district due to the many different responsibilities comprising their position. Some participants discussed the fact that the terms “math specialist” and “math coach” are often used interchangeably, sometimes leading to confusion among staff and administrators about math specialists’ actual roles. Cara shared her perception of how educators in the district have an ambiguous understanding of the role of math specialists:

Our position is so muddy and murky. It’s so unclear. Teachers don’t really know. We don’t really know. I think that’s a point of frustration for the new math specialists this year…. The teachers aren’t really familiar with what a coach is.

The responsibilities of the math specialists in the district have transformed over the past few years. Beginning in the 2015-2016 school year, the school district funded a full-time math specialist in each of the six elementary schools (In previous years, each math specialist split their time between two elementary schools.) Math specialist responsibilities shifted from providing small group math intervention to coaching teachers in math content and pedagogy. Both math specialists reported that they are gradually making the transition to the coaching role. Cara reported that teachers continue to want her to provide small-group math instruction. She described her conflicting feelings when teachers request math intervention support for struggling students:
I’m trying to push into the classrooms. If teachers have specific kids that they’re concerned about and need specific interventions, I’ll push in during their workshop time…we do 15 minutes of intervention and then they go with their teacher for small group reinforcement of the concept… As much as I’m not an interventionist, there’s a need.

Brooke reported that she would like the math specialist to provide more intervention support for students, “I think it would helpful if… the math specialist could take a group of students. She does intervention… with one of my students three mornings a week. That's helpful. I've seen that really be impactful.”

Pam described an instructional model in which she works directly with students in the classroom setting along with the classroom teacher:

There are the classes where I push in, and I’m there for the entire math block, and I’m the second [teacher] who pulls kids that are struggling. I almost parallel-teach. If the teacher is up in front of the classroom teaching the lesson, I have three kids in front of me, and I’m just slowing that down a little bit. I’m checking in with them as we’re going through.

Participants used the following terms during interviews to describe how they perceive the roles and responsibilities of the math specialists in their schools: “intervention,” “math coach,” “curriculum work,” “professional development,” “expert,” and “resources.”

Diana also discussed how math specialists were developing district assessments to bridge the gaps between the content in the new math program and the curriculum. “The math specialists
are doing the benchmark assessments for us, and they’re showing us the questions are so much more rigorous than the enVisions math assessments.”

Some participants reported that they find the math specialist to be a link between teachers and administrators. The role of a math specialist as intermediary can be problematic or beneficial depending on the circumstances; math specialists are often involved in administrative meetings and decision-making situations while continuing to serve as members of the faculty. For their part, math specialists shared that some teachers tend to become nervous when they enter the classroom, as teachers can view the observation as being critical even though math specialists do not serve as administrative evaluators. Lynn remarked that teachers on her grade-level team were able to ask their math specialist directly about “messages” they were hearing from administrators about needing to administer the enVisionMATH tests. “That was, again, one of those direct questions where we said, ‘Do we have to give them?’ …we just clarified that the topic tests aren’t mandatory as long as we give our own assessments.”

Cara spoke of how strongly she felt that building relationships with teachers was a critical first step to gaining their trust and building their confidence in working with her as a peer:

If teachers needed me to make copies for them, I would make copies for them…I wanted them to know that I worked really hard and I knew my stuff. That was my biggest priority. I think the time that I spent doing that was so valuable and worked so well. I can’t speak enough about the relationships and the progress that’s made because of the relationships.
When discussing how teachers feel about her coming into their classrooms, Cara conjectured, “I would say probably 90 percent of the teachers don’t mind me coming in. Teachers see me as an extra set of hands there to help them, that I’m a colleague and not an evaluator.” When describing how teachers appreciated the extra help in the classroom, Cara remarked that some teachers hold a more hesitant view of the math specialist as coach. Cara illustrated her perceptions:

When I built my schedule, it was difficult because teachers here are not familiar with the coaching model and they’re very anti-coaching. The whole coaching cycle of the pre-conference and the meeting and the post-conference is completely… ‘Don’t even think of approaching me about that.’

Both math specialists discussed how they converse about “back door coaching,” explaining that they try to have quick conversations with teachers when they go into classrooms to provide intervention support for students. Cara stated:

I’m pushing into classrooms to help intervene, but while I’m doing it, I’m having conversations about content. I’m having conversations about pedagogy. I’m having conversations about materials used in differentiation…That little connection time is priceless because…it’s applicable to exactly what they’re doing in the moment…if there's something I can do to follow up with them, I will. If there are materials, resources, I’ll literally bring it to them.

Pam described the importance of building relationships with teachers and supporting them in meeting the needs of their students before math coaching around pedagogy can be effective:
For right now, it’s been a lot of direct service. It’s been a lot of co-planning… I have a couple of teachers who send me their lesson plans. It’s nice, too. They come to my door a lot. Those… superstar teachers. Teachers that can’t get enough are at my door. ‘Here’s my data. Here’s the kids I need help with. What do I do?’ Those teachers are so fun to work with because they’re just ready to go.

**Peer support.** Participants reported that they work collaboratively with their colleagues to plan and teach lessons. Mary described how the first grade teachers meet to plan each week: “The three of us meet every single week. We use the same planning sheet and we plan together to make sure we’re on same track and to swap ideas, which is really helpful.” The quantity of time teachers spend each week planning workshop activities and differentiating instruction was mentioned frequently by participants. Mary stressed that she and the special education teacher “stay after school until six o’clock sometimes just planning together.” She added that they keep the lesson plans and materials they create. “The hope is that when we find things that work… it will be less planning and more figuring out how to differentiate even more than what we’re doing.”

Diana shared how she collaborates with the other kindergarten teachers. “We meet every week to plan during one of our common planning times.” She also described how the principal of her school recently began holding vertical team meetings to ensure continuity of math instruction across grade levels. Teachers “meet with the grade level above or below us... we heard from first grade about what our kids were lacking going in to first grade ...... so we’re really trying to beef up what we’re doing here, so they don’t see those same gaps.”
Participants reported that they plan and co-teach lessons with special education colleagues so that both teachers are responsible for the learning of all of their students. They described how they share the workload in creating lesson materials, homework, activities, and games. Mary recounted how she and the special education teacher met over the summer to plan their daily classroom schedule so as to maximize the time the special educator was able to co-teach in her classroom, saying, “It’s so beneficial the way we have it set up.” During one observation, Mary and her co-teacher seamlessly took turns presenting the math focus lesson. While Mary presented verbal information to the class, her co-teacher stepped in to clarify concepts, assist individual students, and draw visual models on the whiteboard. The teachers appeared to be energized by one another and were able to provide individual attention to more students than they could have alone.

By contrast, Cara shared a different perspective about the challenges she faces in scheduling time to collaborate with teams of teachers. “For the most part common planning times are teacher run and teachers send an invitation to the math or reading specialist. They’re encouraged to invite us. They don’t always. Some grade levels are better than others.” Cara added that it is difficult to find time to meet with teachers to review the most recent math assessments before they plan upcoming units.

Pam spoke about how collaborating with other math specialists in the school district has been a positive experience:

Yes, we’re all new but, that’s the rudder. It’s really nice to have that time with them [math specialists], because we get to collaborate. We get to talk about what
we’re doing, run things by each other…The group of six, it’s been incredibly supportive. If I didn’t have that, I would feel a little lost again.

**Teacher autonomy.** The concept of teacher autonomy is defined as the professional independence of teachers and the degree to which they can make autonomous decisions about what they teach to students and how they teach it. Participants frequently mentioned how well they know their students and their desire to have the freedom to make instructional and curriculum decisions on a daily basis in order to meet students’ learning needs. Mary noted that while she was originally uncertain about the district’s expectations for how closely she needed to adhere to the *enVisionMATH* program, she is beginning to feel more comfortable using her own professional judgement when planning math lessons. “I think it’s great when we’re allowed to have our own creativity as teachers and ability to think on our own, because we have these kids right here.” Diana, in turn, discussed how the kindergarten teachers are making decisions about what to teach based on their understanding of the curriculum: “…we’re definitely seeing gaps in the *enVisions* and Standards in the Framework that *enVisions* is not hitting upon…the questions are so much more rigorous than the *enVisions* math assessments…We definitely need to make our lessons more rigorous than they have been.”

Mary expressed that she is able to differentiate and make informed decisions about what to teach within the workshop model because she “knows these kids inside and out…there were kids that needed enrichment, so I had a challenge packet that I kept in their math folder… they went to their packet and it was a lot of logical reasoning problems.”
When describing how she felt about teaching math prior to the implementation of the *enVisionMATH* program, Brooke remarked that she appreciated having autonomy in her teaching practice. She illustrated her perception:

That was the best I ever felt about teaching math, when I was making my own materials. We were making our own curriculum. Then, that went away and we had enVisions. I think it's hard to find supplemental materials for what's lacking in enVisions and teaching enVisions at the same time.

An observation in Lynn’s math workshop showed her making instructional decisions throughout the lesson to meet the needs of her students. She used technology and resources that promoted active student engagement while implementing a variety of instructional strategies in a single lesson, including: modeling, specific feedback and reinforcement, visuals paired with auditory information, and guided practice. Students were observed engaging in mathematical reasoning while working in cooperative groups.

**Summary**

This case study was conducted to explore the ways in which elementary teachers use their knowledge and understanding of math workshop to improve math achievement when planning and executing classroom math instruction, with the specific goals of understanding how teachers employ math workshop to differentiate instruction and of providing insights into how to close the mathematics achievement gap by giving all learners equal opportunities to be successful students.
The findings presented in this chapter were based on analysis of interview transcripts, classroom observations, field notes, and relevant documents provided by participants. Data analysis revealed several themes and sub-themes through the qualitative coding and analysis processes. Three primary themes included: a) math workshop, b) professional development, and c) collaboration, each containing a series of coded sub-themes. Table 2 depicts the connections between the research questions, observed themes, and data supporting those themes.

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<tr>
<th>Research Question</th>
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<td>differentiate instruction and meet the diverse needs of learners?</td>
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<td>Sub-question 3: How do math specialists support teachers in implementing a math</td>
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Table 2: Supportive Data
The findings were detailed in three sections corresponding to the primary themes emerging from the data. Data in the first section focused on participants’ perceptions and experiences of implementing math workshop. Teachers described the structures they use to implement the math workshop model, including the ways they group students for small-group instruction and center activities. Participants also shared their strategies for differentiating math instruction to meet their students’ diverse needs.

The second section concentrated on participants’ perceptions and experiences regarding district-provided professional development as well as more recent training facilitated by math specialists. Findings centered on topics pertaining to the relevance of professional development for classroom practice, school district expectations, and communication issues surrounding the implementation of math workshop and a new math program.

The third section focused on how collaboration among administrators, math specialists, and teachers influences how math specialists support teachers in implementing math workshop. Two predominant topics reflected in the data were participants’ needs for peer and math specialist support and their desire for more autonomy. Teachers observed that when they have the opportunity to collaborate with math specialists and peers, their experiences are generally positive and productive. Participants also emphasized the importance of teachers having a voice in setting common meeting time agendas and autonomy in determining how best to utilize teaching resources and pace instructional units.

Looking ahead, chapter 5 will discuss these findings in relationship to the theoretical framework used as a lens for the study and will compare the findings with the literature.
presented in chapter 2. Finally, chapter 5 will detail the researcher’s conclusions, implications for future study and implications for practice.
Chapter 5: DISCUSSION OF FINDINGS AND IMPLICATIONS OF PRACTICE

“Good teaching is forever being on the cutting edge of a child’s competence.”

Jerome Bruner, Cognitive Psychologist

This researcher was motivated to conduct this research project as a result of the desire to understand how to create engaging and purposeful mathematics learning experiences in elementary classrooms that promote enthusiasm, productivity, and a meaningful understanding of mathematics for all learners. It is critical that our young students develop a strong foundation in mathematics so that doors open wide to enticing opportunities for higher education and promising careers in math and science. The practical goal for this project was to determine how to improve elementary math instruction to begin to close the achievement gaps that exist within the Keenstone School District and to challenge high-achieving students. Elementary students were already actively engaged in successful reading and writing workshops throughout the school district. How could the new math workshop initiative extend this type of differentiated instruction and active learning in math? From this motivation, one central research question and three sub-questions were developed:

Central research question: How do elementary teachers use their knowledge and understanding of math workshops to improve math achievement when planning and executing classroom math instruction in a suburban Massachusetts school district?

Sub-question 1: How do elementary teachers utilize a math workshop model to differentiate instruction and meet the diverse needs of learners?
Sub-question 2: What support systems need to be in place to ensure that elementary teachers understand and implement a math workshop model when executing classroom math instruction?

Sub-question 3: How do math specialists support teachers in implementing a math workshop model in their classrooms?

The research questions were designed to explore how teachers understood the math workshop instructional model and made meaning of their professional development experiences. The questions focused on exploring how teachers’ understandings informed how they designed and executed math instruction to meet the individual needs of their students based on their different levels of math knowledge, and skills. The next goal was to better understand how math specialists could facilitate the transition to a new math instructional approach and provide ongoing support to teachers.

The purpose of this exploratory case study was to discover the ways in which teachers utilize math workshop instruction to differentiate instruction, thereby improving math achievement. The findings in the preceding chapter describe the efforts and reactions of elementary math specialists and of teachers when planning and teaching mathematics after participating in district-provided math professional development. In this chapter, the findings will be synthesized into themes to provide direction for educators designing and implementing curriculum and instruction initiatives in similar settings.

The collected interview transcripts, observations, documents, and field notes revealed evidence that increases the understanding of how elementary teachers differentiate their math instruction when implementing a math workshop model. The process of inductive analysis was
used to identify the emerging themes from the collected data. Triangulation of the data from all sources revealed that there were critical components of the math workshop initiative that contributed to the successful implementation of the model in the classroom. The findings are summarized through the lens of the theoretical frameworks and discussed based upon each research sub-question. Connections to existing research are made and the limitations of the study are described. Implications for future research are discussed.

**Discussion of the Research Findings**

Constructivist and differentiated learning theories provided the lens to explore how elementary teachers understand and utilize math workshop to adapt classroom instruction to meet the diverse needs of their students. Constructivist theory recognizes that learning and development are dependent on the social context in which they occur. Vygotsky (1978) posited that instruction should focus on the process of developing a child’s independent problem solving rather than on the product. In order to engage students in active learning, math instruction and practice need to be differentiated to meet students’ learning styles and individual levels of understanding, which Vygotsky defined as the “zone of proximal development.” Differentiated learning theory responds to the need to transform math instruction by adjusting the teaching process to meet the broad span of students’ differences in mixed-ability classrooms, such as student readiness, interests, and learning, in order to increase math achievement for all students (Tomlinson 1999, 2001). The purpose of the workshop instructional model is to provide opportunities for students to construct knowledge through a variety of engaging, differentiated learning experiences that embrace interactions among teachers and peers.
Participants in the study described their experiences of participating in professional development provided by the school district that focused on math pedagogy and identifying and understanding the grade level teaching standards within a new math curriculum. Teachers and math specialists shared their understandings of math workshop instruction and described how they implement math instruction in their classrooms. The researcher’s observations during math lessons validated the different ways in which teachers implement math workshop. Participants explained how math specialists and teachers collaborate to transform current math instructional practices to a workshop model.

This research captures both the similarities and differences in the participants’ experiences, and it reveals how varied the experiences of teachers can be within the same school district, even when teachers were engaged in a common professional development training program and utilized the same curriculum standards and math program resources.

Math workshop. The findings of this study showed that participants followed a math workshop model in a variety of ways. All of the participants’ classrooms were student-centered; however, the methods teachers utilized to foster student engagement differed considerably. As referenced in the literature review, the *Massachusetts Mathematics Curriculum Framework for Mathematics*, developed by the Massachusetts Department of Elementary and Secondary Education (DESE) in 2011, emphasized that student-centered math instruction should encompass engaging students in solving meaningful and interesting mathematical problems and discussing math ideas. The literature highlights the importance of teachers moving away from a traditional teacher-directed math instructional model in order to increase student achievement in mathematics. Rust, O’Donovan, and Price (2005) asserted that instructional practices need to
change to promote student-centered learning environments based on constructivist concepts of idea sharing, discussion, and problem-based learning.

Some participants in this study embraced math workshops within a common lesson structure described in the literature as consisting of a warm up, focus lesson, rotation of activities, and small group instruction, culminating in sharing by the whole class at the end of the lesson. Other participants found that they needed to adapt this basic workshop structure to meet the needs of their students, some of whom had difficulty maintaining focus and engagement when working independently. Some participants working with upper elementary students noted that they felt their students required more teacher-directed instruction and guided practice because the grade level math curriculum was dense and many skills and concepts that were introduced were new. One teacher assigned the same assignment to all students from the students’ math textbook and provided a range of tiered supports such as teacher-led small-group instruction, heterogeneous partner work, and small group work. While this type of instruction did not follow a typical workshop model, teachers indicated that they were facilitating more student-centered collaboration and math discourse through partnering and teamwork in comparison to the more teacher-directed instruction they had employed in prior years.

Rosenshine and Meister (1992) discussed this gradual shift from teacher-directed instruction to student-focused learning to develop student independence. The current study found that teachers differed in how they viewed their roles as math instructors; some teachers discussed how they are gradually shifting away from a traditional teacher-directed role to that of a facilitator, while other participants reported that they have been comfortable managing student-centered learning activities for many years.
The instructional methods teachers employed during math workshops also differed greatly. Some teachers utilized video clips and interactive white boards to engage students in learning new skills and concepts, while other teachers utilized direct teacher modeling of pencil-and-paper activities. Some teachers elicited student participation by encouraging responses through teacher-directed inquiry. In contrast, other teachers fostered student involvement by asking students to share and model their problem-solving strategies for the whole group.

Constructivist learning theorists stress the importance of bridging present understandings and skills and the development of new learning and mastery using guided practice with other more experienced peers and teachers (Rogoff, 1990). The researcher observed that while all of the teachers in the study engaged students in active problem solving and group discussion of their math work, the types and scope of independent activities varied. This study found that teachers implemented a range of research-based teaching practices to promote students’ deep learning of mathematics as outlined in the 2014 National Council of Teachers of Mathematics (NCTM), *Principles to Actions*. Participants established mathematics learning goals, created problem-solving opportunities, used and connected mathematical representations to content, facilitated meaningful mathematical discourse, posed purposeful questions, supported student perseverance when problem solving, and elicited student thinking and reflection.

**Grouping practices.** The researcher found that one of the most enlightening findings of this study was the varied grouping practices employed by the participants during math instruction. Teachers grouped students both homogeneously and heterogeneously in large groups, small groups, and pairs. The most prevalent reason teachers reported for forming like-ability groups was for ease in designing instruction and materials to meet the skill level of particular students at the same time. For example, one teacher described how she typically
works with a small group of students each day based on their proficiency on informal assessments or class work. She reported that this group is usually made up of the same struggling students. She described how she utilizes re-teaching materials to review and reinforce concepts while the remainder of the class works in pairs on the grade level assignment from the math program. While the teacher adapted the curriculum to meet the readiness levels of her students during small-group instruction, she reported that this same group of students typically works together daily. The reviewed literature emphasized the importance of teachers planning differentiated instruction through a variety of grouping methods including like-readiness peers, mixed-readiness peers, students with similar interests, and students with different interests (Tomlinson, 1999).

Other participants described how they ensure heterogeneous groups by utilizing assessments to inform their lesson planning and center groups on a weekly or daily basis. Teachers described how they often group stronger students with struggling students so that the stronger student provides a model for the other students when talking through problem solving strategies. Teachers described how this mixed-ability grouping benefits all students because the stronger student must slow down and think through his or her problem solving strategies in order to explain that strategy to the other members of the group. The researcher observed students creating visual models and using manipulatives to support their explanations. Stein (2007) asserted that participation in a math community through discourse is as important to learning mathematics as the conceptual understanding. Teachers in the study also described how they listen to students while they work in groups to assess students’ participation in the discussion and their level of understanding of math concepts and skills. This also provides a way for the teacher to evaluate the effectiveness of the lesson in order to plan future instruction.
**Differentiated instruction.** The research on differentiated instruction is clear regarding the importance of teachers employing a variety of flexible grouping practices that are purposefully determined based on students’ levels of understanding, interests, and learning profiles, which differ depending on the topics and subject areas being taught (Tomlinson, 2005). Differentiation incorporates multiple levels of activities to ensure that all students explore ideas at a level that builds on their prior knowledge and prompts continued growth. Tomlinson (1999) described that when teachers utilize flexible grouping to “audition” students to work in different settings and with different kinds of work, students are able to work with mixed-readiness peers and students with different interests. Research has demonstrated that in a math workshop model, students learn mathematical procedures and develop deep conceptual understanding by engaging in differentiated lessons and collaborating with peers with different abilities and interests (Hoffer, 2012).

**Strategies.** As reviewed in the research on differentiated instruction, strategies designed to vary the degree of challenge and support to meet students’ levels of readiness for a topic, interests, and learning styles include tiered assignments, choice boards, small-group instruction, and varied homework (Tomlinson, 1999). Participants in the present study discussed how using these instructional strategies strengthened their abilities to meet a wide range of student needs, which in turn increased their students’ engagement in math lessons and positively impacted student math achievement. In addition to the instructional strategies listed above, participants described their use of differentiated games, hands-on activity centers, teamwork, tiered lessons and materials, technology resources, scaffolded instruction, open-ended questioning, and assessment strategies to engage all students in active learning during math workshops. The findings of this study indicated that teachers differed in the extent and type of differentiated
instruction they implemented in their classrooms. Some participants planned and utilized a wealth of tiered lessons and supplemental materials, while other teachers relied more heavily on providing small group-instruction using the grade level program materials. During math lesson observations, the researcher found that the level of student engagement in problem solving was higher in the classrooms in which students accessed differentiated materials independently without teacher intervention. In one classroom, many students struggled with the math center activity when the teacher was not present to guide them through completing the task. This exemplifies the importance of teachers providing tiered materials so that students are able to access learning at their zone of proximal development and gradually gain increased independence and fluency in math skills. The math specialists discussed how they work with teachers to develop activities that are aligned to students’ instructional levels to foster independent problem solving. Participants described that designing enrichment activities and projects was typically more challenging than planning intervention activities, which is aligned with research suggesting that high-achieving students receive less adapted instruction than their peers due to a belief that these students will succeed without differentiation (Brighton et al., 2005). Math specialists and teachers all discussed the challenges of providing multiple levels of materials for each math lesson.

**Impact on students.** The math workshop framework combines research-based instruction practices to actively engage all students in order to increase their math achievement. As outlined in the 2006 *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*, it is critical to build students’ strength in the use of mathematical processes that incorporate problem solving, reasoning, communication, making connections, and designing and analyzing representations. As documented in chapter 4, observations revealed that participants
implemented these instructional practices within a workshop model in different ways. Four participants discussed how the workshop model has increased students’ math achievement. Two teachers, who reported that they felt the workshop model was not working for their students, discussed how they thought math workshops could be more effective if there were more staff members to support students during math lessons. They indicated that it was difficult to meet the needs of the students who struggled to work independently while they were meeting with other students in small groups. Both teachers questioned the effectiveness of students working in groups without adult support. It is interesting to note that these two teachers reported that they group students by ability during their math workshop.

The theme of grouping practices is consistent throughout this study. Constructivist theory and differentiated learning theory both point to the importance of students constructing knowledge through purposeful activities designed to maximize motivation for cognitive growth (Koutselini & Gagatsis, 2003). Mixed-ability grouping practices provide the opportunity for students to build their knowledge and skills through social constructs within a workshop model. Some participants reported that they utilized flexible grouping; however, when they described their grouping practices in more detail, they stated that most groups did not change over time. The absence of consistent effective heterogeneous grouping practices impacts the potential for students to learn from more knowledgeable and varied peers. Another concern to keep at the forefront of discussion is how students perceive themselves and their math abilities when they do not have the opportunity to participate in higher-level problem solving and discourse when they are continually grouped with other students who also struggle with learning the same math concepts.
**Professional development.** Implementing a new curriculum and instructional method required teachers to solidify their understanding of standards-based instruction and the curriculum standards for the particular grade level they teach. Additionally, teachers needed to understand the district’s math workshop implementation plan and how this change would affect their own math lesson planning and classroom math instruction. Change often leads to insecurity, resistance, and even frustration (Fullan, 2007). Even when change is needed, those most affected by the change may find it difficult to adjust. Teachers need professional development to inform their thinking and improve or change their practice. According to Thompson (2001), school systems need to support the work of teachers and administrators through investment in high-quality professional development in standards-based education. Darling-Hammond and McLaughlin (1995) asserted that teachers and students are greatly impacted by ongoing embedded professional development that is designed to increase both student achievement and the quality of pedagogy.

**Relevance for classroom practice.** The 2008 National Mathematics Advisory Panel (NMAP) cited research confirming the importance of providing teachers with ample opportunities to learn and practice mathematical knowledge through professional development in content knowledge (p. xxi). Participants shared that they were unclear about the purpose and relevance of district-provided professional development training at the beginning of the shift to a new curriculum and workshop model. Some participants explained that they thought the training was going to focus on how to implement math workshop in the classroom, when instead, the trainings described how to analyze the new math curriculum and create teaching materials. However, teachers said that even though the specific purpose of the training was not well defined, the content they learned was relevant to their teaching practice. One teacher shared that
she thought it was important to analyze the standards with her grade level colleagues before they began to design lessons and assessments. Some teachers commented on how they continue to utilize the games and materials they created during the training. In contrast, two participants described how the professional development did not affect their math instruction and how the time they spent out of their classrooms at workshops could have been utilized more effectively. They noted that they could have incorporated the professional development into their teaching practices if there were more connections made between the curriculum standards and the fundamentals of how to implement a math workshop model. Most participants shared that they felt they also needed more training in how to use the new math program materials within a workshop structure.

**Communication, expectations.** Polk (2006) addressed the need for clear communication and expectations when he discussed the importance of ensuring that teachers understand the scope and propositions of differentiated instruction before it can be effectively and fully implemented. Constructivist theory also provides the lens for understanding the importance of teachers knowing and understanding the expectations and the larger context surrounding what they need to learn so that they can be fully invested in constructing new knowledge. Participants in the present study described how they felt the new math initiatives were not clearly communicated by administrators. They shared that there were multiple math initiatives being implemented simultaneously, which added to their confusion about expectations for how and when to implement the changes in their classrooms. Many teachers reported that even though creating units and lesson materials during the workshops was time-consuming and challenging work, they found that the materials were effective in presenting the math curriculum standards at a rigorous level. One teacher shared that she felt that she was most effective in teaching math
and that her students’ math achievement increased when she was able to create her own instructional materials. Unfortunately, the teacher shared that she did not continue to use those materials after the district purchased the new *enVisionMATH* program. As recounted during the interview, she understood the districts’ expectation was to follow the new program with fidelity. However, the same teacher shared that she recently heard the message that the district’s expectation was that teachers should use the *enVisionMATH* materials as a resource and that the program did not need to be used as a primary instructional tool.

**Collaboration.** Research clearly indicates the importance of collegiality in implementing change. The degree of successful implementation increases when educators have frequent and ongoing peer support (Fullan, 2007). Fullan’s suggestion that significant education change consists of “changes in beliefs, teaching style, and materials, which can come about *only* through a process of personal development in a social context” (pp. 138–139), can be viewed through a constructivist lens. Participants discussed how they felt that one of the most effective components of math workshops was that their students demonstrated increased math discourse during cooperative group work as well as during whole-group reflection. This reported effective student math discourse can be likened to the manner in which teachers increase their own effective math instructional practices as a result of participating in collegial math discussions with their own peers. As noted during interviews, teachers shared that they felt the most relevant component of math professional development workshops was the time they spent working with colleagues to plan lessons and create materials.

**Math specialists.** Neufeld and Roper (2003) described the elementary math specialist as an important resource for mathematics content and pedagogy and for providing school-based professional development while also serving as a “community organizer” for mathematics in a
school. One of the math specialists shared how she facilitated a recent parent information session focused on how families can support and encourage math learning at home. Most of the participants shared that the math specialists favorably impacted their math instruction. Teachers discussed how the math specialists help them find enrichment materials, plan lessons, assess students, and provide intervention and enrichment support for students. The math specialists described how they collaborate with teachers individually to plan lessons and to determine how to help specific students increase their math achievement. Tomlinson (1999) asserted that professional development in pedagogy needs to be sustained over time through methods including the following: planning time to create differentiated lessons, opportunities to visit differentiated classrooms, providing meaningful, non-threatening feedback to teachers trying a new approach, and providing a network of support systems. Math specialists shared how they provide sustained professional development opportunities by meeting with teachers in grade level groups during scheduled planning meetings to analyze assessment data and student work, plan instruction, share rigorous math problems for teachers to utilize with students, and introduce instructional strategies.

Hull, Balka, and Miles (2009) suggested that effective math coaches first develop collegial partnerships so they can work with teachers to implement positive changes to curriculum and instruction that increase student achievement. Math specialists and teachers shared positive views of the math specialist’s role as well as describing some of the challenges the specialists face. Math specialists discussed how they are trying to determine the scope of their responsibilities in their first year as full-time math specialists. Some of the teachers shared that they wanted the math specialists to provide more direct student intervention and enrichment instruction. Math specialists described the conflict they experience when they find themselves
functioning as intermediaries between teachers and administrators to clarify misconceptions or more clearly outline expectations. Elementary math specialists work collaboratively in classrooms without evaluating or “challenging the authority of teachers,” and they usually remain as part of the teaching staff although they have the “goal of advancing a teacher’s understanding and professional growth” (Campbell, 2013, p. 6).

Math specialists shared the tensions between fostering trusting peer relationships with teachers and providing constructive feedback in the role of math coach. The math specialists described how they were gradually implementing the coaching portion of their roles. They described how they engage in co-teaching and intervention support in classrooms in order to build trust with teachers through the opportunity to discuss instruction and pedagogy which they both described as “back door coaching.” The literature supported the importance of math coaches building relationships with teachers, especially if teachers are resistant to the idea of having a math coach in their classroom. Research also identified challenges similar to those shared by the math specialists in this study, including time and scheduling constraints and teacher resistance to coaching (Neufeld & Roper, 2003).

**Peer support.** Research that is focused on establishing successful math coaching models points to the isolation math specialists may feel in a school when they are the only math specialist in a building. However, the math specialists in this study described having supportive relationships with other math specialists in the district, with whom they meet on a weekly basis. One math specialist shared how she communicates daily with one or more of the other math specialists to discuss issues they may be having with a teacher or to request materials to help a specific student. The math specialists also explained how they collaborate frequently with the
literacy specialist in their respective schools to discuss coaching roles, professional development, and curriculum planning.

The theme of peer collaboration was evident throughout the findings in this study. Teachers shared how they collaborate with their colleagues both during the school day and after school to plan lessons and create materials. Some teachers discussed how they meet regularly to plan differentiated lessons with the special education teacher who works with their students. They described how they share different responsibilities within a co-teaching model when designing instruction. Teachers explained how the grade level teams meet to analyze assessments to determine how to group students across multiple classrooms for upcoming lessons. Participants also described the challenges of planning differentiated lessons for each subject area in an elementary classroom. Some teachers explained that they share some of the workload by dividing tasks and saving lessons and materials for future use. However, one teacher commented that it is often difficult to reuse materials and lessons because each year she creates new activities and plans lessons to meet the individual needs and interests of her students.

Research on effective mathematics instruction supports the idea that the complex demands of teaching mathematics require teachers to have a deep understanding of the mathematical knowledge they teach (Ball, Thames, & Phelps, 2008) in addition to having a strong repertoire of research-based teaching practices. Participants reported that peer collaboration provides support when they want to discuss new instructional methods or elicit assistance in finding appropriate materials to meet students’ diverse needs. When classroom teachers collaborate with special education teachers, they bring different strengths and backgrounds to the discussion. Frobringer and Fuchs (2014) suggested that general educators have moved to an inquiry approach, while special educators are often taught to use a direct-
instruction model. An integrated approach combining both types of instruction was recommended by the 2008 NAEP final report, which concluded that classroom math instruction should balance conceptual understanding, computation and procedural fluency, and problem solving. Through a constructivist lens, when teachers share teaching responsibilities and work together to design lessons, they are able to construct new ideas based on their current and past experiences as they form shared understandings through their interactions.

**Teacher autonomy.** According to Cerit (2013), a teacher’s strong sense of efficacy regarding their instructional effectiveness has an important effect on their willingness to implement curriculum initiatives. In his review of the research, Jerald (2007) found that teachers with a strong sense of efficacy tend to be open to new ideas and are willing to try new instructional approaches to meet the needs of their students. Participants’ feelings about the importance of their autonomy were in evidence throughout the findings of this study. Research on teacher autonomy argued that granting autonomy and empowering teachers is an important first step in educational reform (Melenyzer, 1990; Short, 1994).

Teachers discussed how they felt that their math lessons were most effective when they had the opportunity to design and create their own teaching materials that were aligned with the district curriculum. Teachers stated that they felt they have a solid understanding of their students’ strengths and areas of weakness as well as an understanding of the types of curriculum materials that work best for their students. In particular, teachers described how they disagreed with the school district’s math curriculum scope and sequence. They reported that they discussed their concerns regarding the curriculum with their principal and math specialist and advocated to change the curriculum pacing and assessments to better meet their students’ needs. Throughout the interviews, there was a sense that participants were frustrated by the way in
which curriculum decisions were communicated to teachers. Teachers spoke about their desire
have more instructional autonomy because they felt that they are in the best position to make
informed decisions about their students’ math instruction given their work with the curriculum
on a daily basis. According to Park (2005), teaching quality has more bearing on student
achievement than any other factor. It is critical for teachers to have autonomy in their
professional decision-making in order to utilize the mathematical knowledge and instructional
skills needed for effective teaching and student learning. School administrators have the
responsibility of ensuring teachers have this knowledge and are consistently implementing these
instructional skills through ongoing classroom observations and teacher-evaluation processes.
Administrators also have the responsibility of finding creative ways to support teachers in their
efforts to differentiate instruction to meet the wide range of student needs in their classrooms and
then acknowledge and celebrate their successes.

**Suggestions for Future Research**

This study provides insight into how elementary educators experience the process of
implementing a math workshop model, as well as the ways in which teachers utilize math
workshops to differentiate elementary math instruction. The study also captures the impact of
professional development and how math specialists support teachers in implementing math
workshop in their classrooms. As noted throughout the research project, the literature highlights
components of effective math instruction, explores effective professional development models,
and identifies strategies math specialists utilize to support teachers in improving math
instruction. Further research investigating how teachers perceive a fully developed professional
development process is recommended. Additional studies focusing on examining how teachers
experience the implementation of a new instructional methodology and their effects on student
engagement and achievement could also be helpful in implementation planning. Additional studies on the effects of math coaching on teachers’ instructional efficacy and the impact on student achievement could be explored to determine how to best provide sustained and tailored school-based professional development and support for teachers’ continued growth. Future research could also focus on examining how education leaders can support teachers in their efforts to implement differentiated instruction in the pursuit of increasing math achievement by providing excellent elementary math education to all students.

The limited scope of this case study may not be generalizable to schools in other settings. However, the researcher hopes that other educators may find that components of this study offer insights they can apply within their unique contexts beyond the parameters of the suburban Massachusetts school district in which this study took place.

Implications for Practice

The goal of this case study was to explore the qualitative features that make elementary math instruction successful for all learners. By describing the context of the implementation of a new math instructional model from the perspectives of teachers and math specialists, a better understanding of how teachers perceive professional development and incorporate their learnings into instructional practice has been offered to complement existing research.

There were implications that arose during the course of the project that may have relevance for practice within the Keenstone School District. The findings of this study point to four recommendations for improving math instruction that are critical for student success: (1) develop consistent methods to communicate initiatives and expectations, (2) increase teacher capacity in differentiation instruction, (3) increase understanding of student grouping practices
and their implications, and (4) develop and sustain professional development in math workshop methods.

**Recommendation 1: Develop consistent methods to communicate initiatives and expectations.** All six participants in this study stressed their desire for clear and consistent communication regarding the district’s expectations for how teachers should utilize math program materials and implement instructional methods. Having a systematic procedure to communicate new initiatives and expectations is paramount for increasing teacher effectiveness. Participants reported that they wanted to understand the expectations so they could utilize their creativity and expertise to design lessons within those parameters. Recognizing that schools face a variety of issues and variables that impact student learning, consistent communication methods enable administrators to better understand the concerns of teachers, in turn allowing them to bring issues forward during planning discussions and when making decisions.

**Recommendation 2: Increase teacher capacity in differentiation instruction.** Any effort to introduce an instructional improvement initiative should consider improving the capacity of teachers and administrators. School leaders have the responsibility of assessing their teachers’ current levels of proficiency and then developing plans to support teachers in moving forward in their understanding and application of new methods. Specifically, building capacity in differentiated instruction requires a range of professional development aligned with understanding diverse student needs, the impact of the delivery of classroom instruction on student learning, and the most effective methods to meet students’ needs, readiness, and interests. Professional development that focuses on how teachers can design instruction that draws on students’ strengths as a means of tackling areas of difficulty, as well as continually raising expectations along with support systems, is an important base of effective differentiation
instruction. Effective differentiation is also influenced by school culture. Artiles et al. (2005) suggested that all students can excel in school when their culture, language, heritage, and experiences are valued and used to facilitate their learning and development and they are provided access to high-quality teachers, programs, and resources. Differentiation embraces the notion that learning should take place within a rich, heterogeneous context.

**Recommendation 3: Increase understanding of student grouping practices and their implications.** Another recommendation for improved teacher and administrator practice is professional development in understanding the issues surrounding and research on mixed-ability versus same-ability grouping of students in mathematics. A central question in educational research concerns the degree of influence classroom grouping methods have on individual student’s school achievement. Studies have shown that teachers justify ability grouping on the basis of needing to adapt class content, pace, and teaching methods to students functioning on different levels (Slavin, 1990). On the contrary, Linchevski and Kutscher (1998) found that student achievement in heterogeneous classes was significantly higher compared to the achievement of peers in same-ability classes. In a different study, the authors also found that workshops had a positive effect on teacher’s attitudes toward teaching in mixed-ability mathematics classes. Training teachers in how to design mixed-ability instruction to provide students with the opportunity to accept, discuss, and listen to the diverse perspectives of others in classrooms where advanced students can build their confidence by modeling their ideas to help their less-able peers will help students build important life skills.

**Recommendation 4: Develop and sustain professional development in math workshop methods.** Participants in the study expressed their need for more specific professional development in the components of math workshops. The stated that they would like
to learn more about how to utilize the current math program materials in differentiated center activities. As highlighted by Stringer (2007), professional development programs are most effective when teachers participate in defining the purpose of the training, teacher inquiry is promoted, and teachers are engaged as leaders and valued as experts.


Fennell, F. (2011). We need elementary mathematics specialists now, more than ever: A historical perspective and call to action. *NCSM Journal,*


Goodwin, B. (2011). *Simply better doing what matters most to change the odds for student success*. Alexandria, VA: ASCD.


Appendix A

Letter to Superintendent of Schools

Dear Superintendent,

As part of my doctoral studies at Northeastern University, I will conduct a research study that addresses an identified problem of practice in education and contributes to the field of study. I am writing to request permission to conduct interviews with six elementary school teachers and a math coach in the district. Teachers will be invited to participate in a field observation in their classroom and to provide documents relevant to math instruction in their classrooms. This letter outlines my intentions and presents the context for the study.

The problem of practice that I seek to address is the complex issue of increasing student achievement in mathematics. Current research highlights the need to discover effective math pedagogy in elementary classrooms to meet the diverse needs of students. The purpose of this study is to explore the ways in which elementary teachers implement a math workshop model and differentiate math instruction in a Southeast Massachusetts school district to improve math achievement for elementary students.

Utilizing qualitative research practices, data will be collected through one interview with each participant and the responses will be professionally transcribed, coded and evaluated for emergent themes. An exploratory case study design for the study will establish an in-depth understanding of the perceptions and experiences of elementary teachers within the context of how they implement a math workshop instructional model after participating in district provided professional development focused on math instruction.

It is my contention that the research will provide insight into the classroom experience and explore how teachers perceive professional development training. Information from this study may create a transferable framework for classroom math instruction that can be applied in a variety of school settings. It is my hope that this study will make a positive contribution to the field of education and benefit teachers and students. I plan to share the results of the study with the teachers and principals, as well as the superintendent.

If you have any questions regarding this study, please contact me at linda.a@husky.neu.edu or my Doctoral Advisor, Dr. Carol Young at c.young@neu.edu. Thank you for your continued support. I look forward to hearing from you regarding this request for permission.

Best regards,

Linda Ashley
Appendix B

Letter of Intent to School Principals

Dear Principal,

As part of my doctoral studies at Northeastern University, I will conduct a research study that addresses an identified problem of practice in education and contributes to the field of study. The problem of practice that I seek to address is the complex issue of increasing student achievement in mathematics. Current research highlights the need to discover effective math pedagogy in elementary classrooms to meet the diverse needs of students. The purpose of this study is to explore the ways in which elementary teachers implement a math workshop model and differentiate math instruction in a southeast Massachusetts school district to improve math achievement for elementary students.

I intend to interview teachers and conduct field study observations in classrooms in various elementary schools in the district. I also intend to invite teachers to provide documentation related to math workshop instruction in their classroom. I have received permission from the Superintendent to interview teachers in your school and I am preparing to contact teachers to be possible participants. With your permission, I will contact teachers via letter and/or email. Interviews would be conducted at a time and place most convenient to each participant. The interviews will in no way disrupt the education of students. I plan to share the results of the study with the teachers and principals, as well as the superintendent.

I will follow up with you via a telephone call in the next two weeks to discuss further how best to contact possible teacher participants. In the interim, if you have questions or concerns regarding my study, please contact me at linda.a@husky.neu.edu.

Best regards,

Linda Ashley
Recruitment Email
Northeastern University College of Professional Studies
Doctor of Education Program

Subject Line: Research Study with Linda Ashley

Dear Teacher/Math Specialist,

I hope you are doing well!

I am a student in the Doctor of Education program at Northeastern University. I am currently conducting a study for my doctoral thesis and am seeking research participants.

I am researching the complex issue of increasing student achievement in mathematics. Current research highlights the need to discover effective math pedagogy in elementary classrooms to meet the diverse needs of students. The purpose of this study is to explore the ways in which elementary teachers implement a math workshop model and differentiate math instruction in a southeast Massachusetts school district to improve math achievement for elementary students.

I’m writing to see if you would consider participating in this study. If you choose to participate, we will meet for approximately an hour to discuss district provided math instruction professional development, differentiated instruction and your experience with math workshop. The interview will be audio-recorded and will take place at a time and place most convenient to you. The interview will in no way disrupt the education of students at your school. You will be asked to consider participating in a field observation during a math workshop lesson in your classroom. You will also be invited to provide any documentation relevant to math workshop instruction in your classroom. Your confidentiality will be maintained at all times; I will assign each participant a letter code and all interviews and documents will be referenced using only this letter code.

I hope to interview six elementary teachers. I am asking that interested potential participants please email me at linda.a@husky.neu.edu. If you are selected to participate, I will follow up with you to discuss in greater depth the study, ask you to sign an informed consent form, and schedule a time for our interview. You may withdraw from the study at any time. If you have any questions or concerns regarding my study, please contact me at linda.a@husky.neu.edu.

Thank you for considering participation in this study.

Best Regards,

Linda Ashley
Appendix D

Informed Consent Form
Northeastern University College of Professional Studies
Doctor of Education Program

Northeastern University, Department of Education

Name of Investigator(s): Linda Ashley, Graduate Student; Dr. Carol Young, Principal Investigator

Title of Project: The Implementation of a Math Workshop Model: Differentiation of Elementary Math Instruction

December, 2015

I am inviting you to take part in a research project. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

You are being asked to participate in this study because you are an elementary teacher/math specialists who has participated in district provided math instruction professional development and you use a math workshop model of instruction.

Why is this research study being done?

The purpose of this study is to explore how elementary teachers implement a math workshop model and differentiate math instruction so that the school district and others like it can continue to improve math instruction.

What will I be asked to do?

If you decide to participate in this study, you will be invited to do the following:

• An informal interview (of approximately 60 minutes).
• During the interview process, the researcher will take extensive notes, and each interview session will be digitally recorded (in order to ensure proper transcription of responses).
• If you are comfortable, you will be invited to provide documents relevant to math workshop instruction in your classroom. This is also a voluntary piece of the study: it is a means for the researcher to gain further insight into your experience.
• If you are comfortable, you will be invited to participate in a field observation during a math workshop lesson in your classroom.
• A follow-up meeting to review interview transcripts for accuracy.

Where will this take place and how much of my time will it take?

The interviews will take place with the researcher, Linda Ashley, at a time and place that is convenient for you. Linda Ashley can be reached at linda.a@husky.neu.edu. The approximate time this will take is noted above.

Will there be any risk or discomfort to me?

The risks of this research project are minimal. As the researcher, I will take every precaution to ensure the confidentiality of the participants, and will ensure that you are comfortable and that you understand each step of the study. Interviews will be conducted entirely in private at your comfort level. If you are not comfortable answering any particular question, you do not have to answer. If an interview needs to be rescheduled at your request, this can be done.

Will I benefit by being in this research?

There are no immediate, direct benefits for participation in the study. However, the information learned from this study may benefit elementary students. In addition, information learned may help professional staff working with students, like you, in the future.

Who will see the information about me?

Your identity as a participant will be matched to your responses, but only the researcher, Linda Ashley, will see the information about you. However, any written summary of this research study will not reveal your name or identity. The results of the study will be completely confidential. No reports or publications will use information that can identify you in any way.

In order to protect your personal information, participants will be identified by a letter code as information is summarized. Themes that emerge from the interviews (e.g. ways in which you implement math lessons) will be coded/identified for review and analysis. Data will be organized in order to learn information about how teachers like yourself are implementing the math workshop model. In order to make sure that your responses are accurately and clearly understood, your interview will be audio-recorded. Please know that any recordings will not be identified with your name.

In rare circumstances, authorized people may request to see research information about you and the other people in this study. This is to ensure that the research is done properly. We would only
permit people who are authorized by organizations as Northeastern University (through which the researcher, Linda Ashley, is working).

**What will happen if I suffer any harm from this research?**

There should be no reason why you might suffer from a research-related injury. No special arrangements will be made for compensation or for payment for treatment solely because of participation in this research.

**Can I stop my participation in this study?**

Your participation in this study is completely voluntary. You do not have to participate in this study, and you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have as a teacher of the school district.

**Who can I contact if I have questions or problems?**

If you have any questions or desire further information, please do not hesitate to contact the researcher, Linda Ashley, who can be reached at linda.a@husky.neu.edu or Dr. Carol Young, Advisor for this study, Northeastern University, Boston, MA, c.young@neu.edu

**Who can I contact about my rights as a participant?**

If you have any questions about your rights as a participant, please do not hesitate to contact: Nan C. Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University Boston, MA 02115 tel. (617) 373-7570 E-mail: irb@neu.edu

**Will I be paid for my participation?**

You will not be paid for your participation, as it is a voluntary study.

**Will it cost me anything to participate?**

It will not cost you anything to participate.

**Is there anything else I need to know?**

Participation in this study will have no effect on your performance evaluation, employment or any other job related service.

**I agree to take part in this research.**

____________________________________________ ________________________
Signature of person agreeing to take part Date
Printed name of person above

Signature of person who explained the study to the participant above and obtained consent  Date

Printed name of person above
Appendix E

Teacher Interview Protocol

In this interview, we will discuss your experiences with and perceptions of the math professional development you participated in during the last two years, differentiated instruction, and math workshop. Do I have your permission to record this interview?

Introductory and warm-up questions:

1. How are you today?
2. How long have you been teaching?
3. How long have you been teaching at this school?

I will now ask you some questions about the district-provided math instruction professional development you participated in over the course of the last two years and your experiences.

4. What do you view as the primary purpose or purposes of the math professional development you participated in?
5. Do you feel the content of the math professional development you participated affected your math instruction? Please explain.
6. What challenges have you had, if any, with continuing to develop your math instruction skills since the professional development ended?
7. Please describe any attempts that you have made to implement the professional development training into your classroom.
8. Please describe any supports that you may have received to develop your math instruction skills since the professional development training.
9. What kinds of supports would be helpful to your implementation of math workshop in your classroom?

I am now going to shift to some questions regarding differentiation instruction.

10. What does differentiated instruction mean to you?
11. How do you plan math instruction for academically diverse learners? For examples, high achieving math students and/or students having difficulty in math?
12. Please describe a lesson that you have implemented within your classroom comprised of academically diverse learners?
13. What types of math assessments do you utilize?
   a. How do you use math assessment data?
14. How do you decide which math content to teach?
15. Do student interests influence your lesson planning and instruction? Is so, please explain?
16. Please describe how your classroom environment is set up during math lessons?
17. What types of resources do you utilize to meet students diverse needs?
18. What types of products do students complete during math lessons?

I am now going to shift to some questions regarding math workshop instruction.
19. What does math workshop mean to you?
20. Will you please describe a typical math workshop lesson in your classroom?
   a. What activities do the students engage in during math workshop?
   b. What do activities do you engage in during math workshop?
   c. If there are other staff members working in your classroom, what do they do during math workshop?
21. Please tell me about how you plan math workshop lessons?
22. How do you group students during math workshop?
23. What kinds of materials do students utilize during math workshop instruction?
24. How do students work and converse with others during math workshop?
25. How do you think math workshop impacts students’ math achievement?
26. How do you think the math workshop model affects your ability to differentiate instruction for a range of learners’ skills and interests?
27. Is there anything else you would like to discuss in terms of your experience with math professional development, differentiated instruction, or math workshop?

Thank you for your participation in our interview today. I will be reviewing our interview in the coming weeks. After the interview recording is transcribed, I will invite you to meet with me to review the typed transcript to check for accuracy. If you have any questions or concerns after our meeting today, please feel free to contact me by email: linda.a@husky.neu.edu.
Appendix F

Math Specialist Interview Protocol

In this interview, we will discuss your experiences with and perceptions of the math professional development you participated in during the last two years and your role as a math specialist. Do I have your permission to record this interview?

Introductory and warm-up questions:

1. How are you today?
2. How long have you been a math specialist?
3. How long have you been a math specialist at this school?

I will now ask you some questions about the district-provided math instruction professional development you and elementary teachers participated in over the course of the last two years and your experiences.

4. What do you view as the primary purpose or purposes of the math professional development you and elementary teachers participated in?
5. How you feel the content of the math professional development you and elementary teachers participated in affected teachers’ math instruction?
6. What challenges do you feel teachers have had, if any, with continuing to develop their math instructional skills since the professional development?
7. What challenges have you had, if any, with continuing to develop your math coaching and instructional skills since the professional development ended?
8. Please describe any attempts that you have made to implement the professional development training when coaching teachers?
9. What kinds of supports would be helpful to you in supporting teachers’ implementation of math workshop?

I am now going to shift to some questions regarding differentiation instruction.

10. What does differentiated instruction mean to you?
11. How do you support teachers in planning math instruction for academically diverse learners? For example, high achieving math students and/or students having difficulty in math?
12. What types of math assessments do teachers in your school utilize?
   a. How do you use math assessment data?
   b. How do teachers use math assessment data?
13. How do you decide which math content to focus on when coaching teachers?
14. Do students’ interests influence teachers’ lesson planning and instruction? Is so, please explain?
15. Have you supported teachers in setting up their classroom for math workshop instruction? If so, please describe how classrooms are set up for math instruction.
16. Do you provide any resources to teachers which they can use to meet students’ diverse needs? If so, please describe.
17. What types of products do students complete during math lessons?

I am now going to shift to some questions regarding math workshop instruction.

18. What does math workshop mean to you?
19. How do you support teachers in implementing math workshop?
20. Will you please describe a typical math workshop lesson in your school?
   a. What activities do the students engage in during math workshop?
   b. What do activities do you engage in during math workshop?
   c. If there are other staff members working in classrooms, what do they do during math workshop?
21. Please tell me about how you support teachers in planning math workshop lessons?
22. What kinds of student groupings do teachers in your school use during math workshop?
23. What kinds of materials do students utilize during math workshop instruction?
24. How do students work and converse with others during math workshop?
25. How do you think math workshop impacts students’ math achievement?
26. How do you think the math workshop model affects teachers’ abilities to differentiate instruction for a range of learners’ skills and interests?
27. Is there anything else you would like to discuss in terms of your experience with math professional development, differentiated instruction, math workshop, or math coaching?

Thank you for your participation in our interview today. I will be reviewing our interview in the coming weeks. After the interview recording is transcribed, I will invite you to meet with me to review the typed transcript to check for accuracy. If you have any questions or concerns after our meeting today, please feel free to contact me by email: linda.a@husky.neu.edu.
Appendix G

Classroom Observation Guide

| Date: __________ | Time: __________ | Participant (number code): __________ |
| Grade: ________________ | Number of Students: ________________ |

Place:

Type of lesson:

Description of classroom:

Description of lesson/sequence of events:

Key quotations:

Examples of math workshop components (e.g. mini-lesson, activity/exploration, summary/reflection)

Examples of instructional methods (e.g. modeling, purposeful questioning, mathematical representations, procedural prompts, guided practice, independent practice, gradual release of responsibility)

Examples of student verbal output (e.g. participation in whole group discussion, partner/small group discussion, asking questions)

Examples of student written output (e.g. practice problems, assessment, note taking)

Examples of materials/resources used (e.g. manipulatives, graphic organizer, counters, game, worksheet, textbook, workbook)

Examples of student grouping (e.g. individual, partner, small group, whole group)

Examples of differentiated instruction (e.g. tiered instruction, leveled materials, modifications, accommodations, opportunity for student choice of activity, interest based)

Examples of adult roles in lesson (e.g. classroom teacher, special educator, educational assistant, math specialist, volunteer)

Researcher reflection: