AN EXAMINATION OF NOVICE TEACHERS' PLANNING AND ENACTMENT OF AMBITIOUS MATHEMATICS INSTRUCTION

A Capstone Project

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Doctor of Education

by

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Abstract

Schools do not always meet the needs of all of their students. Teachers' enactment of standards-based instruction is imperative to providing all students the opportunity-to-learn (OTL). While *novice teachers* (i.e., those with zero to three years of experience) are still developing their skill sets, they are equally accountable for providing students OTL. In mathematics, teachers' enactment of standards-based instruction that provides students OTL can be understood by focusing on a construct called ambitious instruction. *Ambitious mathematics instruction* is defined as a set of teaching practices that foster students' deep conceptual understanding of standards-based mathematics concepts (Newmann & Associates, 1996). My explanatory multiple-case study focused on three novice elementary mathematics teachers' planning and enactment of ambitious mathematics instruction because findings from a larger study, called the Development of Ambitious Instruction, suggest that these novices are capable of enacting such instruction. To understand how these teachers were enacting ambitious mathematics instruction, I focused on factors that seemed to be associated with their planning and implementation of mathematics lessons using a conceptual framework that incorporates activity theory and the mathematical tasks framework (Stein, Grover, & Henningsen, 1996). I conducted interviews and observations with each teacher and I collected artifacts related to their planning and teaching. Using deductive and inductive coding, I developed four assertions related to factors that seemed to be associated with teachers planning and enactment of ambitious mathematics instruction:

1. Teachers negotiate school-wide expectations for planning based on their beliefs about teaching mathematics and opportunities to engage in professional development activities.
2. Interactions with grade-level colleagues influence teachers' appropriation of standards-based mathematics tasks.
3. Teachers enact number sense routines according to school-wide expectations, professional development activities, and their own beliefs.
4. Teachers' enactment of mathematics lessons provide students opportunities to use multiple representations and engage in mathematical discourse.

Keywords: ambitious instruction, elementary mathematics teaching, lesson planning, novice teachers, teaching practices

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APPROVAL OF THE CAPSTONE PROJECT

This capstone project, *An Examination of Novice Teachers' Planning and Enactment of Ambitious Mathematics Instruction*, has been approved by the Graduate Faculty of the Curry School of Education in partial fulfillment of the requirements for the degree of Doctor of Education.

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Dr. Peter Youngs, chair

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Dr. Susan Mintz

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Dr. Robert Berry

DEDICATION

I dedicate this Capstone to those who testify that a high-quality education can transform the life of a student.

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CHAPTER 1: INTRODUCTION

Providing students an opportunity to engage in meaningful learning experiences and develop strong conceptual understanding are top priorities in mathematics education reform. Such opportunity-to-learn is associated with whether or not students meet high-level standards (Schmidt & McKnight, 2012). The National Council for Teachers of Mathematics (NCTM) has strongly influenced mathematics reform efforts for the past 30 years; their resources have guided the development of current standards in the United States as well as teacher practice (Ferrini-Mundy & Martin, 2000; NCTM, 1989; Smith, Stein, & Raith, 2017). Acknowledging that standards alone do not ensure that all students have equitable learning experiences, NCTM has made great strides in promoting standards-based teaching practices that promote equity and students' opportunity-to-learn. This Capstone study focused on the enactment of ambitious mathematics instruction at the elementary school level, specifically how novice teachers planned and implemented standards-based teaching practices in ways that promoted students' opportunity-to-learn. An explanatory multiple-case study was employed to better understand factors that guided novices' planning and implementation. Observations and interviews provided evidence of how these teachers planned and implemented mathematics instruction in ways that are associated with ambitious instruction.

Background of the Problem

The Cyclical Nature of Education Reform

Throughout the history of education in the United States, reforms have often been repeated under the premise that schools are not always meeting the needs of all students. Education reform tends to be cyclical; as the priorities of our nation change, there are frequent shifts in the content taught to students and how instruction is enacted (Henson, 2006). Whereas education in the early-1900s at the elementary level often featured a progressive child-centered approach to instruction, the end of the 20th century offered a much more globalized and standardized style of education. As our nation prioritized global competition in the late-1990s, policy in education focused more on students' mastery of standards rather than how content ought to be taught (Ferrini-Mundy, 2017). Although the content taught in classrooms has become more sophisticated as our society has become more technologically-advanced, the U.S. education system often fails students because priorities are unbalanced. Classrooms need to appeal to high learning standards by engaging all students in intellectual work if our nation is to sustain its global edge (Hassrick, Raudenbush, & Rosen, 2017; Henson, 2006; Schmidt & McKnight, 2012).

Two recent movements of standards-based reform suggest ways in which high-quality standards can shape better learning outcomes for students. These movements will be assessed based on a vision of mathematics that promotes teaching that addresses both standards and diverse needs of students. This vision of mathematics teaching will then be introduced and defined as ambitious instruction.

No Child Left Behind. Under the 2002 No Child Left Behind (NCLB) Act, states were required to administer state standardized tests in reading and mathematics in grades 3 through 8 and one high school grade in order to continue receiving Title I funds. The goal of NCLB was for 100% of students to perform proficiently in both mathematics and reading on state tests by the year 2013-14. Assessment results were mixed at the national level. For example, from 1999 to 2008, the National Assessment of Educational Progress (NAEP) indicated that although 4th-graders' reading performance increased from an average score of 212 to 220, the average scores of 12th graders fell by two points (Kena et al., 2016). Figure 1.1 below shows a similar trend in mathematics performance.

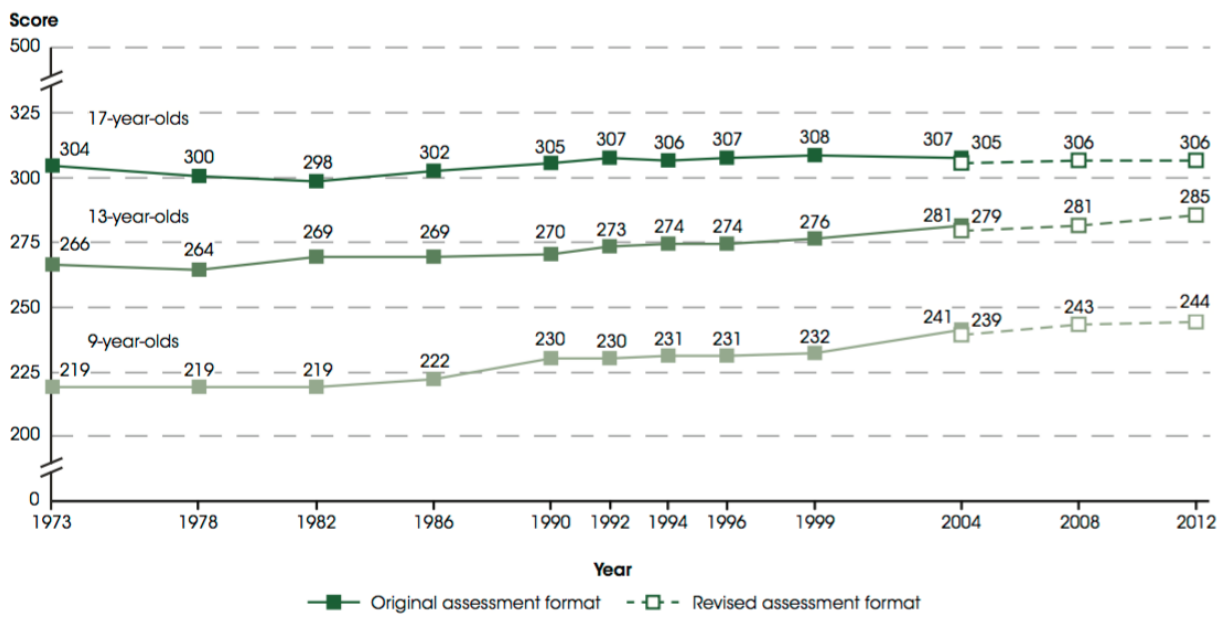


Figure 1.1. Average Mathematics Scale Scores on NAEP Over Time

Variance in content standards contributed to variation in students' opportunity-to-learn (OTL) across states. *Opportunity-to-learn* is defined throughout this proposal as "the set of experiences that schools organize to help students acquire the knowledge, skills, and abilities specified in those official standards" (Schmidt & McKnight, 2012, p. 13). Schools tended to organize learning experiences based on state standards but there were no clear mandates regarding rigorous instruction based on the standards. By 2010, high-quality standards for all was an ideal that had not been realized throughout the U.S.

The Common Core State Standards Initiative. The Common Core State Standards Initiative (CCSSI; National Governors Association, 2008) is a promising counterpoint to NCLB. The Common Core standards were developed to promote OTL in the sense that most or all states would provide rigorous learning experiences to students. The Common Core standards do not guarantee improved instructional quality but they frame a common understanding of what ought to be taught in classrooms (Boykin & Noguera, 2011). States received additional funding for adopting these standards and nation-wide standardized assessments were developed through Partnership for Assessment of Readiness for College and Careers (PARCC) and the Smarter Balanced Assessment Consortium (Tamayo & Joaquin, 2010). The assessments represent a significant improvement over most state tests that were in place under NCLB and have been favorably compared to the NAEP exams (Schmidt & McKnight, 2012; Stancavage & Bohrnstedt, 2013).

Today, the average NAEP scores in both mathematics and literacy remain relatively unmoved (Kena et al., 2016). While the CCSSI is an effort to provide all students across the U.S with greater OTL, there may be a need for schools and districts to provide more support related to the Common Core. For example, in 2014 state surveys revealed that both states and districts recognized a major challenge in providing schools aligned-CCSS supports (Rentner, Frizzell, & Kober, 2017).

Reforms in Mathematics

NCTM seems to have influenced teaching and school practices at the national and state levels as well as at the classroom and school levels. I will discuss NCTM's influence by considering its role in two movements, the "Math Wars" and the Common Core State Standards for Mathematics (CCSSM; National Governors Association, 2008; Council of Chief State School Officers, 2010). Current mathematics reform efforts incorporate NCTM's vision through the CCSSM and it is evident in the enactment of ambitious instruction. As such, it is reasonable to believe that schools are better equipped to meet the diverse needs of students today because mathematics reform has focused on the need to achieve high-level standards through engaging students in meaningful learning experiences. Current standards-based reform in mathematics reflects the importance of providing students OTL through a focus on both content and pedagogy (Hassrick et al., 2017).

"Math Wars" and opportunity-to-learn. The "Math Wars," which arose in the 1990s and still exist today, are a critical focal point in mathematics reform because they highlight a compromise between teaching to the standards while simultaneously promoting progressive ideas in mathematics (Ferrini-Mundy, 2017). While states were not required to enact a specific set of standards in the 1980s, NCTM promoted a vision of mathematics that featured inquiry-based standards of instruction that were both conceptually and procedurally sound. This document, entitled *Curriculum and Evaluation Standards for School Mathematics* (CESSM; NCTM, 1989), promoted learning through social environments and rich conceptual tasks.

The *CESSM* promoted a focus on OTL through standards of content and teacher practice. Additionally, the document provided recommendations regarding how content ought to be taught to students through examples and descriptions of pedagogical practice. As federal policy in the 1990s required states to adopt standards in order to receive funding for schools, NCTM's vision of mathematics strongly influenced standards development.

Common Core State Standards for Mathematics and opportunity-to-learn. By the early-2000s, it was apparent from NAEP data that progress in mathematics was remaining stagnant. This provided leverage for documents released by NCTM after the *CESSM* (1989), such as *Principles and Standards for School Mathematics (PSSM;* Ferrini-Mundy & Martin, 2000). This document promoted more progressive mathematics standards by presenting a sound *equity principle* that stated: "Excellence in mathematics education requires equity - high expectations and support for all students" (Ferrini-Mundy & Martin, 2000, p. 11). This equity principle was foregrounded in the development of the CCSSM.

Along these lines, both the National Governors Association (NGA; 2008) and NCTM's (2006) release of *Curriculum Focal Points* set the stage for the development and enactment of the CCSSM. The NGA (2008) addressed differences in OTL as an "equity imperative" (p. 12), an issue that America must address to maintain its competitive edge into the future. As such the CCSSM (2010) were a necessary step in the standards-based reform movement because they provided states with a set of common and rigorous standards (Schmidt & McKnight, 2012). Related to this point, NCTM's (2006) *Curriculum Focal Points* provided an explicit list of topics to be taught in each grade level so that mathematics teaching would emphasize a richer understanding of content throughout a K-12 trajectory.

A Vision of Mathematics Reform

Stagnant growth in mathematics achievement should not be attributed solely to inadequate state standards because over time they have reflected NCTM's content standards (Fellini-Mundy, 2017). Rather, it is necessary to acknowledge that state standards do not guarantee students access to high-quality teaching (Schmidt & McKnight, 2012). It is important to center reform efforts on the enactment of standards; i.e., the ways in which teachers promote students' OTL through rich problem solving experiences that are aligned with the standards.

Enacting the Common Core State Standards of Mathematics. Indeed, the CCSSM (2010) are a quite progressive set of standards in mathematics education. The standards were developed to promote OTL in mathematics by providing a set of coherent topics that increase in complexity through the grade levels. The standards are research-based and combine to shape conceptually- and procedurally-focused learning goals. The CCSSM website states that the standards feature no directives on how mathematics should be taught but both NCTM (2000) and the National Mathematics Advisory Panel (2008) emphasize that mathematics teaching should be neither exclusively teacher-directed nor entirely student-centered.

Despite the fact that some states never adopted the CCSSM (2010) or dropped them in favor of their own individual state standards, most state standards in mathematics are very similar to the CCSSM. However, it seems that teachers struggle to implement the CCSSM and standards-based instruction because various factors influence students

OTL (e.g., school funding, access to high-quality teachers, socio-econoic status, etc.) (Ferrini-Mundy, 2017; Schmidt & McKnight, 2012). Providing students equitable learning experiences has been at the forefront of standards-based reform. For example, the *PSSM* (Ferrini-Mundy & Martin, 2000) established equity as a fundamental principle of high-quality mathematics education in the following statement:

> All students, regardless of their personal characteristics, backgrounds, or physical challenges, can learn mathematics when they have access to high-quality mathematics instruction. Equity does not mean that every student should receive identical instruction. Rather, it demands that reasonable and appropriate accommodations are made, and appropriately challenging content be included to promote access and attainment for *all* students (p. 12).

At the classroom level, issues of equity can be addressed by focusing on teaching that provides students rich and frequent OTL in mathematics.

Creating the opportunity-to-learn. There is no prescription for high-quality instruction; as a result, mathematics teaching focused on the context-specific needs of students is likely to promote OTL by providing them with appropriate learning experiences (Hassrick et al., 2017). Boykin and Noguera (2011) suggest that to provide OTL, “we must address the learning environment in classrooms and schools; the skills of teachers and the quality of instruction they provide; the specific learning and support strategies that are employed…” (p. 43). Thus, the skills of teachers and the quality of their instruction were the focus of my study.

Since the enactment of the CCSSM, NCTM has made notable progress in providing schools and teachers research-based evidence and support for mathematics instruction (NCTM, 2014; NCTM, 2017). Most prevalent is *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014) which suggests that school mathematics be guided by six guiding principles: teaching and learning, access and equity, curriculum, tools and technology, assessment, and professionalism.

This Capstone focuses on the teaching and learning principle because it seems to directly influence students' OTL. The teaching and learning principle states that "an excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically" (NCTM, 2014, p. 5). By focusing on what it means to teach effectively, this principle progresses focus not only on what content ought to be taught, but also on the enactment of effective pedagogy. Figure 1.2 lists eight research-based mathematics teaching practices that are part of this principle and promoted by NCTM in *Principles to Actions* (2014). These

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

Figure 1.2. Mathematics Practices That Are Part of NCTM's Teaching and Learning Principle

practices describe the process of enacting high-quality standards-based teaching from planning through implementation.

Attention to these teaching practices promotes NCTM's vision of standards-based teaching because it "means recognizing that inequitable learning opportunities can exist in any setting, diverse or homogeneous, whenever only some, but not all, teachers implement rigorous curricula or use the Mathematics Teaching Practices…" (NCTM, 2014, p. 60). A challenge remains in that teachers are not always implementing rigorous instruction. It is reasonable to conclude, however, that teachers can provide students with more high-quality instruction by focusing on these teaching practices because they frame how content ought to be taught.

Ambitious Mathematics Instruction

In the current era of standards-based reform and accountability, how can policy-makers, researchers, and practitioners alike understand mathematics teaching in order to change practice (Windschitl et al., 2018)? This is an important question to consider in response to criticism regarding current accountability measures in the U.S. that are largely based on standardized test performance. As discussed, two key factors over the past decade have been the CCSSI and NCTM's (2014) *Principles to Action*, which explicitly promote ambitious instructional practices.

Ambitious instruction involves teaching to a rigorous set of standards and incorporating equitable practices (Windschitl et al., 2018). In mathematics specifically, *ambitious instruction* can be defined as teaching "in response to what students do as they engage in problem solving performance, all while holding students accountable to learning goals that include procedural fluency, strategic competence, adaptive reasoning, and productive dispositions" (Kazemi, Franke, and Lampert, 2009, p. 11). For the purpose of this study, ambitious mathematics instruction was defined as a set of teaching practices that foster students' deep conceptual understanding of standards-based mathematics concepts (Newmann & Associates, 1996). The notion of ambitious instruction offers a potential solution to the problem of practice that I have identified because it is measurable, it is consistent with guidelines in CCSSI and *Principles to Action* (NCTM, 2014), and it addresses equity.

Mathematics teaching practices support a deep learning of content. Ambitious mathematics instruction can be evidenced in the enactment of teaching practices that support the implementation of conceptually-focused tasks. Ambitious mathematics instruction is visible in teachers' selection and implementation of tasks that "make a specific mathematical point, linking mathematical representations to underlying ideas and other representations, and evaluating students' mathematical reasoning and explanations" (NCTM, 2014, p.12). The enactment of ambitious teaching in mathematics is challenging, however, especially for novice teachers.

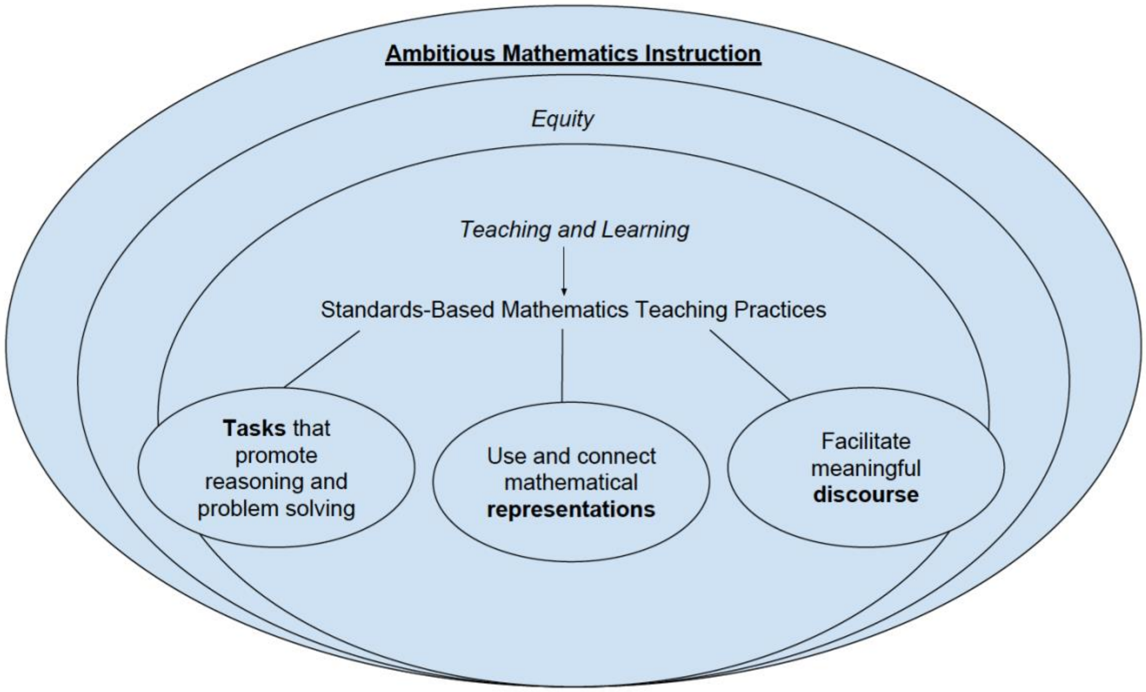
In particular, the development of authentic problem-solving experiences is complex and involves intentional planning and implementation of several mathematics teaching practices presented in Figure 1.2 (Hassrick et al., 2017). The challenge of enacting instruction that is both standards-based and ambitious forms the main problem of practice in this study

> because students need to interact to refine their understanding (and) teachers need to structure those interactions to focus on mathematical goals while managing different levels of competence and interests, while also attending to all students maintaining a productive disposition toward the subject (Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010, pp. 129-130).

Teachers' efforts to enact ambitious instruction can be assessed across four domains: tasks, representations, discourse, and coherence (Berry et al., 2017). These can be defined as the mathematical "tasks that teachers select and the way in which these tasks are enacted in the classroom," the "representations used by teachers and students to represent and translate among mathematical ideas," the "discourse between teachers and children and among children about mathematics," and "the extent to which the mathematical concepts are presented clearly and accurately and organized in a way that leads to deeper understanding" (Berry et al., 2017, p. 3).

When teachers use tasks that promote students' reasoning and problem solving, then selecting and implementing high-cognitive demand tasks is an indicator of ambitious instruction. When teachers employ and make connections among mathematical representations, then the use of multiple representations is a sign of ambitious instruction. When teachers attempt to facilitate mathematical discussions, then evidence of a mathematical discourse community is an indicator of ambitious instruction. The teaching practices are further defined in the Table of Definitions on page 25. Model 1.1 posits how ambitious instruction is understood in this study; the main indicators of ambitious instruction will be further described below.

Selecting and implementing high-cognitive demand tasks. By attending to cognitive demand, a dimension of the tasks domain, teachers can select tasks that focus "students' attention on a particular mathematical idea" (NCTM, 2014, p. 17). In accordance with standards, tasks with high levels of cognitive demand provide potentially meaningful problem-solving experiences but these are often challenging to implement. Studies have found that the cognitive demand of such tasks is often lowered upon



Model 1.1. A Visual Representation of Ambitious Mathematics Instruction

implementation due to various factors (Smith, Stein, & Raith, 2017; Stein et al., 2009). For example, this occurs when the task is inappropriate for the students at hand (i.e., it does not connect to students' prior knowledge, it is not interesting to students, or the expectations for completing the task are unclear). Cognitive demand is more likely to be maintained, however, when the teacher scaffolds the task, students are provided a means of monitoring their progress, and/or when the task builds on prior conceptual understandings.

Use of multiple representations. Teachers can maintain the cognitive demand of mathematical tasks by drawing on students' prior knowledge and emphasizing conceptual understanding. The use of multiple representations, a dimension of representations, can lead students to make connections in order to develop a deeper understanding of mathematics topics (NCTM, 2014). Ambitious teaching in mathematics encourages the use of multiple representations by both teachers and students as a means of flexible problem-solving. Representations are visual, physical, symbolic, contextual, and verbal (Lesh, Post, & Behr, 1987).

A mathematical discourse community. A mathematical discourse community, a dimension of discourse, can help maintain the intended cognitive demand of a mathematics task. When teachers expect students to provide explanations and justifications of their mathematical solutions, this can lead to "the purposeful exchange of ideas through classroom discussion, as well as through other forms of verbal, visual, and written communication [i.e., representations]" (NCTM, 2014, p. 29). This domain addresses equity because doing and speaking about math is often a risk-taking event (Sharma, 2015). A given mathematical discourse community is complex, as its success is dependent on whether or not students feel comfortable sharing both understandings and misunderstandings as a means of problem-solving. High-cognitive demand mathematics tasks that allow the use of multiple representations afford opportunity for mathematical discourse yet are challenging to maintain.

Planning and Enacting Ambitious Instruction.

While teaching practices are not independent of one another, evidence of ambitious mathematics instruction can be examined by attending to specific indicators: selecting and implementing high-cognitive demand tasks, use of multiple representations, facilitating a mathematical discourse community, and lesson coherence. The enactment of ambitious instruction is assumed to be purposeful; teachers must plan to enact ambitious instruction, and as they do so, they must purposely select and plan for the mathematics tasks they will use and how they will implement standards-based goals of the lesson through the use of representations and discourse (Hassrick et al., 2017; Smith & Stein, 2016).

I addressed the problem of practice in this study by considering the ways in which novice teachers (1) select and plan for the use of cognitively challenging mathematics tasks and (2) enact such tasks using multiple representations and facilitating a mathematical discourse community.

Enacting Ambitious Instruction as a Novice Teacher

Acknowledging that "teaching is inherently complex" (Jacobs & Spangler, 2017), it is useful to focus mathematics reform efforts on practices that apply to all teachers. Findings suggest that teachers' planning and instruction in mathematics are guided by their overarching conceptions of math teaching and learning (Superfine, 2010). In Amador and Lamberg's (2013) study, for example, the conceptions that both experienced and novice teachers held about mathematics seemed to influence the way they planned and implemented math instruction.

Novice teachers, defined as those with zero to three years of experience (Davis & Cearley, 2016), are an important area of focus for the enactment of ambitious instruction as studies tend to focus on how teachers learn to enact instructional practices as pre-service teachers (Jacob & Spangler, 2017; Lampert et al., 2013). As such, if novice teachers are to transfer and apply what they have learned in pre-service education in their classroom contexts, we need to better understand how they plan and enact mathematics instruction and how their conceptions of mathematics seem to influence such practices.

Even though novice teachers are still developing their skill sets, they are equally accountable for raising student performance as more experienced teachers. Though novices are still learning to incorporate various factors into their instruction (e.g., their beliefs, understandings about teaching, and context-specific factors), research findings suggest that they often focus on elements of ambitious instruction in their planning (Amador & Lamberg, 2013; Superfine, 2009). Possibly because they lack experience, though, they often struggle to respond to potentially conflicting messages (e.g., from pre-service teacher preparation, professional development, state standards documents, and high-stakes testing and teacher evaluation). Based on the aforementioned findings, this study assumes that novice teachers are capable of planning and enacting ambitious mathematics instruction despite the challenges they face.

Statement of the Problem

Schools often fail to meet the needs of all of the students they serve. If students' success is cumulative, then mathematics lessons in each grade level have a potential impact on student achievement. Education reform frequently aims to provide all students with high-quality instruction yet standards-based reform efforts often overlook issues of equity. NCTM and CCSSI have consistently advocated for standards that promote problem-solving in social environments through rich conceptual tasks. However, standards alone do not guarantee that schools will meet the diverse needs of students. A closer examination of how beginning teachers plan and enact ambitious instruction could help both researchers and practitioners better understand how planning and implementation are associated with students' opportunity-to-learn.

Though many factors seem to influence the success of a child, teaching directly affects' students OTL in the classroom (Boykin & Noguera, 2011; Schmidt & McKnight, 2012). Novice elementary mathematics teachers arguably face great challenges in enacting ambitious instruction and raising student performance. Meanwhile, students' understanding of mathematics in the elementary grades seems to influence their success in future years of schooling. Novice teachers are equally accountable for enacting ambitious instruction though they are still developing their skill sets. How can we help teachers, especially novice elementary teachers, gain the skills needed to plan and enact ambitious mathematics instruction? This is the question that drives the purpose of this study.

Purpose of the Current Study

The purpose of this study is to examine how novice elementary teachers select mathematics tasks and plan for their implementation in order to understand how these activities are associated with their enactment of ambitious instruction. Although enacting such instruction can prove challenging for all teachers, novice teachers are just as likely as more experienced teachers to attempt to engage students in such teaching (Amador & Lamberg, 2013). The research literature currently lacks an in-depth understanding of factors that seem to influence novice teachers' enactment of ambitious instruction. In this study, collecting data across multiple classrooms highlighted (1) the ways in which novice elementary teachers planned mathematics instruction, (2) how and why novice elementary teachers selected and implemented mathematics tasks, and (3) the ways in which planning and implementation seemed to be associated with ambitious instruction.

The following research questions guided this study:

RQ1: How do novice elementary teachers plan mathematics instruction?

RQ2: What factors seem to influence novice elementary teachers' selection and implementation of mathematics tasks?

RQ3: How is novice elementary teachers' planning associated with ambitious instruction?

Conceptual Framework

For over 20 years, research related to mathematics teaching has been influenced by Stein, Grover, and Henningsen's (1996) conceptual framework titled, "The Mathematical Tasks Framework" (MTF; p. 459). Figure 1.3 below displays the phases of mathematics instruction that are associated with student outcomes and factors that generally influence the setup and implementation of mathematics tasks. Indicators of teaching practices that promote ambitious instruction are embedded within the MTF.

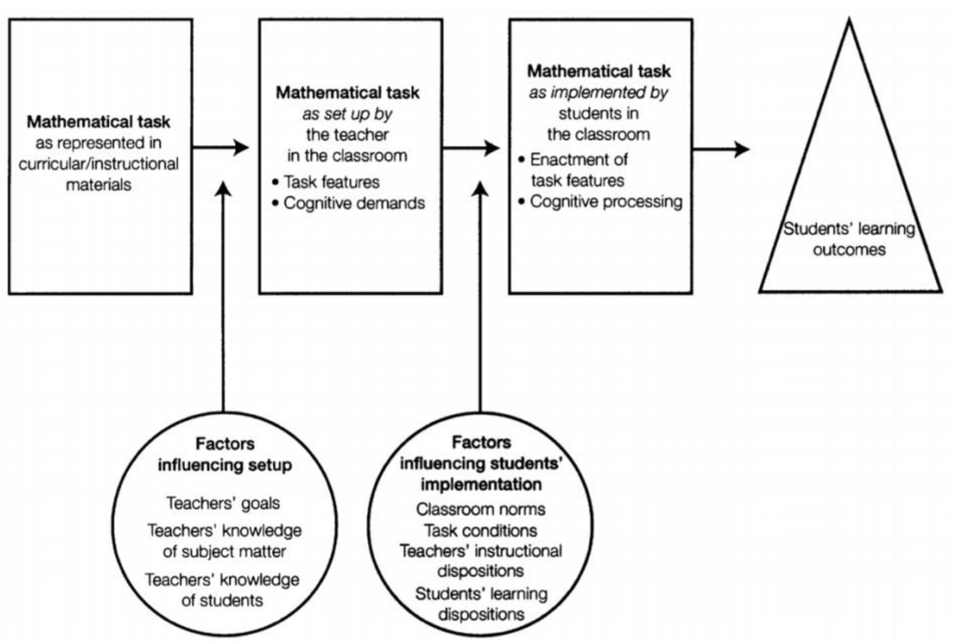


Figure 1.3. The Mathematical Tasks Framework (MTF)

Selecting and Implementing High-Cognitive Demand Tasks in the MTF

Cognitive demand was identified by the Stein, Grover, and Henningsen (1996) as a variable influencing student OTL and learning outcomes within the phases because "the tasks used in mathematics classrooms highly influence the kinds of thinking processes in which students engage, which in turn, influences student learning outcomes" (1996, p. 458). The cognitive demand of a mathematics task can be rated either high or low, as evidenced in task analysis guide in Figure 1.4 below (Stein & Smith, 1998). At both the set-up and implementation phases of the MTF, teachers are challenged to maintain the intended level of cognitive demand. As such, some studies have focused more

Low-Level Cognitive Demands	High-Level Cognitive Demands
Memorization Tasks • Involve either producing previously learned facts, rules, formulae, or definitions *or* committing facts, rules, formulae, or definitions to memory. • Cannot be solved using procedures because a procedure does not exist or because the time frame in which the task is being completed is too short to use a procedure. • Are not ambiguous—such tasks involve exact reproduction of previously seen material and what is to be reproduced is clearly and directly stated. • Have no connection to the concepts or meaning that underlay the facts, rules, formulae, or definitions being learned or reproduced. *Procedures Without Connections Tasks* • Are algorithmic. Use of the procedure is either specifically called for or its use is evident based on prior instruction, experience, or placement of the task. • Require limited cognitive demand for successful completion. There is little ambiguity about what needs to be done and how to do it. • Have no connection to the concepts or meaning that underlie the procedure being used. • Are focused on producing correct answers rather than developing mathematical understanding. • Require no explanations or explanations that focus solely on describing the procedure that was used.	*Procedures With Connections Tasks* • Focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas. • Suggest pathways to follow (explicitly or implicitly) that are broad general procedures that have close connections to underlying conceptual ideas as opposed to narrow algorithms that are opaque with respect to underlying concepts. • Usually are represented in multiple ways (e.g., visual diagrams, manipulatives, symbols, problem situations). Making connections among multiple representations helps to develop meaning. • Require some degree of cognitive effort. Although general procedures may be followed, they cannot be followed mindlessly. Students need to engage with the conceptual ideas that underlie the procedures in order to successfully complete the task and develop understanding. *Doing Mathematics Tasks* • Require complex and non-algorithmic thinking (i.e., there is not a predictable, well-rehearsed approach or pathway explicitly suggested by the task, task instructions, or a worked-out example). • Require students to explore and to understand the nature of mathematical concepts, processes, or relationships. • Demand self-monitoring or self-regulation of one's own cognitive processes. • Require students to access relevant knowledge in working through the task. • Require students to analyze the task and actively examine task constraints that may limit possible solution strategies and solutions. • Require considerable cognitive effort and may involve some level of anxiety for the student due to the unpredictable nature of the solution process required.

Figure 1.4. The Task Analysis Guide

specifically on factors that seem to influence the maintenance or decline of cognitive demand within the setup and implementation phases of mathematics tasks, such as those shown in Figure 1.2 (Boston & Smith, 2009; Stein, Grover, & Henningsen, 1996).

Use of Multiple Representations in the MTF

Representations serve as "the vehicle through which mathematical ideas are explored, considered and justified" (NCTM, 2017, p. 27). The representations that teachers plan for and implement can influence the maintenance of cognitive demand as evidenced in the implementation phase of the MTF. Features of high-cognitive demand mathematics tasks often call for multiple representations that allow students to deepen their understanding by making connections, as shown in Figure 1.5 below. The figure features Lesh, Post, and Behr's (1987) model of important connections among representations. Teachers enacting ambitious instruction can provide students OTL by choosing tasks with multiple entry points that are model of procedures (NCTM, 2017).

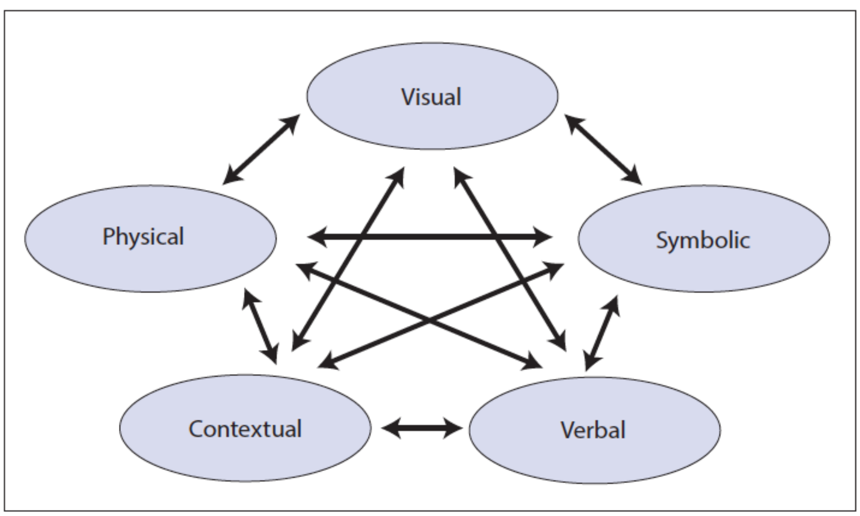


Figure 1.5. Model of Important Connections Among Mathematical Representations

Mathematical Discourse Community in the MTF

Within the MTF, discourse most often takes place in the implementation phase. A mathematical discourse community is not only evident through conversation, but it is also manifested by the ways in which students make meaning through representations (NCTM, 2017). The norms of mathematical discourse, however, are typically established in the planning and set-up phases of a lesson. Students are provided OTL when they have opportunities to facilitate the mathematics discourse community. In enacting ambitious instruction, teachers also elicit student thinking, support student-to-student exchanges about mathematical ideas, and guide the mathematics, as evidenced in the rubric of levels of discourse in Figure 1.6 (Berry et al., 2017; Hufferd-Ackles, Fuson, & Sherin, 2014; NCTM; 2014, NCTM, 2017).

	Teacher role	Questioning	Explaining mathematical thinking	Mathematical representations	Building student responsibility within the community
Level 0	Teacher is at the front of the room and dominates conversation.	Teacher is only questioner. Questions serve to keep students listening to teacher. Students give short answers and respond to teacher only.	Teacher questions focus on correctness. Students provide short answer-focused responses. Teacher may give answers.	Representations are missing, or teacher shows them to students.	Culture supports students keeping ideas to themselves or just providing answers when asked.
Level 1	Teacher encourages the sharing of math ideas and directs speaker to talk to the class, not to the teacher only.	Teacher questions begin to focus on student thinking and less on answers. Only teacher asks questions.	Teacher probes student thinking somewhat. One or two strategies may be elicited. Teacher may fill in an explanation. Students provide brief descriptions of their thinking in response to teacher probing.	Students learn to create math drawings to depict their mathematical thinking.	Students believe that their ideas are accepted by the classroom community. They begin to listen to one another supportively and to restate in their own words what another student has said.
Level 2	Teacher facilitates conversation between students, and encourages students to ask questions of one another.	Teacher asks probing questions and facilitates some student-to-student talk. Students ask questions of one another with prompting from teacher.	Teacher probes more deeply to learn about student thinking. Teacher elicits multiple strategies. Students respond to teacher probing and volunteer their thinking. Students begin to defend their answers.	Students label their math drawings so that others are able to follow their mathematical thinking.	Students believe that they are math learners and that their ideas and the ideas of their classmates are important. They listen actively so that they can contribute significantly.
Level 3	Students carry the conversation themselves. Teacher only guides from the periphery of the conversation. Teacher waits for students to clarify thinking of others.	Student-to-student talk is student initiated. Students ask questions and listen to responses. Many questions ask "why" and call for justification. Teacher questions may still guide discourse.	Teacher follows student explanations closely. Teacher asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher.	Students follow and help shape the descriptions of others' math thinking through math drawings and may suggest edits in others' math drawings.	Students believe that they are math leaders and can help shape the thinking of others. They help shape others' math thinking in supportive, collegial ways and accept the same support from others.

Figure 1.6. Levels of Classroom Discourse

Theoretical Framework

Unlike theories of learning, Hiebert and Grouws (2007) argue that "robust, useful theories of mathematics teaching do not exist" (p. 373) because not only do teaching methods vary by learning objectives, but there are also various factors impacting students' OTL. The authors further contend that in order to develop sound teaching theory, current research should not focus solely on teachers but on patterns of teaching rather, and their resulting impact on OTL (Hiebert & Grouws, 2007). Rather than reinventing the wheel, connections can be drawn to prior research in order to develop "working theory," or to identify factors that are understood to impact on students' OTL in mathematics classrooms.

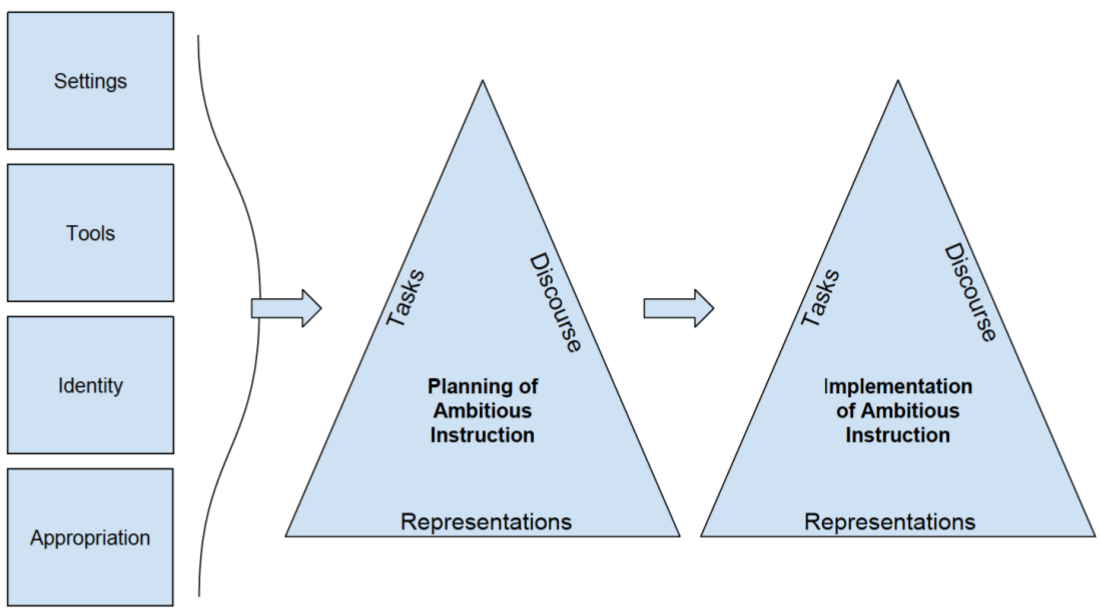
Activity theory is useful for understanding how students' OTL may be influenced by teachers' planning and instruction in mathematics (Chahine, 2013; Engeström, Miettinen, & Punamäki, 1999). Stemming from the Vygotskian theory of cognition, activity theory examines cognitive activity from a socio-cultural lens (Chahine, 2013). In particular, activity theory considers how a given subject/s and mediating artifacts influence a given object/s. Similar to how researchers interpret the MTF, a teacher (subject), influenced by various factors (mediating artifacts), plans and implements instruction in ways that raise, maintain, or lower the potential cognitive demand of a mathematics task as it is worked on by students (object).

When applying activity theory to studies of how teachers enact ambitious mathematics instruction, it is important to consider mediating artifacts that may influence students' OTL. In this case, such artifacts include *settings, tools, identity,* and *appropriation* (Grossman et al., 2000). *Settings* refer to whether or not teachers plan individually and whether there are mandates within the school context for how mathematics instruction is taught. They also ask us to consider whether beginning teachers' experiences in university courses and student teaching are similar to or different from the settings in which they work as full-time teachers. *Tools* refer to "classroom practices, strategies, and resources" (Grossmann et al., 2000, p. 634) that a teacher implements. *Identity* is a given teacher's beliefs about mathematics teaching and learning which are potentially carried out as they plan and enact mathematics instruction. Finally, *appropriation* concerns teachers' efforts to take up, integrate and use practical tools and ideas about mathematics teaching based on their identity. Such efforts can shape the enactment of ambitious instruction because teachers' conceptions of mathematics teaching appear to influence their planning and instruction (Amador & Lamberg, 2013).

Activity theory compliments mathematics teaching research, which often focuses solely on conditions embedded within the MTF, addressing the settings in which teachers learn to enact instruction as well as the role that ambitious instruction may play in students' OTL. It helps us understand that teachers' mathematical beliefs and instructional practices develop through social interaction in particular settings and are mediated both by individual and institutional histories and by conceptual and material tools.

Chapter Summary

The problem of practice in this chapter stated that schools do not always meet the needs of all students. Although the standards-based movement argues that all students deserve high-quality instruction, students' OTL often varies across classroom contexts. When teachers enact ambitious mathematics instruction, they provide students OTL by structuring context-specific lessons that are standards-based and rigorous. In mathematics, ambitious instruction can be evidenced in tasks, representations, discourse, and coherence. I argue that the enactment of ambitious instruction cannot be fully understood without considering both teachers' planning and implementation of math tasks. At present, it is unclear what factors are most often associated with teachers' planning of ambitious instruction and how their planning seems to affect students' OTL upon implementation. This study focuses on novice elementary teachers' enactment of ambitious instruction because such teachers are often negotiating many factors in their planning as they are developing their skill sets. Prior to this study, however, it was unknown how these factors affect their planning and enactment of ambitious instruction. Model 1.2 below provides a visual representation of the study.



Model 1.2. Visual Representation of the Study

Definition of Terms

Opportunity-to-Learn	The set of experiences that schools organize to help students acquire the knowledge, skills, and abilities specified in those official standards.
Equity	Promoting access and attainment for all students by providing reasonable and appropriate accommodations and appropriately challenging content.
Ambitious Mathematics Instruction	A set of teaching practices that foster students' deep conceptual understanding of standards-based mathematics concepts.
Implement tasks that promote reasoning and problem solving	"Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies" (NCTM, 2014, p. 17).
Use and Connect Mathematical Representations	"Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving" (NCTM, 2014, p. 17).
Facilitate Meaningful Mathematical Discourse	"Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments" (NCTM, 2014, p. 17).
Novice Teacher	Those with zero to three years of teaching experience.
Settings	Whether or not teachers plan individually and whether there are mandates within the school context for how mathematics instruction is taught.
Tools	Classroom practices, strategies, and resources.
Identity	A given teacher's beliefs, related to themselves, or their understanding of pedagogy and teaching practices.
Appropriation	What teachers deem relevant to the individual students and learning objectives at hand.

CHAPTER 2: LITERATURE REVIEW

When teachers enact ambitious instruction in mathematics, they are affording students opportunity-to-learn (OTL) by providing appropriate learning experiences that are aligned with a rigorous set of standards. This literature review focuses on how teachers enact ambitious teaching practices in their classrooms. The goal of this literature review is to first describe an ideal approach to planning for ambitious mathematics instruction. Second, I describe how various factors may be associated with the ways in which teachers plan for their mathematics instruction. Finally, I describe how these factors seem to be associated with ways in which teachers enact standards-based teaching practices, with a particular focus on activity theory and novices. There is a gap in the literature related to how novice teachers plan and implement ambitious instruction, but research suggests that a focus on teaching practices has implications for improving students' OTL.

Planning for Ambitious Instruction in Mathematics

A Backwards Design Approach to Planning

Both researchers and educators seem to agree that the ultimate goal of learning is transfer, or when one "can take what you have learned in one way or context and use it in another, on your own" (Bransford, Brown, & Cocking, 2000, p. 14). From a constructivist perspective, teachers support transfer by developing lessons that are motivating and suitable to students' interests (Shapiro, 2013; Taba,1962; Wiles & Bondi, 2002). Researchers have found that the likelihood that transfer is achieved is dependent on a child's conceptual understanding of a topic or problem (Calais & Larmon, 2006). In mathematics, transfer can be achieved by providing students opportunities to engage in rich standards-based tasks that promote the use of multiple representations and mathematical discourse. Arguably, and in accordance with the definition of ambitious mathematics instruction, if teachers are to hold students accountable for learning goals then they ought to purposefully plan for how they will respond to students and engage them in problem solving (Kazemi, Franke, and Lampert's, 2009)

A *backwards design* (Wiggins & McTighe, 2011) approach to planning can support the enactment of ambitious instruction and transfer of learning. Rather than developing lessons arbitrarily, a backwards design approach encourages teachers to develop lessons beginning with standards-based learning goals. As standards in mathematics focus on both conceptual and procedural understanding, teachers can promote transfer by developing stimulating lessons aligned with these standards-based goals.

The process of backwards design is challenging. Data from Surveys on Enacted Curriculum (SEC), a set of nationally representative surveys of instruction, has shown a weak alignment between instruction and state standards (Polikoff, 2012; 2013). These SEC studies were largely conducted between 2003 and 2009 and in the surveys, teachers self-reported what they taught during a school year. Instructional alignment findings were calculated by comparing the reports with state standard maps. In an analysis of over 40,000 SECs, Polikoff (2012) found low alignment between instruction and state standards, less than 0.5 on a scale from 0 to 1.

Findings from another study by Polikoff (2013) showed that almost all teachers indicated that aligning instruction was important, yet results showed similar gaps in alignment between standards and instruction. As noted by the author, aligning standards and instruction is challenging because enactment is influenced by many factors (e.g., teachers' access to resources, number of years teaching, class size, school specific policy, etc.).

A Framework for Planning in Mathematics

Smith and Stein (2011) associate ambitious teaching in mathematics with purposeful planning. From a backwards design perspective, teachers intentionally select tasks with multiple solutions from standards-based goals. This lesson design approach supports the enactment of ambitious teaching practices because teachers plan to facilitate meaningful discourse, which allows students to connect various representations in order to draw connections and build rich understandings of concepts. Figure 2.1 shows an example of a standards-aligned lesson plan in mathematics at the middle school level.

Factors Associated with Planning Mathematics Instruction.

Research is rich with ideas of planning (Chizhik & Chizhik, 2018; Smith & Stein, 2011; Wiggins & McTighe, 2012). Studies have focused less frequently, however, on how teachers' approaches to planning seem to be associated with their enactment of ambitious instruction. This section of my literature review focused on broader studies of settings, tools, identity, and appropriation to help understand how these factors might be associated with the ways in which teachers plan their mathematics instruction.

Settings. Recall that settings refer to whether or not teachers plan individually and whether there are mandates within the school context for how mathematics

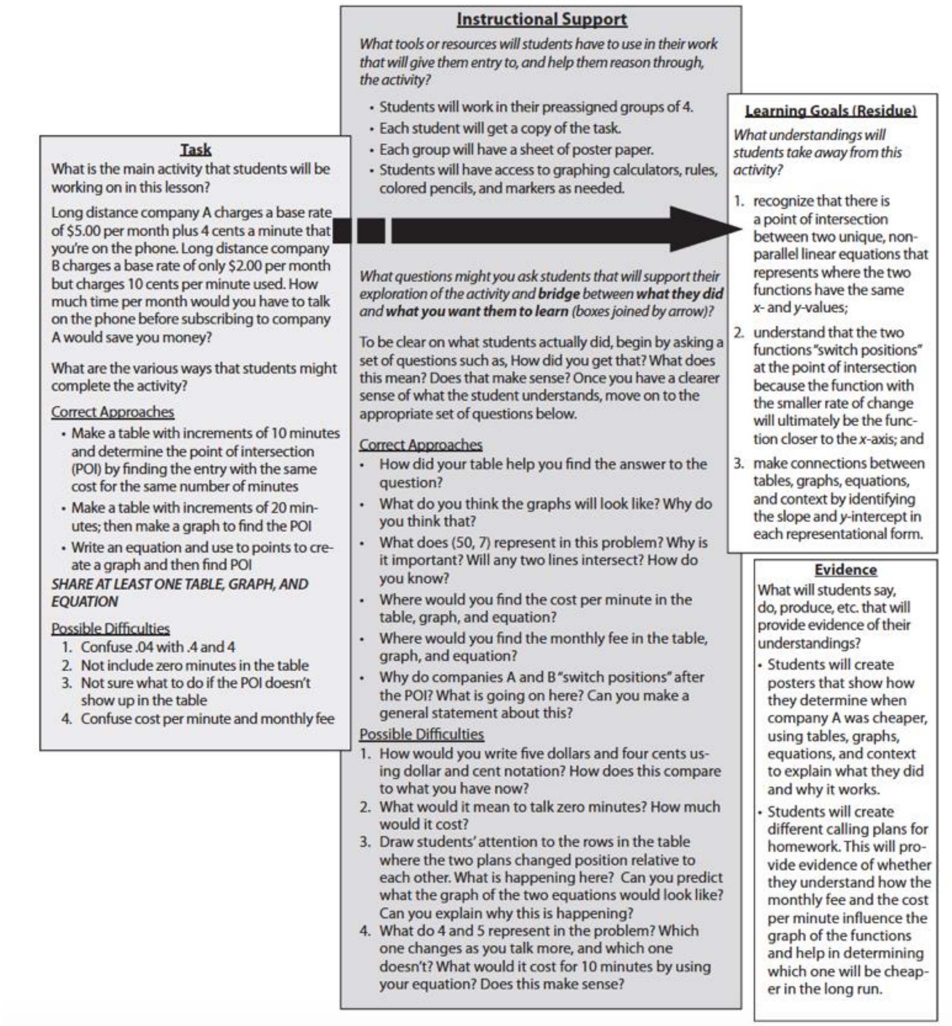


Figure 2.1. Standards-Aligned Lesson Plan in Mathematics

instruction is taught. A longitudinal study by Boaler and Staples (2008) examined the potential influence that settings have on teachers' enactment of mathematics instruction. At one focus high-school, 12 out of 13 teachers regularly planned their curriculum together and shared teaching methods over a three-year period. Based on a shared understanding that opportunities to engage in group worthy tasks would provide meaningful learning experiences for students, teachers attempted to develop their curriculum in ways that promoted conceptual tasks. An analysis of 55 hours of lesson observations revealed that teachers only lectured 4% of the class time, and 72% of the time students worked in groups. At the end of the second and third-year of this study, the focus school had a higher mean score on a post-test compared to a more traditional school in the study. The ways in which teachers collaborated seemed to contribute to their students' overall success as they shared ideas during collaborative planning time and implemented a conceptually-focused curriculum (Boaler & Staples, 2008).

Tools. Conceptually-focused curriculum was a common feature in my review of literature that focused on ambitious instruction. Teachers commonly implemented tasks from curriculum like *Everyday Mathematics* and the *Connected Mathematics Project* curricula (Boston & Wilheim, 2015; Henningsen & Stein, 1997; Jackson, Gibbons, & Sharpe, 2017; Stein, Grover, & Henningsen, 1996; Superfine, 2010). These curricula offered conceptually-focused and reform-based tasks but the ways in which they were implemented seemed to afford students different learning opportunities. For example, Stein, Grover, and Henningsen (1996) noted that although teachers tended to select high cognitive demand tasks from the *Connected Mathematics Project* curricula, the cognitive demand declined 38% of the time upon implementation. However, the extent to which teachers in this study planned outside of task selection is unknown.

There is little research on the influence of tools (e.g., resources or processes) on teachers' planning and the extent to which these are associated with the enactment of ambitious instruction. However, portraits of teachers' planning indicate that their processes could be associated with the ways in which teachers enact mathematics instruction. In Charalambos and Charalambos (2010) exploratory study, a fifth-grade teacher named Lisa planned by anticipating all possible outcomes. She stated that

> I want [students] just to try their best to figure things out, but I always try to set it up so that it's as close to a hundred percent success as possible . . . so I sit down when I plan a lesson and I try to think of everything . . . a kid might do wrong and why would they be doing it that way. And then think, okay, what can I do . . . how can I set the lesson up so that it has the least amount of pitfalls? (p. 270).

Lisa's lessons were largely focused on procedures and memorization upon enactment; this occurred in approximately 83% of the lessons. It is possible that the teacher's planning processes were associated with this finding as the authors noted that her instruction lent itself to teaching in a certain way, or with fewer solution paths. Smith and Stein (2011), on the other hand, stress that in backwards design teachers should plan for many solution paths in order to incorporate both student conceptions and misconceptions in the implementation of a lesson (Smith & Stein, 2011).

Identity. Teachers' understanding of content and pedagogy as well as their prior experiences may shape beliefs about how subject-matter should be taught (Grossman et al., 2009). Teachers' beliefs are often inferred based on self-reports or uncovered in qualitative research. One measurable characteristic of teachers' identity is self-efficacy, or "their beliefs about their capability to teach their subject matter even to difficult students" (Holzberger, Philipp, & Kunter, 2014, p. 774). In Hill et al.'s (2015) study of teacher characteristics and instructional quality, teachers' efficacy was determined using three Likert-scale survey questions related to behavior, motivation, and their ability to “craft good instruction” (p. 8). In a pairwise test, teacher efficacy seemed to be correlated with ambitious instruction as findings were statistically significant ~$p<.10$.

Building a case that teacher efficacy could be correlated with ambitious instruction, Jong (2016) asserted that reform-based teaching practices were enhanced as a teacher’s self-efficacy shifted over time. Using constant comparison as the focal teacher completed a pre-service teaching program and transitioned into the classroom setting, self-efficacy was evident from the teacher’s commitment to enacting meaningful instruction. The teacher “consistently aimed to teach mathematics with a focus on connecting the conceptual knowledge and computational skills” (Jong, 2016, p. 305), despite the fact that she first struggled to support students’ misconceptions. Based on observations that took place over three years, the author reported that the teacher’s practice changed as she developed lessons around the use of multiple strategies and representations.

It is also possible that there is an inverse relationship between teachers’ identity and their enactment of ambitious instruction (Gujarati, 2013). In a multiple-case study of three novices in their second year of teaching, Gujarati (2013) holistically categorized teachers as “having a positive, negative, or neutral mathematics identity” (p. 639). The major strengths of this research in comparison to the studies mentioned above is that the author collected data from many sources: math autobiographies, semi-structured interviews, observations, unstructured interviews, reflective journal entries, and classroom artifacts. These sources supported data analysis because they allowed for triangulation between what teachers reported as beliefs and what was present in lesson enactment. The authors reported that the teachers described their own negative learning experiences in mathematics as reasons for enacting instruction in strategic ways. For example, as one teacher found mathematics intimidating to learn, she regularly incorporated representations into her instruction to promote deeper understanding for all students.

Appropriation. The four teachers in Amador and Lamberg's (2013) study developed learning objectives based on varying students' needs that seemed to be associated with how teachers appropriated learning experiences in their classrooms. In their study, teachers seemed to develop learning objectives for the purpose of mastering standardized assessments. Three teachers in the study designed lessons that were more procedurally-focused, and as such their lessons were more focused on one of way of understanding. Another teacher wanted to promote mastery by designing opportunities for students to develop richer understanding, and as such she planned more student-centered instruction. In one instance, the authors described a portrait of this teacher stopping midway through a lesson to bring in a model to help students meet the current lesson objective. There was no assertion made in these cases that one approach was more ambitious than another.

In contrast, Chizik and Chizik's (2018) study, which focused on ten pre-service teaching candidates portfolios, reported that the ways in which teachers planned were associated with whether students' needs were addressed upon implementation. In their study, the authors found that the candidates' lesson plans overlooked individual student's needs and the students also performed low overall on the unit assessment. In summary, studies of ambitious instruction have found that various factors seem to be associated with the ways in which teachers plan and enact their mathematics instruction.

Enacting Ambitious Mathematics Instruction

The enactment of ambitious mathematics instruction is often evident from the ways in which teachers implement standards-based teaching practices. Boston and Wilhelm define ambitious instruction as “a set of instructional practices that appear to support students’ learning of mathematics with understanding” (2015, p. 2). Three examples of these teaching practices are using tasks that promote problem solving and reasoning, using and connecting mathematical representations, and facilitating meaningful mathematical discourse (NCTM, 2014). Mathematics education literature has called for research on factors that are associated with the enactment of ambitious instruction.

In my review of the literature, the selection of high cognitive demand tasks appeared to shape the enactment of ambitious instruction. Three factors were commonly associated with the types of tasks that teachers enacted: teachers’ practical tools, learning goals, and grade-level colleagues.

Factors Associated with the Enactment of Ambitious Mathematics Instruction

Practical tools. Teachers’ practical tools refer to the resources that teachers draw from to select or possibly design mathematics tasks. The tools that teachers draw upon when enacting mathematics instruction are relevant because the enactment of mathematics tasks seems to influence students’ OTL. When students are “doing mathematics” they are exploring the nature of mathematical concepts by engaging in rich mathematical tasks (Stein, Smith, Henningsen, & Silver, 2016, p. 4). Studies which focus on cognitively challenging mathematics tasks often draw upon teachers’ use of practical tools.

Stein, Grover, and Henningsen (1996) examined teachers' enactment of mathematics tasks in a large-scale, longitudinal, mixed-methods study in six urban middle schools in the early-1990s. In this study, called the QUASAR project, teachers from six middle schools participated in professional development programs that focused on reform-based mathematics teaching practices. Using video observations and narratives of mathematics teaching in middle school classrooms, the researchers found that out of 144 enacted tasks from a stratified sample, 97 called for the use of multiple strategies, 96 called for multiple representations, and 88 required communication. Teachers in this study either designed their own tasks or selected from various resources; 39% of the time, teachers chose tasks from *The Middle Grades Mathematics Project,* a conceptually-focused curriculum. In this reform-oriented teacher development study, the authors asserted that the high-cognitive demand tasks that teachers selected were possibly associated with the practical tools involved.

In a different study, Fuson, Carrol, and Druek (2000) observed third-grade teachers who selected tasks from the *Everyday Mathematics* curriculum. This curriculum was developed "based on the belief that children can learn far more mathematics, with deeper understanding, than expected in more traditional programs" (Fuson, Carrol, & Druek, 2000, p. 279). In second and third grades, students completed assessments that paralleled national and international assessments to determine how they performed relative to various comparison groups. Specifically, 236 third-grade students from multiple schools were assessed with 22 of 33 question items taken from the fourth-grade National Assessment of Educational Progress (NAEP) assessment. Of those 22 questions, the third graders in the study who were exposed to the *Everyday Mathematics* curriculum scored higher than a comparison group of fourth-graders, 65% to 52%. Upon enactment of these tasks, Fuson, Carrol, and Druek (2000) described students who enacted in the tasks as being more “engaged” and wrote that teachers developed more “supportive climates” (p. 281) in classes which enacted *Everyday Mathematics*.

Learning goals. Conceptually-focused curriculum was a common feature in my review of ambitious teaching literature. Teachers commonly implemented tasks from the *Everyday Mathematics* and the *Connected Mathematics Project* curricula (Boston & Wilheim, 2015; Henningsen & Stein, 1997; Jackson, Gibbons, & Sharpe, 2017; Stein, Grover, & Henningsen, 1996; Superfine, 2010). However, in many instances the cognitive demand of tasks seemed to be influenced by learning goals. Cobb and Jackson (2011) assert that learning goals must be explicit at all levels. At the district level, Boston and Wilhelm’s (2015) study assessed the extent to which teachers’ instruction varied within and across four districts who were “striving for ambitious instruction” (p. 16). All four of the districts enacted a reform-based curriculum, and tasks that were selected at high levels of cognitive demand ranged between 62.1% of the time and 85.7% of the time, depending on the district. The authors described these districts as instructionally-focused, and their findings contrasted with typical urban districts where students were exposed to less cognitively challenging tasks.

Learning goals also seem to be associated with the enactment of tasks at the classroom level. Just as the range of high cognitive demand tasks varied at the district level in Boston and Wilhelm’s (2015) study, learning goals vary at the classroom level are based on the ways in which teachers interpret the standards and modify tasks. Amador (2016) utilized a case study approach to conduct interviews and observations of four fourth-grade teachers to understand their learning goals. With common access to the *Everyday Mathematics* curriculum and no specific professional development support, teachers adapted tasks and planned lessons based on different learning goals. Smith and Stein (2011) state that lesson goals should be developed from a set of standards. Conversely, the authors in the study found that teachers' plans were based on the skills that students would need in order to master a summative assessment. Amador (2016) stated that "they continually focused on teaching that would be tested. At one point, Ms. Creeggan had students practice the exact problem they would find on the district summative assessment, to be given one week later." (p. 248). In the case of Ms. Creeggan, the teacher seemed to develop learning goals based on test questions rather than tasks that would support rich understanding of topics for transfer.

Networks of colleagues. Though the four teachers in Amador's (2016) study taught at the same grade level, there was no description of colleague interaction. At the same time, other studies suggest that networks of colleagues may be associated with the enactment of ambitious instruction. For example, the majority of teachers in one of the schools in Boaler and Staples (2008) continuously collaborated to design reform-based curricula. The authors in this mixed-methods study noted that in comparison to two other schools, higher cognitive demand was evident in both the selection and implementation of tasks. The authors stated that the teachers at the first school, Railside, "deliberately and carefully discussed their teaching approaches, a practice which included sharing good questions to ask students" (Boaler & Staples, 2008, p. 619). Planning with a network of colleagues is one approach that Smith and Stein (2011) recommend as a way for teachers to anticipate students thinking and to share tasks, especially when teachers are novices.

Novice Teachers and the Enactment of Ambitious Mathematics Instruction

It is generally understood that as teachers gain experience, they seem to have stronger classroom management skills, higher levels of pedagogical content knowledge, and knowledge of scope and sequence of curriculum, and they are better able to negotiate expectations in their schools. Feiman-Nemser's (2001) central tasks of learning to teach (CTLT) framework, presented in Figure 2.2 below, describes a continuum of tasks that teachers typically develop over stages of time.

CENTRAL TASKS OF LEARNING TO TEACH

Preservice	Induction	Continuing Professional Development
1. Examine beliefs critically in relation to vision of good teaching	1. Learn the context—students, curriculum, school community	1. Extend and deepen subject matter knowledge for teaching
2. Develop subject matter knowledge for teaching	2. Design responsive instructional program	2. Extend and refine repertoire in curriculum, instruction, and assessment
3. Develop an understanding of learners, learning, and issues of diversity	3. Create a classroom learning community	3. Strengthen skills and dispositions to study and improve teaching
4. Develop a beginning repertoire	4. Enact a beginning repertoire	4. Expand responsibilities and develop leadership skills
5. Develop the tools and dispositions to study teaching	5. Develop a professional identity	

Figure 2.2 The Central Tasks of Learning to Teach

The stages of time include pre-service, induction (i.e., teachers in their first through third years), and continuing professional development.

As teachers develop in the induction phase (i.e., learn the school context, design a responsive instructional program, create a classroom learning community, enact a beginning repertoire, and develop professional identity), their quality of teaching is likely to improve. In a study of 16 first-year teachers in Australia, researchers found that classroom management was a central issue in the first year of teaching (McCormack, Gore, & Thomas, 2006). However, as teachers described feeling more comfortable in their contexts, they more commonly developed lessons based on “students’ abilities, needs, and interests” (McCormack, Gore, & Thomas, 2006, p. 104). Findings from this study indicated that the first year of teaching is unique because there are context-specific challenges to overcome that teacher preparation programs cannot necessarily address. As such, teachers must address several challenges in order to develop along the CTLT continuum (McCormack, Gore, & Thomas, 2006).

It is important to examine novice teachers’ experiences because they are likely to incorporate additional factors into their planning and instruction. These factors include prior experiences in teacher education programs, their relationships with colleagues, and accountability pressures they face even though they are still developing their skill set. These additional factors make it challenging for novice teachers to enact ambitious instruction because essentially they have two jobs; “they have to teach and they have to learn how to teach” (Feimen-Nemser, 2001, p. 1026). Studies of novice teachers that enact ambitious instruction are uncommon (Jong, 2014), but it was evident from my review of the literature that teaching candidates are often exposed to ambitious practices in their pre-service preparation experiences. This section of the literature review examines the ways in which various factors may be associated with novice teachers' enactment of ambitious instruction.

Experiences in Teacher Education

Researchers have asserted that pre-service mathematics methods courses do not always provide novices with the appropriate experiences they will need as early career teachers (Grossman, Hammerness, & McDonald, 2009; Jong, 2014). In response, methods courses are increasingly providing pre-service teachers opportunities to engage in *pedagogy of enactment,* or opportunities to practice ambitious teaching (Kazemi, Franke, & Lampert, 2009). These opportunities in methods are important because "good induction support can keep novices from abandoning these approaches in favor of what they may perceive as safer, less complex activities" (Feiman-Nemser, 2001, p. 1029).

Research on ambitious instruction has benefited from longitudinal studies that follow teachers from pre-service through their first year(s) of teaching (e.g., Jong, 2016; Thompson, Windschitl, & Braaten, 2013). In one such study, Thompson et al. (2013) followed 26 science teachers over a three year span using a multiple-case design. Within these three years, the novices participated in university coursework, spent a year with a cooperating teacher, and then taught as a first-year teacher. One focus of the authors examination was on teachers' development of practice over time. They found that 11 out of 26 teachers consistently used ambitious teaching practices from their pre-service courses while seven teachers used these practices to much less of an extent, and eight did not use them at all. Recalling that ambitious teaching practices can help students achieve deep understanding, there was a pattern of discourse among these 11 teachers' use curriculum that prioritized student thinking. Not only was this *pedagogical discourse,* or way of thinking about the curriculum, characteristic of the teachers, but their practice seemed to align with the framework of instruction from their pre-service coursework.

In a separate longitudinal study, Jong (2014) focused on one teacher's practice over a span of three years. One year was spent observing and interviewing the teacher in her practicum experience, and the following two years focused on the teacher's own classroom context. The author focused on this teacher's reform-oriented identity. This teacher, named Sonia, discussed how her prior experiences learning mathematics were associated with her teaching practices; these practices were also reaffirmed in her teacher preparation experience.

Although the definition of reform-oriented practices was not clearly defined in this study, Sonia stated that her mathematics methods course focused on concrete, pictorial, and abstract representations within their standards-reform model (Jong, 2014). Potentially due to the fact that her method's course substantiated her beliefs about teaching, it was evident in the author's data analysis that Sonia transferred the use of representations from her pre-service program to her second-grade teaching context.

In summary, practices in pre-service experiences may be associated with novice teachers' identity. This is because, as Feimen-Nemser (2001) stated,

> beginning teachers form a coherent sense of themselves as professionals by combining parts of their past, including their own experiences in school and in teacher preparation, with pieces of the present in their current school context with images of the kind of teachers and colleagues they want to become and the kids of the classroom they want to create (p. 1030).

Mentors

In addition to pre-service experience, other studies have shown an association between ambitious teaching and relationships with mentors (Desimone, 2014; Thompson et al., 2013). Relationships with both formal mentors, or those assigned to work with a novice teacher, and informal mentors may be associated with teachers' enactment of ambitious instruction. Many states have provided policy to support novice teachers with mentors under the premise that the relationship "tends to produce mentoring that has more positive effects on teacher satisfaction and increases retention" (Desimone, 2014, p. 89). Desimone and colleagues collected data from 57 novice teachers embedded within a five-year study. The authors asserted that both formal and informal mentors seemed to support teachers by providing feedback on their practice. In this particular study, 39 out of 57 teachers stated that they valued feedback. Additionally, teachers mentioned that they sometimes had standards-based discussions with their formal mentors (Desimone et al., 2014). The relationship between novice teachers and mentors could support the enactment of ambitious instruction but notably, novices' experience seems to vary by context.

School-Wide Expectations

Mentoring can help bridge the gap between novice and veteran teachers' practice, which is important because novice teachers are equally as accountable for student performance as their more experienced colleagues. However, it is sometimes the case that mentors or other influences, like school-wide expectations, privilege more traditional instructional practices (Achinstein, Ogawa, & Speiglman, 2004; Desimone, 2014). Achinstein et al.'s (2004) study of novice literacy teachers focused on varying contextual influences on their practice. Using descriptive cases, the authors portrayed differences in teaching practices between two teachers, Liz and Sam. Though many plausible influences of practice were described, state policy seemed to influence teaching practices at these two schools. Liz's school culture seemed to adhere to strict district curriculum, and her instruction was observed to be more textbook-bound. On the other hand, Sam was given more autonomy at his school and he appeared to develop more student-centered lessons.

Gap in the Literature

Various factors seem to be associated with the ways in which novice teachers enact ambitious mathematics instruction. Research on ambitious instruction has benefited from studies that have followed teachers from their pre-service programs through their first year(s) of teaching and shown evidence of teachers engaging with ambitious teaching practices. To my knowledge, however, there are no studies that provide rich understanding of how various factors (e.g., tools, settings, identity, and appropriation) seem to influence novice teachers' planning and implementation of ambitious instruction. Generally speaking, there are few studies that characterize novice teachers' enactment of ambitious instruction. My study aimed to fill this gap in literature by focusing on factors that seem to be associated with how novice teachers plan and enact ambitious mathematics instruction.

Chapter Summary

This chapter focused on my review of literature related to mathematics teachers' planning practices and factors associated with how teachers enact ambitious instruction, especially novices (Achinstein et al., 2004; Feimen-Nemser, 2001; Grossman et al., 2009; Jong, 2014; Thompson, et al., 2013). My problem of practice states that teachers do not always meet the needs of their students. Ambitious instruction provides better learning opportunities for students because standards-based teaching practices promote cognitively challenging tasks, use of multiple representations, and opportunities for students to engage in meaningful discourse. This chapter showed how various factors possibly influence teachers' engagement with ambitious teaching practices. I then argued that there is a gap in the literature related to how novice teachers plan and enact ambitious mathematics instruction. A rich study of novice teachers' planning and implementation might affirm that certain factors are associated with their enactment of ambitious mathematics instruction.

CHAPTER 3: METHODS

To examine factors associated with beginning elementary teachers' planning and enactment of ambitious instruction, I used an explanatory case study approach (Yin, 2018). An explanatory case study is appropriate when one aims to "develop ideas of what are significant lines of relation and to evolve one's conceptual tools in the light of what one is learning about the area of life" (Blumer, 1969, p. 40). Researchers know less about novice mathematics teachers' planning than we know about their instructional practices. Exploring factors that seemed to affect planning allowed me to build on and modify my conceptual framework by considering activity theory alongside each phase of the Mathematical Tasks Framework (MTF; Munton, Silvester, Stratton, & Hanks, 1999). Studying the association between planning and ambitious mathematics instruction makes it possible to identify patterns that could strengthen researchers' understanding of current theory and conceptual frameworks; i.e. activity theory and the MTF (Miles, Huberman, & Saldana, 2014).

Research Design

During the 2018-2019 school year, I interviewed and observed three novice elementary mathematics teachers who were teaching in the state of Virginia. The candidates for my research were participants in a larger study entitled the Development of Ambitious Instruction (DAI) study. The DAI study investigates how teacher preparation programs support elementary candidates in developing ambitious instruction and factors that are associated with how graduates of these programs enact mathematics instruction as first-, second-, and third-year teachers (Award Abstract, 2018). This larger study uses a longitudinal, mixed-methods research design to examine how novice teachers' characteristics and their prior experiences in teacher preparation interact with factors in their schools to shape their enactment of ambitious instruction. The goal of the larger project is to further develop teacher preparation programs that ensure new elementary teachers are capable of enacting ambitious instruction (Award Abstract, 2018).

The DAI study collected observation data from 40 first-year elementary teachers in the 2016-2017 school year, and 75 first- and second-year elementary teachers in the 2017-2018 school year, as they taught mathematics. These teachers graduated from five university preparation programs in three states. Within the larger study, these teachers were observed using the Mathematics Scan (M-Scan) classroom observation instrument (Berry et al., 2017). The M-Scan represents a schema of instruction that can be used to measure teachers' implementation of standards-based teaching practices on a scale of one to seven.

The M-Scan instrument is useful in research that focuses on ambitious mathematics instruction because it captures differences between teaching for conceptual understanding versus teaching for acquisition of procedural knowledge (Berry et al., 2017). Similar to the Common Core State Standards for Mathematics, the Virginia Standards of Learning encourage conceptually-focused teaching that supports students in developing a rich understanding of topics as well as procedural fluency (Virginia Standards of Learning & Common Core, 2011). Dr. Robert Berry co-developed the M-

Scan measure and also co-authored *Principles to Actions* (NCTM, 2014), which both focus on a set of standards-based teaching practices (i.e., the ways that teachers enact ambitious mathematics instruction). The student learning goals presented in Kazemi, Franke, and Lampert's (2009) definition of ambitious mathematics instruction are consistent with the National Research Council's strands of mathematical proficiency (e.g., procedural fluency, strategic competence, adaptive reasoning, and productive dispositions) which are captured in the Common Core State Standards' eight Standards for Mathematical Practices. M-Scan also connects teacher practices with student practices as presented in Table 3.1 below (Berry et al., 2017).

The M-Scan was useful for my study because it is based on the National Council for Teachers of Mathematics (NCTM)'s principles and standards; in particular, M-Scan can be used as an observation instrument and it has nine dimensions that measure teaching practices in four domains: task selection and enactment, the use of representations, the use of mathematical discourse, and lesson coherence (Berry et al., 2017). Each of the nine dimensions is measured using the M-Scan rubrics. Figure 3.1 shows a conceptual model of these teaching practices (see Appendix A for an example of the M-Scan scoring rubric).

The larger study also features interviews and surveys with candidates. Prior to candidates' first year of teaching in the 2016-2017 school year, they completed a Mathematical Knowledge for Teaching (MKT) survey (Hill, Schilling, & Ball, 2004). During their first year, they completed a survey of Mathematical Content Knowledge (MCK; Saderholm, Ronau, Brown, & Collins, 2010). The MKT survey is a validated and

M-Scan (Teacher Practices)	**Common Core State Standards - Mathematics, Standards for Mathematical Practices (Student Practices)**
Tasks · Cognitive Demand · Problem Solving · Connections and Applications	· Make sense of problems and persevere in solving them · Look for and make use of structure
Discourse · Mathematical Discourse Community · Explanation and Justification	· Reason abstractly and quantitatively · Look for and express regularity in repeated reasoning · Construct viable arguments and critique the reasoning of others
Representations · Use of Representations · Use of Mathematical Tools	· Use appropriate tools strategically · Model with mathematics
Mathematical Coherence · Structure of Lesson · Mathematical Accuracy	· Attend to precision

Table 3.1 The Relationship Between Teacher Practices and Student Practices in Mathematics

norm referenced measure that captures teachers' knowledge of the work of teaching mathematics. this includes "explaining terms and concepts to students, interpreting students' statements and solutions, judging and correcting textbook treatments of particular topics, using representations accurately in the classroom, and providing students with examples of mathematical concepts, algorithms, or proofs" (Hill, Rowan & Ball, 2005, p. 373). On the other hand, the MCK survey is a validated measure that was developed to capture teachers' mathematical content knowledge. The MCK survey assesses three types of knowledge: memorized and factual knowledge, conceptual understanding, and pedagogical content knowledge, for a total of 40 possible points. MKT surveys and MCK surveys can be used to explore the nature of teachers' knowledge as it relates to high-quality instruction (Hill, Rowan, & Ball 2005; Saderholm, et al., 2010).

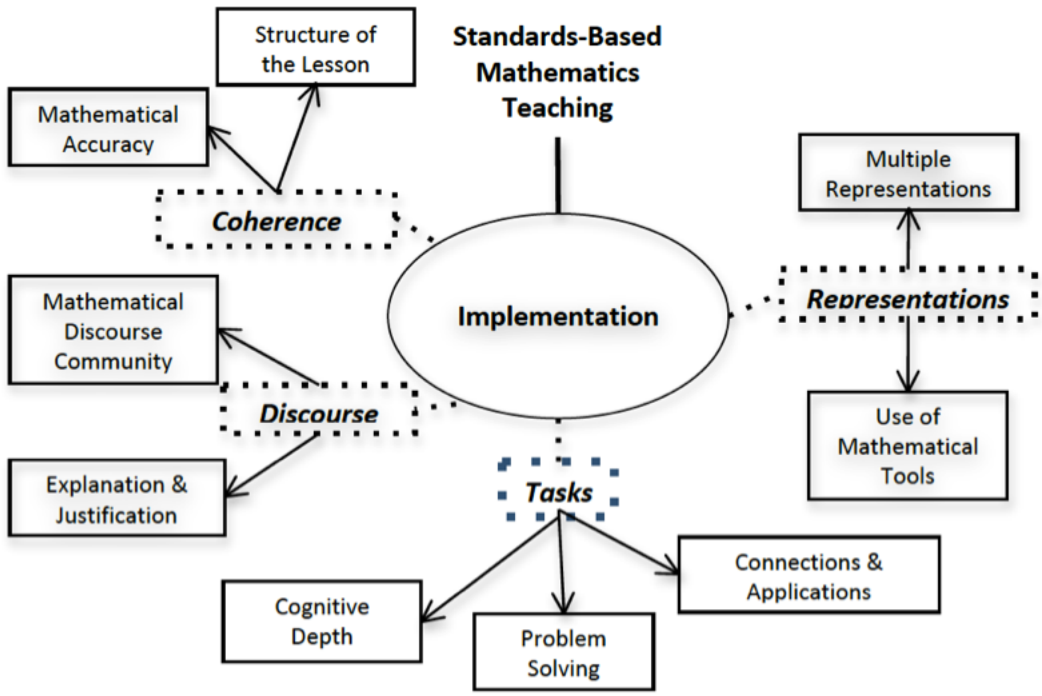


Figure 3.1. Conceptual Model of Standards-Based Mathematics Teaching Practices

Early findings from the larger study reveal that novice teachers are capable of enacting ambitious mathematics instruction. An unexplored issue in the larger study, however, is how novice teachers' planning might be associated with their implementation of such instruction. For this reason, my research included participants from the larger study whose M-Scan scores evidenced elements of ambitious mathematics instruction. M-Scan was chosen as the primary data source for selecting participants because the teachers' M-Scan observation scores were representative of their implementation of mathematics instruction. Using a multiple case study design, I examined how planning seemed to be associated with enactment of ambitious mathematics instruction. Data collection paralleled that of the larger study with additional interview and artifact data that was captured as it related to individual teachers' planning.

Participants

Novice teacher participants in their third year of teaching were purposefully selected for this study in the 2018-2019 school year. My sample was purposeful because I wanted to focus on teachers who were most likely to evidence ambitious mathematics instruction in their teaching. As such, I identified candidates who had relatively high M-Scan scores using early findings from the larger study. Potential candidates for my study spanned multiple states; however, for convenience sake my research focused on three teachers who were teaching in elementary classrooms in the state of Virginia in the 2018-2019 school year.

I examined teachers' average composite M-Scan scores using observation data available from the 2016-2017 school year for up to three mathematics lessons (i.e., when they were in their first year of teaching). While the original sample of first-year teacher observation participants in the 2016-2017 school year was 40, the resulting pool of potential candidates who taught in the state of Virginia was 23. These teachers' average composite M-Scan scores ranged from to 2.111 to 4.944 out of seven. From the remaining sample, I eliminated potential candidates who were identified as teaching in private schools or gifted-only classrooms. One teacher from the pool, who would have otherwise been eligible for the study, was on leave and unable to participate.

Subsequently, interview data from the larger study was reviewed to narrow the focus to those who indicated that they routinely planned their mathematics instruction. Teachers who routinely planned their mathematics instruction seemed to have a structured time and approach to planning that took place either independently or with colleagues; e.g., with grade-level teams, mentors, and/or instructional coaches. Teachers' MKT and MCK scores were not considered when selecting potential candidates for my study. Instead, these scores were intended to potentially inform my study findings.

The resulting sample included three white female teachers who all previously consented to participate in the larger study (see Appendix B for consent form; see Appendix C for IRB approval). These teachers graduated from two of the five teacher preparation programs within the larger study. Two teachers in my research study, Ms. Cohen and Ms. Bellamy, attended the same teacher preparation program and also taught at the same elementary school. The third teacher, Ms. Mack, graduated from a different teacher preparation program and taught at a different school in a different school district. Pseudonyms were used for teacher, school, and university names for the purpose of anonymity. Table 3.2 provides background information for each of the three teachers. It includes the university where they completed their teacher preparation program, their schools' demographics, and their average composite observation and survey scores from the 2016-2017 school year.

Data Collection Strategies and Instrumentation

Observations of mathematics instruction are commonly utilized in studies that apply activity theory because they allow the researcher to attend to "both individual

Participants	**Ms. Mack**	**Ms. Cohen**	**Ms. Bellamy**
University	Oriole University	Robin University	
School Name	Halas Elementary School	McCaskey Elementary School	
School Demographics	White (53%) Black (23%) Hispanic (13%) Other (11%) Total number of students: 691	White (69%) Hispanic (25%) Other (5%) Black (1%) Total number of students: 367	
Grade Levels Taught	1st grade only	4th grade (Y1), 5th grade (Y2, Y3)	4th grade only
Number of Students in Homeroom	18	22	20
Average Composite M-Scan Scores from the 2016-2017 School Year	3.388	3.194	3.259
MKT Score	0.686107	0.577661	-0.198695
MCK Score	22	39	36

Table 3.2 Background and Demographic Information of Participants

understandings and perceptions as well as social contexts by describing classroom interactions as a complex system where an individual's participation is understood in relation to the other people and material objects" (de Freitas, Lerman, & Parks, 2017, p. 165). In my research, each teacher was observed three times in order to obtain representative data about their instructional practices and for purpose of triangulation and pattern building. Multiple observations supported my goal of reporting findings within and across teachers. I video-taped each observation, as teachers were accustomed to in the larger study, for the entire mathematics lesson. As part of the larger study, I was trained to observe and assess mathematics instruction, live and on video, using M-Scan by a researcher from the University of Virginia. After the observations, I used M-Scan to score each teacher's video-recorded math lesson. As I scored each math lesson, I typed field notes that reflected teacher and student actions as well as timestamps.

In addition to observation data and documentation, I interviewed each teacher using a structured interview protocol at the beginning of my study to understand school- and district-wide mathematics instruction expectations that they faced, available resources for planning, and typical planning practices. I then conducted a semi-structured interview with each teacher after every mathematics teaching observation. After the first interview, a semi-structured interview was conducted with each teacher after each mathematics teaching observation; these interviews lasted up to 45 minutes and were audio-recorded (Seidman, 2006). See Appendix D for the initial interview protocol and Appendix E for the semi-structured interview protocol.

Because I entered the field with a specific focus in mind, semi-structured interviewing allowed me to flexibly examine various factors that might be associated with teachers' planning and enactment of mathematics tasks. In each semi-structured interview, I asked about the goals of the lesson and how the teacher planned for that lesson. The structured questions in the first interview largely paralleled the interview protocol from the larger DAI study. The purpose of adding questions to the first interview was to understand the overall structure and expectations of mathematics planning within the teachers' classrooms, schools, and districts. Teachers shared lesson plans and copies of instructional activities during each semi-structured interview. These artifacts provided opportunities for them to describe how they planned, how they selected tasks, etc.

Both of my interview protocols were pilot-tested prior to implementing them in the study. One fourth-year elementary mathematics teacher from the state of Illinois served as the piloter. This person provided feedback related to how they experienced the questions and the order of the questions. Pilot-testing helped me ensure that my interview questions aligned with my research questions; she agreed that they did. My advisor and I met afterwards and added one question to the semi-structured interview protocol that focused on the extent to which teachers planned for the use of discourse and representations in their planning. This helped me better understand whether or not teachers were intentionally planning to enact elements of ambitious instruction that could then be observed using the M-Scan instrument. My study also featured pre-observation prompts (see Appendix F). Prior to each observation, teachers emailed a copy of their response to the prompt to describe their intended goals, how they prepared for the lesson, the materials and resources that they considered in their planning, and a description of how they would instruct students during the lesson. The prompts served as a source of triangulation as I examined their planning and enactment of instruction.

Analytical Strategies

The research questions for my study were as follows:

RQ1: How do novice elementary teachers plan mathematics instruction?

RQ2: What factors seem to influence novice elementary teachers' selection and implementation of mathematics tasks?

RQ3: How is novice elementary teachers’ planning associated with ambitious instruction?

As part of my effort to answer my research questions, I examined how planning was associated with the enactment of ambitious instruction. I began to review my interview data with a predetermined structure that included three cycles of coding. This structure is presented in Figure 3.2 below.

Figure 3.2 Structure for the Three Phases of Coding

My initial set of deductive codes were developed from my literature review. In particular, I considered factors that seemed to be associated with the ways that novice teachers plan mathematics instruction: mentors teachers, other colleagues, school-wide expectations, professional development activities, and teacher education experiences. Additionally, I incorporated three big bin codes that related to my research questions: planning, task selection, and ambitious instruction. Using line-by-line inductive coding, I expanded my list to the full set of codes presented in Appendix G. These inductive codes related to activity theory. For example, in my first round of codes I noticed that teachers tended to consider pacing guides as a tool for planning. As such I developed a code called “Tools/pacing guide.”

In my third round of coding, I reviewed interview transcripts, pre-interview prompts, lesson plans, and observation data using process codes. These process codes were categorized by the four domains of the M-Scan teaching practices: tasks, representations, discourse, and coherence. The process codes helped me understand the ways that teachers appropriated elements of ambitious instruction from planning through enactment, as illustrated in the visual model of my study in Chapter 1. Table 3.3 describes how my research questions were associated with my data sources and data analysis.

Research Question	**Data Source**	**Data Analysis**
RQ1: How do novice elementary teachers plan mathematics instruction?	Structured Interview Semi-Structured Interview Pre-Observation Prompt Lesson Plans	Deductive Coding Inductive Coding Process Coding
RQ2: What factors seem to influence novice elementary teachers' selection and implementation of mathematics tasks?	Structured Interview Semi-Structured Interview Pre-Observation Prompt Lesson Plans	Deductive Coding Inductive Coding Process Coding
RQ3: How is novice elementary teachers' planning associated with ambitious instruction?	Structured Interview Semi-Structured Interview Pre-Observation Prompt Lesson Plans Observation Field Notes	Process coding

Table 3.3 Description of Research Questions, Data Sources, and Data Analysis

Throughout the coding process, I reviewed my data using the constant comparison method (Corbin & Strauss, 2015) and I wrote analytic memos. Constant comparison also helped me develop a set of inductive codes; this was an important process because it lessened my interpretive bias, which may have occurred if I were adhering to a strict set of pre-determined codes. My initial approach allowed me to be responsive to patterns within and across my data on planning and enactment, an analysis strategy recommended by Yin (2018).

I personally transcribed 50% of the interviews and outsourced the remaining interviews to a service called TranscribeMe. In order to code my data, I utilized Dedoose coding software and developed analytic memos after each coding cycle in the program. Additionally, I double-scored two of the nine videos with the lead M-Scan scorer from the larger DAI study for inter-rater reliability. For all nine dimensions of M-Scan my scores and those of the lead M-Scan scorer were the same or within one number of each other. For the purposes of M-Scan, scorers within two numbers on any given dimension are considered to be reliable with each other.

Establishing Credibility and Validity

In the summer of 2018, I developed a methodological log to outline a schedule for my study. My methodological log was maintained throughout the study. During my data collection, I also wrote a reflective log after each interview and observation to attend to my questions and biases. My interpretations were member-checked with participants throughout the semi-structured interviews. My final assertions were based on identified similarities and differences among the teachers and, therefore, rich descriptions were used to substantiate my claims and help transfer to theory.

Yin (2018) recommends strategies for establishing a sound case study design by considering issues related to validity and reliability. In terms of construct validity, data was collected in the forms of observations, interviews, lesson plans, and prompts. I engaged in cross-comparison using data from these different sources to establish internal validity. Additionally, I addressed reliability through analytic logs which were maintained in Dedoose.

A group of peer colleagues acted as critical friends as I developed codes and themes in my data analysis as part of a writing group that met on a weekly basis throughout the 2018-2019 school year. The writing group consisted of four doctoral peers, three of whom are simultaneously developing Capstone projects. In this writing group, we also shared preliminary findings and drafts of our writing for feedback.

Role of Investigator

When the study was implemented, I was a 3rd-year EdD student in Curriculum and Instruction at the University of Virginia. I had served as a graduate research assistant with the larger study throughout my doctoral program. In my role with the larger study, I observed and scored videos of mathematics instruction, interviewed and transcribed data, and also conducted big bin coding with a team of qualitative researchers. Prior to the 2018-2019 school year, I had not had any interactions with the participants who were selected for my Capstone.

In addition to my current role in the larger study, my background as an instructional coach, mathematics teacher, and NCTM intern has led me to believe that the enactment of cognitively challenging tasks plays a key role in efforts to enact ambitious instruction because they set the standard for students' opportunity-to-learn. However, my experience in the EdD program has taught me to be reflexive and to appreciate education as ever-evolving; as such, I do not believe that my prior experience negatively impacted data analysis or my role as an investigator. Additionally, prior qualitative coursework has helped me learn to conduct ethical research and interpret data in new and creative ways.

IRB Considerations

Prior to conducting my study, I applied for and received IRB approval for one research study entitled *Middle School Students' Rational Number Reasoning.* My familiarity with the process helped me address ethical considerations throughout my research. Additionally, my familiarity with the logistics of the larger study guaranteed that data collection was carried out efficiently. Last spring, I also applied for and received a $1,000 grant as part of the Curry Innovative, Developmental, Exploratory Awards (IDEA) Competition which was used toward this Capstone study. All funds were used to support data analysis and dissemination of my results.

When I received IRB approval, all three teachers were consented as part of the larger study and students' parents received notification forms (see Appendix H for a copy of the parent notification form). All data pertaining to the participants, their students, and the school context are intended to remain anonymous. My advisor, Dr. Peter Youngs, is the chair of my Capstone committee and the principal investigator for the larger study. The other committee members include Dr. Susan Mintz, an associate professor at the University of Virginia; and Dr. Robert Berry, a professor of the University of Virginia and the current president of NCTM.

Limitations

Since March 2018, I have been meeting with Dr. Youngs on a regular basis to discuss my Capstone project. We have spoken about the data collection and analysis throughout and we identified two notable limitations to my study. First, the time period for data collection for my Capstone project was limited to only two months in the field and the project did not allow time for team-based coding and interpretation. Second, to truly understand what is typical or common in a teacher's practice, a larger number of observations over a lengthened amount of time would be helpful.

Additionally, the number of potential candidates for the study was limited to graduates of two of the five teacher preparation programs (who were participating in classroom observations for the larger study) due to time and travel constraints. At the time the participants were selected for the study, M-Scan scores for 2017-2018 were not yet available, but 2016-2017 M-Scan scores were available for all teachers. Due to these limitations, the sample was not inclusive of all teachers in the study who could have had high average M-Scan composite scores, but instead those with relatively high composite scores who taught in Virginia as first-year teachers during the 2016-2017 school year.

Significance

The findings of this explanatory case study add to the research literature on mathematics education by using activity theory to examine the planning and enactment of ambitious instruction. Additionally, the qualitative nature of the study leads to a rich description of patterns of novice planning and teaching whereas previous studies of instruction have often emphasized mixed methods or quantitative approaches with a focus on instruction.

It is important that both researchers and practitioners understand how novice teachers plan and enact ambitious instruction because trends in NAEP reports indicate that instructional quality has remained relatively unchanged over the past decade (Kena et al., 2016). On a smaller scale, the larger DAI study is strengthened by my Capstone as the observations and interviews provide an in-depth case study of novices' planning. In addition, the findings have been disseminated at two conferences in 2019: the Curry Research Conference and the VCTM Research Conference.

Chapter Summary

As part of a larger study, my multiple case study explored how novice elementary teachers' planning seems to be associated with their enactment of ambitious mathematics instruction. A focus on ambitious instruction provides a potential solution to my problem of practice because it promotes standards-based mathematics teaching that is responsive to the diverse needs of students. On a broader level, research that is contextualized can potentially address reform-based problems because they "probe the complexity of lived experience, with the aim of shedding light on that complexity rather than furnishing a definitive answer" (de Freitas et al., 2017, p. 162). To fill gaps in literature, I used a variety of methods to generate findings focused on factors associated with novice teachers' planning and enactment of ambitious instruction.

CHAPTER 4: FINDINGS PART I

This qualitative multiple case study examined three elementary teachers' planning and enactment of mathematics instruction. In order to understand factors that seem to be associated with the ways that they plan and enact elements of ambitious mathematics instruction, I conducted interviews and observations, and collected artifacts related to teachers' lesson planning. As shown in Table 4.1, these data sources helped me answer research questions one and two by developing findings and assertions regarding all three teachers' planning and instruction.

In this chapter of findings, I first present descriptions of each teacher and their school settings. Then, using activity theory, I present findings related to factors that seemed to influence teachers' (i.e., subjects) planning and instruction across all three cases (Engeström, Miettinen, & Punamäki, 1999). These findings are further developed into assertions where I describe how mediating factors (i.e., settings, tools, identity, and appropriation) seem to be associated with teachers' planning and enactment of mathematics instruction within each case (Grossman et al., 2000).

Subjects

Ms. Mack, Ms. Cohen, and Ms. Bellamy were white female third-year teachers in their 20s. All three of worked in public schools in the state of Virginia and attempted to teach mathematics according to the expectations set forth by the Virginia Standards

Research Question	Data	Assertion
RQ1: How do novice elementary teachers plan mathematics instruction?	Structured Interview Semi-Structured Interview Lesson Plans	Teachers negotiate school-wide expectations for planning based on their beliefs about teaching mathematics and opportunities to engage in professional development activities
RQ2: What factors seem to influence novice elementary teachers' selection and implementation of mathematics tasks?	Structured Interview Semi-Structured Interview Pre-Observation Prompt Lesson Plans	Interactions with grade-level colleagues influence teachers' appropriation of standards-based mathematics tasks

Table 4.1 Research Questions, Data Sources, and Assertions

Learning. Each teacher was distinct from one another by the grade level they taught and the ways that they planned and enacted mathematics instruction. In general, however, they seemed to have developed beliefs about teaching mathematics from their university coursework. Each teacher seemed to negotiate their beliefs about teaching mathematics based on district-and school-wide expectations as well as their interactions with grade-level colleagues. For the case of Ms. Mack, her beliefs were in conflict with the expectations set forth by her administration and this seemed to have implications for the ways that she planned and enacted her mathematics instruction. In contrast, however, Ms. Cohen and Ms. Bellamy described similar beliefs about teaching mathematics but their approaches were supported by their administration as well as school and district-wide professional development experiences. The following sections will further describe characteristics of the teachers, the settings that they taught in, and their beliefs about teaching mathematics.

Ms. Mack and Halas Elementary School

After completing her Master of Teaching degree from Oriole University, Ms. Mack sought to teach in a middle class public school in a school district near her home in Virginia. In an interview that took place in the 2017-2018 school year, she noted that her school, Halas Elementary School (HES), was not her ideal fit and a further drive than she had wanted (Interview, Mack, April 26 2018). Additionally, she explained that HES, located in a suburb of Virginia, had borderline Title I status without having received federal resources. Furthermore, she noted that her school lacked physical resources for teaching mathematics, such as a school-wide curriculum. All of these factors made Ms. Mack feel unsatisfied. Although HES was not an ideal fit, she chose to stay at HES because she felt it could be more challenging to start over somewhere new. During the 2018-2019 school year, HES was designated as a Title I school which meant that Ms. Mack was receiving support from an interventionist for a select number of students (Interview, Mack, November 6, 2018). She still did not have access to a school-wide curriculum but all teachers at her school received additional support for planning their mathematics instruction from a school-wide instructional coach.

For the third consecutive year, Ms. Mack was teaching first-grade in a general education setting and her mathematics instruction took place daily from 12:15 p.m. to 1:30 p.m. She had a formal mentor in her first year of teaching at HES and in the 2018-2019 school year she had an instructional coach for mathematics who supported the development of her lesson plans. The structure of Ms. Mack's mathematics instruction remained relatively constant over the past three years; she started her class with 30 minutes of centers while she met with individuals or small groups of students to focus on number sense strategies and assessments, followed by a calendar routine, and then the mini lesson for the day. When an interventionist was present in her room, they worked with a small group of three to four students at desks across the room from Ms. Mack. The students who were provided intervention support were selected by the school's administration. The classroom was organized with groups of four to five desks where students faced each other, a small group table, a rug, an easel, and a Smart Board. There were also two desktop computers in Ms. Mack's room, a sink, and a bathroom for students. There were materials present on various surfaces of the classroom; this included counters, the small group table, within students' desks, in cubbies where students store their belongings, and along the edges of floor.

When Ms. Mack described her beliefs about teaching mathematics over the past three years in interviews, she consistently drew upon a methods course that she took at Oriole University. She believed that students learn best from a concrete, representational, and abstract (CRA) approach to teaching mathematics. For example, in an interview she stated:

> You have to start with objects- manipulatives, and that's how you're initially teaching a concept. So, if for addition and subtraction if you're doing "two and three" you're getting two cubes and you're getting three cubes… And I think a lot of time needs to be spent in that portion of it, and then you can go to pictures and then you can go to symbolism equations (Interview, Mack, November 6, 2018).

Ms. Mack didn't feel that what she was expected to teach aligned with her beliefs about teaching mathematics. For example, the district's pacing guide asserted that by the end of the first quarter students were supposed to be able to write addition and subtraction equations. Ms. Mack didn't think that first-grade students should be ready to write equations by the end of the first quarter of the school year. She routinely described this conflict with what ought to be taught as frustrating. Sometimes her beliefs seemed to be in conflict with the pacing set forth by the school district and at other times with school-wide expectations.

McCaskey Elementary School

McCaskey Elementary School (MES) was designated as a Title I school and was located in a rural Virginia school district. MES had one change in leadership since Ms. Cohen and Ms. Bellamy arrived in 2016; the former assistant principal became MES' principal in the 2017-2018 school year. As such, there was no assistant principal during the 2018-2019 school year. One unique characteristic of McCaskey Elementary school was its high percentage of English Language Learners (ELLs). As such, an ELL support staff was assigned to both teachers' classrooms for periods of time during their mathematics lessons. The ELL support staff helped students understand vocabulary words and removed some of them from the classroom for individualized instruction. At the time that I began my study, MES was transitioning to be a one-to-one school where every student would have access to a Chromebook in their classroom to enhance learning experiences. In previous school years, the teachers rotated Chromebooks between classrooms and, therefore, they had prior opportunities to incorporate technology into their classrooms.

Ms. Cohen. Ms. Cohen completed her Master of Teaching degree from Robin University and once stated that she aspired to be a school principal (Interview, Cohen, April 23, 2017). She believed that being an elementary school teacher and teaching in different grade levels would help prepare her for that role. In the 2016-2017 school year, Ms. Cohen taught fourth-grade mathematics and social studies and then she transitioned to teaching general subjects for fifth-grade in the 2017-2018 school year. She taught mathematics daily from 9:00 a.m. to 10:00 a.m. She had a mentor her first year of teaching but has not worked with an instructional coach in mathematics. Rather, she used to regularly meet with her assistant principal for instructional support. Additionally, she had sporadic opportunities throughout each school year to participate in professional development. These opportunities tended to focus on instructional strategies. However, in 2018-2019 she also had an opportunity to visit the Ron Clark Academy with her grade-level team for professional development that focused on the classroom environment.

School-wide professional development opportunities had helped Ms. Cohen value students' working collaboratively for the purposes of staying engaged (Interview, Cohen, April 11, 2018). Her university experiences in mathematics courses seemed to parallel these efforts as she stated that they provided opportunities to see engaging instruction through the eyes of students and, as such, Ms. Cohen also believed that stations serve as opportunities for students to work together. She stated that her beliefs had been well-aligned with the expectations at MES over the past three school years. For example, the school and district emphasized a hands-on learning approach. Hands-on learning at MES meant that kids are out of their seats and collaborating with one another. It came as no surprise that flexible seating was a noticeable feature in Ms. Cohen's classroom.

Colleagues commented that her classroom looked like a lounge; there were two couches present in the room, yoga balls for sitting, and desk arrangements where students faced one another.

In addition to the flexible seating arrangement, Ms. Cohen's classroom also featured a rug, Smart Board, and designated small group table. Her classroom resources and materials for mathematics were in labeled storage bins around the room. The structure of Ms. Cohen's mathematics block seemed to mimic that of her beliefs where students consistently participated in partner activities; sometimes, she facilitated whole-group lessons around the room or with students manipulating objects at their seats.

Ms. Bellamy. Like Ms. Cohen, Ms. Bellamy graduated with her Master of Teaching degree from Robin University in 2016. She had been a fourth-grade teacher for the past three years, and she taught with Ms. Cohen on the same grade-level team their first year. However, Ms. Bellamy tended to collaborate with her ELL teacher in the 2016-2017 school year more so than Ms. Cohen and her other grade-level colleagues. Ms. Bellamy taught mathematics daily from 8:40 a.m. to 9:45 a.m. In her tenure at MES, she had not worked with an instructional coach in mathematics but she had a mentor in her first year of teaching. Although it wasn't until the 2018-2019 school year that MES became a one-to-one school for technology, Ms. Bellamy stated in an earlier interview that she seemed to stray from her colleagues in her approach to teaching mathematics and using technology because she wanted to take risks with integrating different resources into her teaching (Interview, Cohen, March 14, 2018).

Ms. Bellamy noted that her beliefs about teaching mathematics were associated with her mathematics methods course at Robin University. In an interview, she stated that this is because “I was put in the shoes of a student trying to solve a problem and [saw] that I needed more than one strategy at times” (Interview, Bellamy, March 14, 2018). She added that her beliefs about teaching mathematics were supported by her assistant principal who, in her first two years of teaching, was in charge of the mathematics program at her school.

Although Ms. Bellamy’s beliefs about mathematics were supported by her assistant principal, she also stated that she disagreed with an entirely concrete, representational, and abstract approach to teaching mathematics because as kids age they will not always have access to manipulatives (Interview, Bellamy, March 14, 2018). In contrast, Ms. Bellamy frequently detailed the importance of building students number sense in the interviews that took place in the 2018-2019 school year. For this reason, the structure of her mathematics block tended to begin with a daily number sense routine and her lessons often encouraged students to share their strategies for solving mathematical problems. Not only was this approach supported by her administration, but Ms. Bellamy had opportunities to observe number sense routines live in other teachers’ classrooms; in addition, during the 2018-2019 school year she participated in a professional development activity that focused on number sense routines.

Assertion 1: Teachers Negotiate School-Wide Expectations for Lesson Planning Based on Their Beliefs About Teaching Mathematics and Opportunities to Engage in Professional Development Activities

"Every teacher teaches three lessons; the one we plan to teach, the one we actually teach, and the one we wish we had taught" – Anonymous

Through an analysis of teachers' lesson plans, observation of their instruction, and post-lesson interviews, I found that their lesson plans did not always parallel what was taught in the classroom. Instead, what teachers actually taught seemed to differ from their lesson plans. My first research question asks "how do novice elementary teachers plan mathematics instruction?" In all three cases, teachers' conceptions of lesson planning seemed to be influenced by school-wide expectations. The lesson plan template seemed to be a coincide with school-wide expectations but in most cases it differed from what was actually taught in the classroom. In all cases, teachers were required to submit a lesson plan template to a Google Drive, but school-wide expectations differed between HES and MES. In each case, school-wide expectations lent themselves toward different conceptions of lesson planning for the teacher; that is, the lesson plan served as a draft of what was actually taught in the classroom.

School-Wide Planning Expectations at Halas Elementary School

The school-wide expectations for planning mathematics instruction at HES had been developed by the school's administration and were associated with the school's Title I designation. Ms. Mack's first-grade-level team had five teachers and they participated in bi-weekly planning cycles as a grade-level team with the support of an instructional coach. Typically, the teachers planned after school every other Tuesday, sometimes for up to two-and-a-half hours at a time. A math lead, whose role was similar to that of an instructional coach, added details to the lesson plan template pertaining to designated standards and topics to be taught. All teachers and the administration at HES had access to the lesson plans on the school's Google Drive. Then, every other Wednesday, the grade-level team met during the school day with the math lead and a specialist from the district to receive feedback on their lesson plans. Year after year, Ms. Mack had stated that there was no mathematics curriculum at her school and, as such, teachers select resources based on recommendations from a district-wide pacing guide and teachers' varying knowledge of materials.

Ms. Mack stated in an interview that it is common for her grade-level team's lesson plans to be more than ten pages, which she described as lengthy (Interview, Mack, November 6, 2018). HES' lesson plan template included the following topics: standards of learning, essential knowledge and skills, essential vocabulary, guiding questions, common misconceptions, lesson objectives and learning targets, student engagement, supporting resources, materials, checks for understanding, anticipatory sets, delivery process, small groups, stations, assessment, and a closure (See Appendix I for an example of the lesson plan template). HES' approach to planning in the 2018-2019 school year was different than the way that Ms. Mack planned in her first two years of teaching. In the past, teachers submitted lesson plans but with no requirement to plan with fellow grade-level colleagues. This loss of autonomy from the school-wide lesson plan requirements seemed to be frustrating for Ms. Mack. For that reason, she seemed to plan in two phases: once with her grade-level colleagues and again to revise plans that were more aligned with her beliefs about teaching mathematics.

Ms. Mack's Conception of Planning for Mathematics

Drawing from activity theory, I assert that school-wide expectations seem to be associated with Ms. Mack's conception of planning for mathematics instruction. HES' expectations for planning as a grade-level team (i.e. settings) and utilizing a strict lesson plan protocol (i.e., practical tool) seemed to be in conflict with Ms. Mack's beliefs (i.e. identity and conceptual tools) as they related to planning her mathematics instruction (i.e., appropriation). Statements from our interviews will further illustrate Ms. Mack's conception of lesson planning.

Settings. In the first two years of teaching, Ms. Mack tended to plan formally with a grade-level colleague who was directly next door to her classroom. In the 2018-2019 school year, HES' requirement to plan as a grade-level team seemed to be in conflict with how Ms. Mack preferred to plan. In an interview, Ms. Mack described the differences in setting between the 2018-2019 school year and the 2017-2018 school year

> [Last year] it was more of "we're not going to type this out together but let's talk about … what would you do in these subjects? And then pull things out, get things copied, and then kind of write the plans yourself. That works best for me personally … but that's not what we're supposed to do now (Interview, Mack, November 28, 2018).

The 2018-2019 school year's planning expectations did not seem to work for Ms. Mack because she believed that planning with the entire grade-level team forced her to plan for certain activities that may differ from her preferred activities. Regardless of the requirement to plan as a grade-level team, Ms. Mack continued to meet with her colleague next door to informally revise the lesson plans prior to enacting lessons in her classroom. When Ms. Mack and her colleague decided to make changes to the grade-level plan, she did not formally revise the lesson plan template but these decisions provided closer approximations of what she actually taught in the classroom.

Tools. The lesson plan template at HES was developed by the administration and was expected to be submitted in its entirety. In reviewing Ms. Mack's lesson plan template, it was noticeable that this tool supported the enactment of ambitious mathematics instruction because teachers intentionally selected tasks, attended to representations, and pre-developed questions for each lesson in alignment with potential student misconceptions. However, in an interview Ms. Mack seemed to suggest that the process of lesson planning that was required at HES could negatively impact her instruction. As she stated:

> I honestly feel like these plans have changed [what I do]. I feel like I'm not doing what I would necessarily do if it was up to me which is frustrating… I still try and go from [the plans] as much as I can and do the best I can but I just have a general frustration… (Mack, Interview 1, November 28, 2018).

There wa a conflict between the lesson plan expectations and Ms. Mack's preference for lesson planning. Ms. Mack stated that in previous years she did indeed utilize a lesson planning template but the main difference in the 2018-2019 school year seemed to be the loss of autonomy that she had in designing the lesson plan.

Beliefs. On multiple occasions, Ms. Mack described herself as frustrated by HES' current expectations for lesson planning. The school-wide expectations for planning also seemed to make her feel judged because, as she described in an interview, the administration's strict focus on designing lessons was related to what they look for when they conducted classroom observations (Interview, Mack, November 06, 2018). Ms. Mack seemed to believe that the administration was looking for what teachers were doing incorrectly, based on what the lesson plan indicated they ought to be teaching. She seemed to understand that the school-wide expectations were a result of the school's Title I designation; however, these expectations conflicted with her beliefs about planning for mathematics instruction.

Appropriation. It seemed that as a result of the conflict that Ms. Mack had with HES' lesson planning expectations, she negotiated lesson plans based on follow-up conversations with her colleague next door. For example, in a post-observation interview Ms. Mack detailed the way that she planned for the lesson and described modifying the lesson with this colleague:

> My teammate and I looked back at [the plan] and a week of just dominos, it's kind of boring… we had done it yesterday I kind of felt they're getting it. I changed Monday to do a count on bingo because I think it's linked … And then we decided to do a story problem book at the end of the week because I think you can still tie in related facts with that (Interview, Mack, November 28, 2018).

Ms. Mack's decision to change the intended lesson was typical of her descriptions of how she planned for the lessons that I observed. These decisions were not formally developed into alternative lesson plans but they were considered in conversation with her colleague.

School-Wide Planning Expectations at McCaskey Elementary School

The school-wide expectations for planning mathematics instruction at MES were developed by the school's administration and also influenced by the district's priorities. In Ms. Cohen and Ms. Bellamy's first two years of teaching, they were introduced to lesson-planning expectations by the former assistant principal who met with grade-level teams each week in planning sessions. In the 2018-2019 school year, the former assistant principal was serving as the principal of the school and no longer met with grade-level teams for planning purposes. There was no assistant principal at their school in the 2018-2019 school year. The current planning expectations at MES pertained only to literacy where teachers were provided with an instructional coach and required to meet with that person on a weekly basis. Outside of the expectation to upload weekly lesson plans to a Google Drive, teachers at MES did not have any additional lesson planning expectations for mathematics. The lesson planning template that the teachers used during the 2018-2019 school year was consistent with the format that they used in their first two years at MES (See Appendix J for an example of the lesson plan template).

Other expectations that Ms. Cohen and Ms. Bellamy described for planning mathematics instruction in 2018-2019 originated from the district but were interpreted as guidelines. As described by the teachers, the district expected that technology would be incorporated into mathematics instruction in order to familiarize students with standardized test-taking strategies. The district had recently provided Chromebook tablet computers to each student at MES. The district also expected that instruction would be student driven. Student driven, in this case, meant that students were "talking, up out of their seats, practicing math or different problem solving tasks" (Interview, Cohen, November 8, 2018). There were also guidelines on writing language objectives that considered the needs of ELL students. Teachers could flexibly plan for the structure of their math block and there was a curriculum available at the school called Envision but teachers were not required to implement it. Rather, both teachers tended to access a Google Drive that stored resources from across the district and within the school.

Ms. Cohen and Ms. Bellamy's Conceptions of Planning for Mathematics

For Ms. Cohen and Ms. Bellamy, their conceptions of lesson planning seemed to be associated with school-wide expectations and they also considered district expectations. The purpose of completing lesson plans at MES was to help the principal anticipate what to expect when observing instruction but Ms. Cohen and Ms. Bellamy seemed to plan as a way to organize the structure of their mathematics block. For example, their lesson plans featured topics, standards, essential knowledge objectives, language objectives, vocabulary, routines, procedures, and activities.

The teachers' conceptions of lesson planning can be understood using activity theory. Although MES and the school district did not require teachers to plan in a structured environment (i.e., setting), teachers were supported with tools from professional development activities that they considered when structuring their lesson plans (i.e., appropriation). For example, teachers incorporated number sense routines and technology programs that they learned from their professional development experiences. Statements from our interviews will further describe Ms. Cohen's and Ms. Bellamy's conceptions of lesson planning.

Settings. As previously noted, Ms. Cohen and Ms. Bellamy spent their first two years planning in weekly meetings that took place with their assistant principal. In the 2018-2019 school year, Ms. Cohen tended to plan on her own or with her grade-level colleagues. Ms. Bellamy, on the other hand, tended to plan alongside her grade-level colleague who also taught math. This is a decision that Ms. Bellamy had made on her own. She stated:

> I could plan by myself if I wanted to but since there's four of us in fourth-grade and two of the four teach math, naturally we should plan together so we're on the same page…I like flexibility. I don't like to be told exactly what I have to do and when because it doesn't always fit the mold of my class (Interview, Bellamy, January 11, 2018).

Although the setting for planning at MES was flexible, both teachers tended to plan during school hours. In addition, Ms. Cohen would sometimes plan on the weekends. In an interview, Ms. Cohen noted that she didn’t spend a lot of time planning because she liked to have more time to finish what needed to be done around the classroom (Interview, Cohen, November 13, 2018). She has also described this process of lesson planning as a way of brainstorming possible activities to facilitate in the classroom.

Tools. MES’ lesson plan template seemed to be a tool they used with their colleagues that seemed to serve as guidance for their plans that they turned in individually. There was a noticeable difference, however, in the ways that these two teachers incorporated practical tools into their instruction. For example, Ms. Cohen planned for the use of technology in ways that supported standardized test-taking strategies. On the other hand, Ms. Bellamy tended plan for the use of technology in ways that she felt would make activities more engaging for her students.

Ms. Cohen. Ms. Cohen regularly commented that she drew upon her lesson plans from last year when considering what to teach. Then, she considered other resources, such as an assessment resource called Power Test and a website called IXL, to develop practice questions for her students. Her interviews indicated that she used these resources as a way to efficiently teach mathematics concepts. For example, as Ms. Cohen described how she planned for a lesson about rounding decimals:

> I looked at my lesson plan from last year and I actually – I want to be done with up through decimal adding and subtracting by next week. I took my lesson plans from last year and I kind of condensed them. What I used to do is five days last year [and] I've taken it down to three and a half… I condensed the presentation from last year into a simpler version to kind of cut back some time and to kind of push it altogether. So then um, after doing that I decided on a few assessments that I wanted them to do. Like exit tickets or worksheets or online quizzes that would show me their understanding of rounding. I cut out a lot of activities last year that were meaningful but weren't as meaningful. I made sure to choose only the most important (Interview, Cohen, December 3, 2018).

Ms. Cohen's rationale for condensing lesson came from the district's pacing guide. The pacing guide at MES was not a mandate but it suggested what topics to teach at different time points during the school year. She did not tend to stay on pace with this guide nor did her colleagues, rather she has augmented the pacing guide based on what she believed was best for students.

Ms. Bellamy. Ms. Bellamy and her grade-level colleague tended to adhere more closely to the pacing guide. Although Ms. Bellamy had potential lessons that she could use from prior years, she and her grade-level colleague tended to begin planning by first looking for lesson ideas on the Virginia Department of Education (VDOE) website. She stated:

> Me and my teammate plan together. We rely heavily on our county's pacing guide and we try to follow that in terms of the order that we're teaching things. We also use the VDOE to find some good lessons but a lot of it we use from last year or create ourselves. (Interview, Bellamy, December 3, 2018).

Ms. Bellamy tended to rationalize the design of her lessons based on tools provided by the district and state. When creating new lessons, Ms. Bellamy tended to plan for what she described as “fun lessons.” These lessons came from websites such as Pinterest and Teachers Pay Teachers. She typically incorporated the use of technology into her planning because all students had laptops.

Beliefs. The lenient lesson planning expectations at MES provided Ms. Bellamy and Ms. Cohen opportunities to incorporate their beliefs about teaching mathematics into their lesson planning. However, Ms. Cohen had described the lesson plan as a waste of time because she did not believe in planning for a week at a time. This was due to the fact that lessons seemed to change depending on what students understood, and it could be why she tended to see the lesson planning as a brainstorming process. Conversely, Ms. Bellamy favored the current school-wide expectations because she didn’t “like being told exactly what [she had] to do and when because it [didn’t] always fit the mold of [her] class” (Interview, Bellamy, January 10, 2019).

A characteristic of Ms. Cohen and Ms. Bellamy’s conception of planning was that the structure of their lessons also seemed to be influenced by professional development opportunities that coincided with their beliefs about teaching mathematics. For example, the district urged teachers to incorporate number sense routines into daily lessons and, in turn, the teachers had participated in professional development to support number sense routines on multiple occasions. These sessions had been provided by colleagues within their school building, and by faculty at Robin University. Their school district also provided resources based on priorities, like number sense routines, in a shared Google Drive to which all teachers had access.

Appropriation. As previously implied, Ms. Cohen and Ms. Bellamy seemed to appropriate lesson plans in accordance with school-wide expectations and their beliefs about planning. Their lesson plans appeared to detail the structure of their mathematics blocks where conversations with their colleagues or lesson plans from last year served as brainstorming processes for their lessons. With the pacing guide as a frame of reference for developing lessons, Ms. Cohen rationalized her decision making based on what she wanted students to do as well as what the school-wide expectations suggested. For example, in an interview, she stated:

> So, I have a document where I have to put each day what I do. So under each day I always plan an objective, what I want the students to walk away knowing. An "I can" statement. Then per school guidelines we have to have a language objective as well… what kind of language area are they focusing on to help them achieve their learning goal for the day. Then I will briefly outline what my mini lesson looks like. I don't truthfully go into too many detailed plans because I think that becomes very scripted and I kind of just go with where the students take me… (Interview, Cohen, November 13, 2018).

In contrast, Ms. Bellamy and her colleagues tended to plan their lessons based on what the pacing guide and Virginia Department of Education recommend. For example, in an interview she stated:

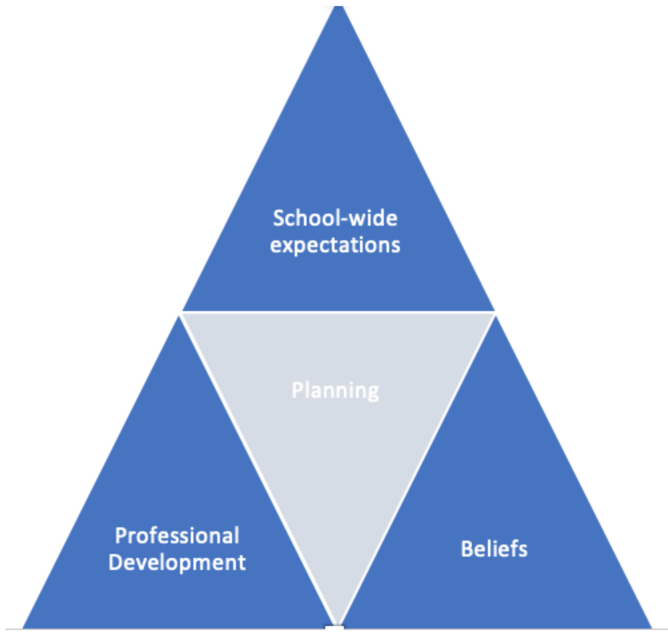
> We get together, sit down, look at what we have already done and kind of see what's next.... But then we think of ways to make it more fun… We figure out “do we need to spend more time on it or are they ready to move on?” Then, if they’re are ready to move on, we look at the next steps on the pacing guide… and go from there with fun activities.

The teachers’ conceptions of lesson planning seemed to be appropriated based on various factors. They seemed to negotiate school-wide expectations based on what they believed ought to be taught to their students. Teachers’ conceptions of what ought to be taught fluctuated between what the district’s pacing guide suggested and what they understand about teaching mathematics from previous experience, as well as what they believed to be best for the students at hand.

Teachers’ Conceptions of Lesson Planning

Assertion one states that teachers negotiate school-wide expectations for lesson planning based on their beliefs about teaching mathematics and opportunities to engage in professional development activities. The school-wide expectations at HES and MES were distinct from one another. Each teacher’s perception of lesson planning expectations appeared to be negotiated based on what teachers believed ought to be taught in the classroom setting. Although Ms. Cohen seemed to believe the lesson planning could be a waste of time, she was generally compliant with the school’s expectations and submitted lesson plans for an entire week at a time. MES was distinct from HES, however, in it's focus on on-going professional development that coincided with the district and schools expectations for teaching mathematics. The professional development activities seemed to coincide with teachers’ beliefs and the school’s expectations for teaching mathematics.

As such, teachers seemed to regularly outline the structure of their lesson in accordance with the professional development activities available to them; for example, teachers at MES incorporated vocabulary and number sense routines into their daily plans. Model 4.1 represents the factors that seemed to be associated with the ways that teachers planned at MES.



Model 4.1 Factors That Seem to Affect Teachers' Lesson Planning

Professional development opportunities seemed to differ at HES, yet, Ms. Mack also drew on these experiences when planning her lessons. One such example was a biweekly professional learning community (PLC) session that took place at her school. These sessions focused on feedback on grade-level lesson plans to ensure compliance with school-wide expectations. Ms. Mack described her PLC as less meaningful than other professional development opportunities in which she been offered. Other professional development sessions at HES tended to take place prior to the start of the school year and teachers could opt in to sessions of their choice for ‘Curriculum Day’. One such example of a professional development session that Ms. Mack participated in was ‘Kathy Richardson’ in the 2016-2017 school year which focused on number sense activities for centers. Ms. Mack had since incorporated these activities, which addressed students’ uses of concrete manipulatives, into her planning and instruction.

I assert that teachers plan in accordance with their school-wide expectations by negotiating these expectations to align with their beliefs about teaching mathematics. Professional development activities seemed to serve as tool that coincided with school-wide expectations and teachers beliefs about planning. It was not always the case that teachers’ these three aspects (e.g. school-wide expectations, professional development activities, and beliefs) were aligned. When that was the case, teachers tended to rely on their own beliefs to develop lesson plans. To be specific, Ms. Mack outwardly disagreed with the school-wide expectations for planning at her school. For that reason, she did not seem to have strong impressions of the professional development activities that her school offered, which were aligned with those expectations. At the same time, she planned to incorporate number sense routines that were a school-wide expectation and that were also featured in a professional development activity at the start of the school year. In other cases, she revised lesson plan expectations based on her beliefs about how mathematics ought to be taught. Ms. Cohen and Ms. Bellamy’s beliefs were aligned with school-wide expectations and they seemed to favor the professional development activities that were provided to them. As such, their lesson plans seemed to comply with school-wide expectations while simultaneously incorporating each teacher’s beliefs about how mathematics ought to be taught.

Assertion 2: Interactions With Grade-Level Colleagues Influence Teachers' Appropriation of Standards-Based Mathematics Tasks

"The most valuable resource that all teachers have is each other. Without collaboration our growth is limited to our own perspectives." - Robert John Meehan

My second research questions asks "what factors seem to influence novice elementary teachers' selection and implementation of mathematics tasks?" Grade-level colleagues seemed to support teachers selection and implementation of tasks by providing them with resources and guidance for their instruction. Each teachers' relationship with their colleagues seemed to differ but in all cases the grade-level colleagues offered practical and conceptual tools to teachers. They also offered ideas and support for implementing mathematics tasks that seemed to align with teachers' beliefs about planning.

Association Between Grade-Level Colleagues and Ms. Mack's Selection of Mathematics Tasks.

The first-grade team at HES was comprised of five general education teachers. These teachers' classrooms were all situated within the same hallway. Two of Ms. Mack's grade-level colleagues were directly near her room; one of her colleagues was next door and the other directly across the hallway. When school-wide expectations for planning were more flexible in the 2016-2017 and 2017-2018 school years, Ms. Mack tended to plan with two of the five grade-level partners on a weekly basis. In an interview, Ms. Mack noted that the teachers used this time to compile resources and talk about how they could implement them (Interview, Mack, April 26, 2018). Then, each teacher would write their own lesson plan to submit to the administration. In Ms. Mack's tenure at HES, there was teacher turnover on the first-grade team but she maintained a collaborative relationship with one of these colleagues, Ms. Hicks.

Settings. Ms. Hicks' classroom was situated directly next to Ms. Mack's classroom and in the 2018-2019 school year the two teachers tended to check in with each other on a frequent basis. These check-in conversations focused on revisions to the grade-level teams' lesson plans. Sometimes Ms. Hicks shared resources with Ms. Mack and at other times they discussed ideas for implementation. Ms. Mack noted that she liked to meet with Ms. Hicks because she had been teaching in the field of education longer and their ideas tended to align with one another. The teachers had "similar styles" (Interview, Mack, November 15, 2018).

Beliefs. During the interviews that took place in the 2018-2019 school year, when Ms. Mack was asked to describe what she discussed with Ms. Hicks, she generally noted changes that the two made together. For example, in an interview she stated that her interaction with Ms. Hicks was typically associated with her beliefs about teaching mathematics that she developed at Oriole University. They seem to both believe that students learned best from a CRA approach and, as such, the tasks that the teachers selected seemed be organized in that way.

Tools and appropriation. Although Ms. Mack frequently collaborated with Ms. Hicks, there were occasions when she identified resources or ways of implementing tasks on her own. When designing lessons on her own, she noted using Teachers Pay Teachers, YouTube, and links on the school's pacing guide as resources. She also tended to appropriate her lessons differently than Ms. Hicks based on what she knew to be best for her students. For example, she often conducted her mini lesson for mathematics at the rug in her classroom whereas Ms. Hicks tended to enact her lessons with students working in pairs at their seats.

Association Between Grade-Level Colleagues and Ms. Cohen's Selection of Mathematics Tasks

The fifth-grade team at Halas elementary school had three teachers. Ms. Cohen and her grade-level colleagues taught all general education subjects and their classrooms were situated in the same hall as one another. Ms. Cohen and her colleagues tended to specialize in particular subject areas for planning; she attended science focused meetings on behalf of her grade-level team. The team shared ideas and resources for lesson planning in person or using a shared folder on Google Drive, and each teacher turned in their own set of plans. For this reason, Ms. Cohen seemed to plan with her grade-level partners on an informal basis.

Settings. Regardless of whether or not the fifth-grade team was formally planning together, they tended to check in with one another on a daily basis. She noted that not only were they grade-level colleagues but they were also friends with one another outside of school (Interview, January 15, 2019). Thus, it was common that they would meet to discuss a wide range of topics. On multiple occasions, I observed Ms. Cohen and her grade-level colleagues seated at a table together during their planning and lunch periods. She did tend to prioritize lesson preparation in her planning period however. For example, when describing how she structured her planning period, she stated:

> Usually on Mondays and Tuesdays I hang to myself and plan for the rest of the week … I either make copies, or sometimes I will grade… The three of us have

been teaching for two years together so we are using a lot of the same things from last year. There's not a lot of sitting together and coming up with new things… we will share lesson plans online (Interview, Cohen, December 7, 2018)

Possibly because the planning expectations at MES were flexible, Ms. Cohen seemed to draw on her planning period and interactions with colleagues as needed in developing lesson plans.

Beliefs. The nature of the relationship between Ms. Cohen and her colleagues allowed her to structure her planning time according to what she felt she needed. She chose to consult her colleagues for ideas about task selection and advice for implementation because they had more years of teaching experiences. However, Ms. Cohen most commonly noted in interviews that she tended to consult her colleagues when modifying lesson plans from last year. She was behind her colleagues in pacing; thus, their experiences helped her decide how to implement tasks with her students For example, when Ms. Cohen's grade-level colleagues' were ahead of her pacing for rounding decimals, she asked them what she could consider condensing. Overall, however, Ms. Cohen tended to plan her mathematics lessons individually in the 2018-2019 school year. In an interview she stated that this was because "I either use what I did last year or I take what I did and tweak some things to it for this year's kids" (Interview, Cohen, December 12, 2018).

Tools and appropriation. Ms. Cohen's colleagues helped her conceptualize the implementation of mathematics tasks. In years prior to the 2018-2019 school year, however, she more regularly met with her colleagues to select mathematics tasks. For example, when discussing the rounding decimals activity that she modified from the

2017-2018 school year she stated that it was originally an idea that a colleague gave her. Over the past three school years, the fifth-grade teachers had compiled resources online using MES' school wide Google Drive. Ms. Cohen referred to this resources as "a big sharing bank" (Interview, Cohen, November 13, 2018). The Google Drive stored assessments, activities, and videos that her and her colleagues had previously used or learned about in content focused meetings and professional development activities. When drawing upon mathematics tasks that Ms. Cohen used from the 2017-2018 school year, she described condensing them or revising them into files that could be used on her Smart Board or for students' use on laptops. The purpose of these modifications, as Ms. Cohen noted in an interview, was to make the lessons more meaningful for her students (Interview, Cohen, November 13, 2018). She also mentioned what students would need to know for the state standardized tests when describing her modifications.

Association Between Grade-Level Colleagues and Ms. Bellamy's Selection of Mathematics Tasks

The fourth-grade team at MES is comprised of four general education teachers. Ms. Bellamy's classroom was situated along the same hallway as her grade-level colleagues with one of those teachers directly next door. In years past, Ms. Bellamy taught general subject classes but this 2018-2019 school year she and one other colleague in the fourth-grade taught mathematics. As such, Ms. Bellamy taught two periods of mathematics per day, in addition to teaching literacy to her home room. Ms. Bellamy's team teacher for mathematics, Ms. Miller, had been teaching for six years and the two teachers had also planned together as a team in the past. Although school-wide expectations for planning were more flexible in the 2018-2019 school year at MES, Ms.

Bellamy and Ms. Miller tended to meet on a weekly basis to plan for their mathematics instruction. However, each teacher submitted separate lesson plans.

Settings. Ms. Bellamy and Ms. Miller typically planned with one another each Wednesday for the following week. In contrast to Ms. Cohen, Ms. Bellamy and her team teacher tended to stay on pace with one another and they implemented the same resources. Ms. Bellamy and Ms. Miller planned for their lessons by first looking at the pacing guide and then drawing from the VDOE website. Although they used some of the same resources as last year, the teachers seemed to consider the tasks that were available on the VDOE website first. Ms. Bellamy stated in an interview that this process framed the “skeleton” of what they were going to teach (Interview, Bellamy, December 3, 2018). Then, the teachers considered what vocabulary matched the standards set forth on the pacing guide. They communicated these vocabulary terms to their shared ELL teacher who designed vocabulary lessons to teach in each of the classrooms.

Beliefs. As previously stated, Ms. Bellamy believed that she should plan with Ms. Miller in order to have a thought partner. Ms. Miller had supported Ms. Bellamy with resources for planning year after year. In years prior, however, Ms. Bellamy noted that she had a stronger focus on incorporating technology than other teachers. Once the district provided every classroom with laptops in the 2018-2019 school year, Ms. Bellamy noted that the two also focused on incorporating technology into their instruction. As such, she and her grade-level colleague seemed to develop tasks together that incorporated the use of technology. When describing how she planned for a particular lesson, she stated:

> My teammate and I knew we were going to cover input-output tables but we didn't just want to give them tables on a piece of paper with numbers typed in… We thought " how could we use the computer and get more of an interactive lesson? (Interview, Bellamy, January 11, 2019).

For that lesson, Ms. Bellamy and Ms. Miller found an activity to use on Pinterest that supported students' use of input-output tables on the computer. As she described planning for lessons in our interviews, Ms. Bellamy commonly described how the teachers developed tasks that incorporated technology.

Tools and appropriation. When Ms. Bellamy planned her mathematics lessons, she tended to select tasks from websites like the VDOE, IXL, Pinterest, and Teachers Pay Teachers. These resources tended to provide ideas for integrating technology into instruction. Sometimes, the teachers modified these ideas within a platform called Google Classroom. For example, in the input-output table lesson, Ms. Bellamy asked students to input their solutions on a recording sheet that she developed using Google Documents (see Appendix K for a copy of the computer-based recording sheet). Ms. Bellamy rationalized the use of technology as a way to make mathematics instruction interactive and more fun. For example, when I asked her to describe how she prepared for a lesson that I observed, she stated:

> Those are questions pulled from [the VDOE] so they feel start to feel comfortable with the question stems… Then [Ms. Miller and I] thought of a fun way they can continue practicing these questions… I made puzzles on the computer that would solve a riddle gradually as they answered the questions (Interview, Bellamy, January 11, 2019).

Ms. Bellamy's appropriation of computer-based tasks represented a way to substitute for the use of a worksheet. The same seemed to be true for the design of other activities that she planned for. For example, she described planning for an activity called "Santa Beard" in an interview (Interview, Bellamy, December 3, 2018). In that instance, students solved multiplication problems on a slip of paper. Then, students rolled up each slip of paper and glued it onto template to make a beard. This activity seemed to substitute for solving problems using a worksheet.

Teachers' Selection of Mathematics Tasks

The second assertion states that interactions with grade-level colleagues influence teachers' appropriation of standards-based mathematics tasks. As presented in Table 4.2, each teachers' interactions with their grade-level colleagues were distinct from one another, yet these seemed to influence how each person appropriated their mathematics instruction. As teachers planned, they tended to select and design their lessons based on what they believed to be best for their students. In turn, they drew on interactions with their colleagues for this purpose.

However, this rationalization was not necessarily related to their stated beliefs about teaching mathematics. Ms. Mack believed that mathematics should be taught using a concrete, representational, and abstract approach. This belief aligned with her grade level colleagues, thus, Ms. Mack and Ms. Hicks often made revisions to lesson plans for that purpose. In contrast, Ms. Cohen and Ms. Bellamy described the importance of engaging students in the use of multiple strategies when describing their beliefs. However, they didn't describe planning or interacting with their colleagues in that way.

Teacher	Interaction with Grade-Level Colleagues	Purpose of Interaction	Influence on Teachers' Task Selection	Influence on Teachers' Implementation of Tasks
Ms. Mack	Informally plans with grade-level colleague, Ms. Hicks	Revise grade-level lesson plans, select tasks, share ideas for implementation	Selects tasks that align with a concrete, representation, abstract approach	Appropriates tasks based on what they believe is best for their students
Ms. Cohen	Informally plans with grade-level colleagues	Brainstorming ideas for tasks and advice for implementation	Revises tasks from last year or implements a recommended task from the Google Drive	Appropriates tasks based on what she believes to be meaningful for her students
Ms. Bellamy	Formally plans with grade-level colleague, Ms. Miller	Selecting tasks and planning for implementation	Selects tasks that are engaging and incorporate the use of technology	Appropriates tasks based on what is interactive and fun for students

Table 4.2 Teachers' Interactions With Grade-Level Colleagues and Appropriation of Mathematics Tasks

Ms. Cohen tended to describe how she consulted with her colleagues to revise lesson plans to be more meaningful for students for the state standardized test, but she didn't mention incorporating the use of various strategies when planning. Furthermore, Ms. Bellamy often described the planning for fun and engaging lessons alongside her grade-level colleague.

Teachers' descriptions of the way that they appropriated mathematics tasks supported the notion that teachers planning seems to be influenced by various factors (e.g. school-wide expectations, beliefs, and interactions with colleagues). For this reason, teachers' interactions with grade-level colleagues also seemed to influence their selection of mathematics tasks. Additionally, interactions with grade-level colleagues seemed to coincide with the tasks that teachers selected and the ways that they planned to implement their instruction.

Consequentially, however, teachers did not seem to describe how their lesson plans ultimately aligned with the standards. This is potentially due to the fact that they did not specifically associate standards-based instruction with their beliefs about teaching mathematics or the reasons for interacting with grade-level colleagues. Although Ms. Mack's lesson plans seemed to reflect elements of ambitious instruction (e.g., clearly articulated learning goals, question stems, etc.), she often noted that the tasks she implemented differed from those plans. When she selected new tasks with her grade-level colleague, she noted that she did not formally plan for their implementation and, as such, there was no evidence to suggest that her tasks were standards-aligned. Furthermore, Ms. Cohen and Ms. Bellamy's lesson plans provided scarce detail about how their tasks were associated with standards-based learning goals. Their descriptions and physical artifacts of their lesson plans did not seem to reflect the various elements of ambitious instruction. Rather, Ms. Cohen appropriated tasks based on the types of questions that she believed her students would encounter on the state standardized test. For her part, Ms. Bellamy appropriated tasks based on what she believed was fun and engaging for her students.

Chapter Summary

This chapter of findings described how Ms. Mack, Ms. Cohen, and Ms. Bellamy developed lesson plans and factors that seemed to influence their selection and implementation of mathematics tasks. Teachers seemed to negotiate school-wide expectations for planning based on their beliefs about teaching mathematics and opportunities to engage in professional development activities. Additionally, teachers' interactions with their grade-level colleagues influenced their appropriation of mathematics tasks. Up to this point, it was not understood how the nature of teachers' planning seemed to be associated with the enactment of ambitious mathematics instruction.

To understand the ways that teachers' lesson planning seemed to be associated with elements of ambitious instruction, I observed teachers' mathematics lessons and analyzed field notes alongside lesson plans and interview data. Chapter five will present findings that describe how factors associated with teachers' planning could be associated with their implementation of instruction. Using process coding, I determined that the structure of teachers' mathematics lessons provided students an opportunity to engage in mathematical discourse. Additionally, teachers appropriation of mathematics tasks tended to incorporate the use of multiple representations.

CHAPTER 5: FINDINGS PART II

This chapter focuses on teachers' enactment of mathematics instruction. In order to understand the factors that seemed to be associated with novice teachers' enactment of ambitious instruction, I video recorded mathematics lessons, conducted interviews, and collected artifacts related to teachers' lesson plans. Next, I developed field notes that coincided with each observation and I scored each mathematics lesson video using M-Scan. Using a set of process codes that focused on teaching practices, I identified patterns involving teachers' planning and instruction. As presented in Table 5.1, these data sources helped me answer my third research question by developing assertions within and across cases.

Research Question	**Data**	**Assertion(s)**
How is novice elementary teachers' planning associated with ambitious mathematics instruction?	Structured Interview Semi-Structured Interview Pre-Observation Prompt Lesson Plans Observation Field Notes	Teachers enact number sense routines according to school-wide expectations, professional development activities, and their own beliefs Teachers' enactment of mathematics lessons provide students opportunities to use multiple representations and engage in mathematical discourse

Table 5.1 Research Question, Data Sources, and Assertions

In the first part of this chapter, I focus on each teacher's appropriation of a number sense routine. Number sense routines are a component of mathematics lessons that typically incorporate conversations around students' use of strategies for solving problems in order to build procedural fluency (Parrish, 2014). Across all three cases, number sense routines seemed to be associated with teachers' enactment of ambitious mathematics instruction. As such, I present a vignette of a number sense routine as it was enacted in each teacher's classroom. Next, I use activity theory to describe how each teacher's practical tools and beliefs seemed to be associated with their planning and enactment of number sense routines in their classroom.

In the second part of my findings, I further describe how teachers enacted ambitious instruction by focusing on each teacher's use of representations and mathematical discourse and I describe how these teaching practices were not only present in their enactment of number sense routines but other components of their mathematics lessons as well. Finally, I more broadly describe how teachers seemed to draw on school-wide expectations, professional development activities, and their own beliefs in their enactment of ambitious mathematics instruction.

Assertion 3: Teachers Enact Number Sense Routines According to School-Wide Expectations, Professional Development Activities, and Their Own Beliefs

"Learning math is more like taking a meandering nature walk than like climbing a ladder of one-topic-after another. Kids need to wander around the concepts, notice things, wonder about them, and enjoy the journey" – Denise Gaskins

Through an analysis of lesson plans and video-recorded observations, I found that each teacher organized their mathematics instruction in different ways. Additionally, all three teachers enacted components of their lessons differently. Table 5.2 shows the structure of each teacher's mathematics block for the lessons that I observed. The table presents the components of each teacher's mathematics block in the order that they enacted them.

Structure of the Mathematics Lesson	Ms. Mack	Ms. Cohen	Ms. Bellamy
Number Sense Routine	2 2 2	1 1 1	1 1 1
Whole Group Instruction	3 3 3	2 2 2	2 2 2
Small Group Instruction	1 1 1	3	
Independent Work	4		
Partner Work	4 4	3	3 3 3

Table 5.2 The Structure and Components of Teachers' Mathematics Block
Note. Each color represents a different mathematics lesson and each number represents the order in which the component was incorporated into the lesson. Blue represents the first lesson observation, orange represents the second lesson observation, and brown represents the third lesson observation.

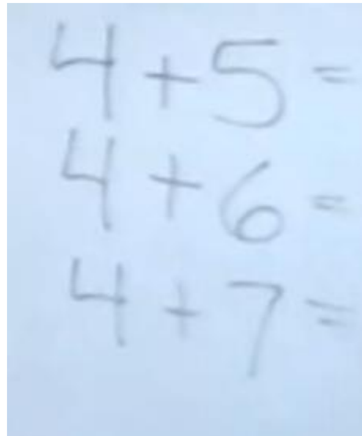
While Ms. Mack began each of her lessons with students working in small groups and centers, Ms. Cohen and Ms. Bellamy began their lessons with a number sense routine. Ms. Mack also included a number sense routine later in each lesson. The teachers commonly referred to these routines as "number talks," or opportunities for students to discuss strategies for solving mathematical problems. Across cases, the number sense routines took place prior to whole group instruction. Additionally, each teacher seemed to facilitate number sense routines in ways that supported the use of multiple representations and a mathematical discourse community.

For the case of Ms. Mack, number talks were a school-wide expectation, although she first learned about these types of number sense routines in her teacher preparation program. Her number talks were pre-developed and followed the school's pacing guide for mathematics. On the other hand, Ms. Cohen and Ms. Mack noted that number sense routines were strongly recommended by the school and district. For this reason, McCaskey Elementary School (MES) provided its teachers with professional development activities that focused on number sense routines throughout the 2018-2019 school year. The two teachers selected their own number sense routines to enact in their classroom.

The next section of findings focuses on each teacher's enactment of a number sense routine. These vignettes illustrate the distinct ways that teachers presented a number sense routine in their classroom. Next, I analyze each vignette to explain how teachers' enactment seemed to be associated with their practical tools and beliefs. Finally, I describe how these factors seemed to be associated with how each teacher appropriated number sense routines in accordance with school-wide expectations.

Association Between Ms. Mack's Planning and Enactment of Number Sense Routines

The first-grade students are seated at the rug with their bodies facing the board in the classroom. Some students are wiggling and talking to one another until Ms. Mack says "when I open my eyes we are going to be ready." When Ms. Mack opens her eyes, students are much quieter and most students are looking at her. She then writes these three equations on the board:



Ms. Mack asks "What do you see?"

Student One says "Four plus five is nine."

Ms. Mack looks at student one and asks "How do you know that?"

Student One says he knew that four plus five was nine so five and four was nine.

Ms. Mack clarifies this and says "So you are telling me you know five plus four is nine so four plus five has to be nine?"

Student one says "Yeah."

Ms. Mack praises the student and says "Really awesome thinking!"

Ms. Mack asks the same question again, "What do you see?"

Student Two comes to the board and says "I know six is one more than five so the next one is two more than five so this one has to be 11"

Ms. Mack repeats what she believed the student said and asks "Is that what you did?"

Student Two says "Yes."

Ms. Mack praises the student and says "Woah that is some good thinking!"

The teacher then asks students if anyone else has anything that they notice about the numbers. After students respond, the number talk concludes at just over four minutes. The class then transitions to a whole group lesson on related facts.

Ms. Mack used a specific type of number sense routine in her mathematics lessons called a number talk. Number talks specifically call for students to use mental math when solving problems. The focus of each number talk that I observed in Ms. Mack's classroom differed, but students were always situated at the rug for the class' number sense routine. Regardless of the task, the teacher's and students' actions were predictable; during number talks, students typically shared their strategies for solving problems as Ms. Mack facilitated the discussion with questions like "What do you see?" and "What do you notice?"

Tools. Ms. Mack's number talks were enacted on a daily basis with students all together at the rug. In every interview, she described the structure of her mathematics block in the same way; in each mathematics lesson students engaged in a number talk prior to beginning the whole group lessons. Her number talks were pre-selected and embedded within the school's pacing guide document that was linked to the lesson plan template. The pacing guide noted particular tasks that teachers should present to their students and it listed corresponding page numbers that teachers could reference from the book *Number Talks: Whole Number Computation, Grades K-5* (Parrish, 2014).

Sometimes the number talks called for the use of tools and at other times students shared their strategies for solving problems using only mental math. During two of my three observations, Ms. Mack's students used rekenreks, a mathematics manipulative that supports number sense development, as a tool during the number talk component of her lesson. I was able to confirm from her lesson plans that teachers were indeed directed to use this tool by the number talk guidance document. Additionally, she noted in an interview that students typically used ten frames, rekenreks, or representations of equations in the daily number talks (Mack, Interview, November 6, 2018).

Beliefs. The guidance document that HES provides to teachers for enacting number talks calls for its implementing them three to five times per week. However, Ms. Mack believed they should be incorporated every day so that students knew what to expect. As such, number talks were a daily routine in her classroom. She first learned about number talks in her elementary mathematics methods course at Oriole University. In that course, she had an opportunity to practice using rekenreks when the professor modeled a number sense activity for the class. In an interview, she noted that the course was where she "picked up on" the use of tools and how to facilitate a number sense routine (Mack, Interview, November 28, 2018). More specifically, Ms. Mack learned to incorporate question stems like "What do you see?" that provided students the opportunity to connect what they already knew about numbers to the task at hand. Ms. Mack also attributed the way that she facilitated number talks to another first-grade teacher in the district that she had the opportunity to observe in her second year of teaching.

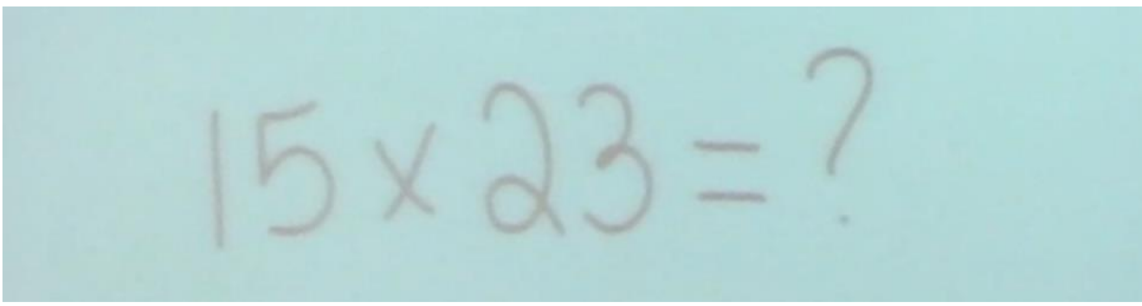
Appropriation. Ms. Mack's facilitation of number sense routines exemplified ambitious instruction; in each of the number talk activities, students had opportunities to use multiple representations and engage in mathematical discourse. In examining the structure of her entire mathematics block, however, it became evident that the number talks were sometimes not aligned with the rest of the lesson. This was due to the fact that the number talks were sometimes a precursor for the lesson at hand but often times they were focused on concepts with which the students were not necessarily familiar. This was a conflict that Ms. Mack also addressed in her interviews. In the vignette, student one happened to describe his strategy that related to the day's lesson topic, related facts. In the other two lessons that I observed, however, students' strategies for problem solving were not connected to the rest of the mathematics lesson.

In spite of this, Ms. Mack attempted to stay on pace with the number talk guidance document. This document suggested that number talks should span a time frame of five to ten minutes. The vignette depicts a number talk that was less than five minutes but typically her number talks were approximately five minutes. When her principal previously observed her enact a number talk in the 2017-2018 school year, they asked her not to praise students. But it was evident in my observations that she did so. For example, in the vignette she stated "really awesome thinking!" When students got an answer incorrect, however, she tended to ask students to describe or show their thinking to elicit student understanding. In an interview, she noted that her questions to students were intentional, based on prior feedback from her principal (Interview, Mack, November 15, 2018). At the same time, she did not agree that she should avoid praising students in her instruction.

Despite the conflict with her administrator's feedback, Ms. Mack's appropriation of number sense routines seemed to demonstrate ambitious instruction. She mostly complied with school-wide expectations for enacting number talks while seeming to enact teaching practices that aligned with her beliefs about teaching number sense routines. These beliefs were developed within her teacher preparation program and from opportunities to engage in professional development activities.

Association Between Ms. Cohen's Planning and Enactment of Number Sense Routines

The fifth-grade students are seated in groups of four to five. They are facing one another and their eyes are on the board at the front of the classroom. Students are focused on an equation that Ms. Cohen wrote on the board:



Ms. Cohen asks students to quietly think about a solution to the problem on the board. After 30 seconds, she asks students to begin sharing their strategies and solutions to the problem on the board. The "recorder" for each group is writing down their groupmates' strategies. The discourse remains steady throughout. After approximately three minutes, Ms. Cohen counts down from 20 and the class shares their strategies for solving the problem.

> *Ms. Cohen asks "Does anybody have a strategy they would like to share with us?"*
>
> *Student One describes to Ms. Cohen how they used the standard algorithm to solve the problem and she writes down the steps on the board.*
>
> *Ms. Cohen asks "Does anyone agree with this strategy?"*

Students raise their hands around the room signaling that they agree.

Ms. Cohen asks "What is a different strategy?"

Student Two describes how they used the standard algorithm for division to check their answer and the teacher writes the steps on the board.

Ms. Cohen continues to ask students for different strategies.

Student Three describes how they used the box method to solve the problem and then student four describes how they used partial products.

Student Four says, "10 times 20 is 200 and 5 times 3 is 15"

Realizing that the student is finished sharing their strategy, Ms. Cohen asks "Does anyone know why this doesn't work?"

Student Five states that the answer does not equal 345.

Ms. Cohen replies "Think about the box method right here. Are these all the same multiplication problems?"

The class replies no

Ms. Cohen follows up and states "I can't just stop here… this is hard to think about in your head but try and think about the box method."

The number sense routine ends and the teacher asks students to high-five their group as they transition to different seats in the classroom. After students give a high-five to one another, Ms. Cohen notes "glows and grows" based on how groups worked together and presented. The class then transitions to whole-group instruction after 12 minutes.

Tools. Ms. Cohen's number sense routines were enacted on a daily basis at the beginning of each mathematics lesson. She noted in the structure of her lesson plan documents that she would conduct a number sense routine but she didn’t formally plan for them. She also noted in an interview that she tended to think of each number sense routine on the day of the lesson (Interview, Mack, November 13, 2018). Typically, the number sense routines focused on review of a topic that students had already learned and sometimes they were connected to the whole group lesson topic. For example, during my second observation, students identified the pattern in a sequence of decimals during the number sense routine and then the lesson focused on comparing and ordering decimals. Students tended to sit together in groups during the number sense routines. Sometimes students were able to use whiteboards when discussing their strategies with their group but at other times they solved and discussed problems using mental math. This was evident from the number talks that I observed.

Beliefs. In accordance with Ms. Cohen’s beliefs about teaching mathematics that she developed in her courses at Robin University, she tended to focus on students’ use of multiple strategies when she facilitated number sense routines. In addition to this belief, she also viewed number sense routines as an opportunity for students to focus on communication skills, She stated “I shouldn’t say I don’t care about the math they are doing… but I think the communication is most valuable in that situation” (Interview, Cohen, November 13, 2018). This focus on communication was evident in lessons that I observed. In the vignette above, she spent time after the number sense routine to praise communication within groups and to provide ideas for next steps. Prior to my final observation, Ms. Cohen also had an opportunity to visit another school for professional development. During the school visit, she saw students leading the conversation at the front of the classroom when they were sharing their work. As a result, she had just begun to incorporate a similar approach in her classroom. I was able to observe this in my final visit when a student described their strategy at the board and then the class gave the student feedback on tone of voice, and whether they agreed with the strategy used.

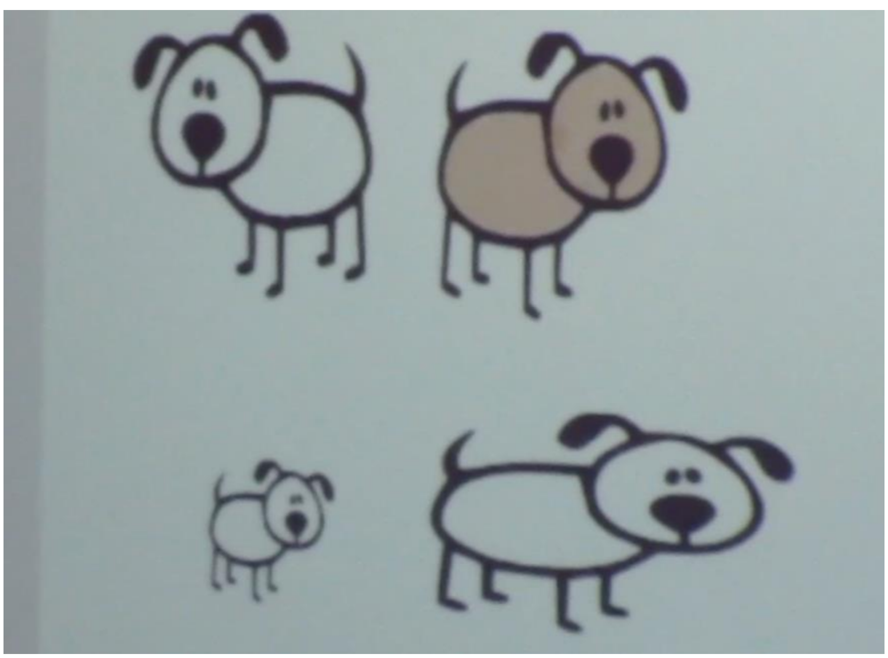
Appropriation. Ms. Cohen's approach to facilitating number sense routines provided students opportunities to use multiple representations and participate in a mathematical discourse community. Her vignette illuminated ambitious instruction. Students had opportunities to collaborate with one another and student discourse was focused on the topic at hand. Student discourse was evident during all of the mathematics lessons that I observed. Whiteboards seemed to support students in tracking their groupmates different strategies and provided evidence that students used a range of strategies when solving problems.

However, Ms. Cohen tended to plan for number sense routines in the moment and it seemed to negatively impact the coherence of her lesson. In two of the three post-lesson interviews, Ms. Cohen noted that she developed the tasks for her number sense routines on the spot. In one interview she stated "I don't necessarily always think about the problems. It's kind of what comes to mind" (Interview, Cohen, November 13, 2018). In another, she said, "I just chose that one on the fly" (Interview, Cohen, December 7, 2018). In these instances, the number sense routines were not directly connected to the whole group instruction. Furthermore, Ms. Cohen once noted a goal to keep number sense routines to no more than ten minutes but this was not the case in the lessons that I observed. In contrast, however, when she described intentionally using a number sense task that involved patterns, it was pre-developed on her board, it connected to the lesson for the day, and it was under ten minutes.

Although Ms. Cohen's number sense routines didn't necessarily transfer to the lesson at hand, her enactment of them demonstrated ambitious instruction. She incorporated daily number sense routines not only because it was recommended by the school and district; the incorporation of number sense routines into her instruction aligned with her beliefs related to students' use of multiple strategies. She also developed conceptions of the number sense routines from professional development activities that provided ideas for facilitating and pacing.

The Association Between Ms. Bellamy's Planning and Enactment of Number Sense Routines

The fourth-grade students are seated at the rug in the front of the room or in seats around it's perimeter. Students are silent and facing the board as Ms. Bellamy presents a picture of four dogs on the board:



Ms. Bellamy states that today's number sense activity is called "Which One Doesn't Belong?" The class discusses what it means when you don't belong and the teacher *relates the concept to a book that they read in their guidance class. The teacher asks students to silently think about which of the four dogs doesn't belong and why. She knows when students are ready to share because they each put a thumbs-up to their chest. After approximately 30 seconds, Ms. Bellamy asks students to talk with a partner about which one doesn't belong. Then, the class discusses which one doesn't belong. Ultimately, the class justifies each dog as one that doesn't belong. After the discussion Ms. Bellamy states:*

> *"I really love this game because there's not one right answer and in math sometimes we are really worried about getting that one right answer. It's more about the strategy, which one doesn't belong and why. That "why" is what I care about most … this time it's going to be with numbers."*

Ms. Bellamy draws a square on the board with four boxes and writes one number in each box: 6, 7, 8, and 24. The class repeats the same process that they did with the last task; students individually think about which one doesn't belong and why and then they share their ideas with a partner. Ms. Bellamy calls each number aloud and asks if they chose it as the one that doesn't belong and why. There are hands raised for all numbers except the number six and the class discusses why each of the other three don't belong.

Ms. Bellamy asks "Who would like to share why they think 24 doesn't belong?

Student One says "Because all of the other numbers have one digit."

Ms. Bellamy asks for another reason why 24 doesn't belong.

Student Two states "Because it's bigger than the other three."

Ms. Bellamy repeats this with all of the numbers and asks the class about the number seven.

Student Three says "The six, eight, and 24 are all even"

Student Four says "Eight plus eight plus eight is 24 and six plus six plus six plus six is 24. That doesn't work with seven."

Ms. Bellamy asks, "What is this called?" and writes out what student four said on the board.

Student Five says "Repeated addition."

Ms. Bellamy's class continues to discuss which number doesn't belong and then they transition from the rug to their desks and the class begins whole group instruction after approximately 15 minutes.

Tools. Ms. Bellamy enacted her number sense routines with all of the students situated at the rug or in seats surrounding it. She noted that she doesn't implement number sense routines on a daily basis. She formally planned for the number sense routines in her classroom based on whether she believed they fit with the lesson. During all three of my observations, Ms. Bellamy facilitated a number sense routine and the materials were prepared for presentation on her board at the start of the lesson. She noted that, in general, the structure of her mathematics block varied. However, in my observations of her instruction the structure was the same and rather the type of activity differed. For example, in facilitating number sense routines, Ms. Bellamy used the "which one doesn't belong" strategy, a pattern building activity, and a computation task.

Ms. Bellamy commonly referenced professional development activities when describing how she learned to enact number sense routines. Prior to our first interview in the 2018-2019 school year, she had engaged in a professional development session that provided her with conceptions for implementation (Interview, Bellamy, December 03, 2018). The tasks that she used in her number sense routine were selected and planned for on her own or with her grade-level colleague.

Beliefs. Number sense routines aligned with Ms. Bellamy's beliefs about teaching. She believed that students should have opportunities to use multiple strategies because, as she stated, "A lot of the time the things that are taught are simply memorized rather than understood" (Interview, Bellamy, October 31, 2018). Ms. Bellamy's vignette depicts her beliefs as they related to students' abilities to represent their understanding. In all three of my observations of her mathematics lessons, she provided students opportunities to explain their thinking using various strategies.

Ms. Bellamy noted in an interview that she did not like to use number sense routines in her classroom on a daily basis because it could get boring having the same structure (Interview, Bellamy, December 3, 2018). As such, she tended to incorporate various types of activities that provided students opportunities to share their strategies and explain their reasoning. The professional development activities at MES seemed to support Ms. Bellamy's beliefs about teaching mathematics and her school's expectations provided her the flexibility to enact number sense routines as she wanted.

Appropriation. In alignment with her beliefs about teaching mathematics, Ms. Bellamy's enactment of number sense routines provided students opportunities to incorporate the use of multiple strategies. Additionally, she encouraged students to explain their thinking and engage in mathematical discourse. The ways that Ms. Bellamy planned for number sense routines tended to be positively associated with the degree of coherence of her lessons. In two of the three lessons that I observed, students had opportunities to transfer their understanding and use of representations to the whole group lesson. Additionally, she noted that number sense routines were meant to be ten minutes or less. As such, in two of the three lessons that I observed, the number sense routine fit this time block. Perhaps this is due to the fact that she planned for the number sense routines that she enacted.

Ms. Bellamy's number sense routines provided evidence of how she enacted elements of ambitious instruction. Students used more than one representation when engaging in activities and they were encouraged to participate in a mathematical discourse community. Number sense routines aligned with Ms. Bellamy's beliefs about teaching mathematics and professional development activities provided her with ideas for implementation. Furthermore, her appropriation of number sense routines seemed to comply with school-wide expectations for teaching mathematics.

Teachers' Enactment of Number Sense Routines

My third assertion states that teachers' enactment of number sense routines is shaped by school-wide expectations, professional development activities, and their own beliefs. In accordance with school-wide expectations, Ms. Mack enacted number talks. Although the expectations for sequencing number talks differed from her preferred approach to planning, these activities supported a concrete, representational, and abstract approach to teaching. Furthermore, Ms. Mack's teacher preparation program helped her conceptualize how to enact number talks in ways that supported the use of multiple representations and mathematical discourse.

Although Ms. Cohen and Ms. Bellamy taught at the same school, their enactment of number sense routines differed. Whereas Ms. Cohen loosely planned for the number sense routines that she enacted, Ms. Bellamy prepared materials in advance in her classroom. Regardless, these approaches to facilitation seemed to align with the teachers' beliefs about planning for mathematics instruction and they also provided students opportunities to incorporate the use of multiple strategies. Professional development activities helped both teachers conceptualize the enactment of number sense routines. As such, the activities in their classrooms supported students' use of multiple representations and mathematical discourse. There was no evidence to suggest that one teacher's approach to planning and enacting number sense routines was superior to the others; however, Ms. Bellamy's number sense routines were more often connected to the rest of the lesson. This meant that students had more opportunities to incorporate the use of multiple representations in different settings to build a deeper understanding of mathematical concepts.

To better understand the ways that teachers' enactment of ambitious mathematics instruction varied within and across cases, I analyzed the teachers lesson plans and field notes from my observations of their lessons as well as interview data. As such, I considered the extent to which various factors seemed to be present in teachers' enactment of mathematics lessons. My final assertion focuses on teachers' use of multiple representations and a mathematical discourse community because teachers tended to enact these practices most consistently in my observations. Rather than the lesson plans themselves, teachers enactment of ambitious instruction seemed to be influenced by various factors. As such, I focus on the ways in which school-wide expectations, professional development activities, and teachers beliefs seemed to be associated with their enactment of ambitious instruction.

Assertion 4: Teachers' Enactment of Mathematics Lessons Provide Students the Opportunity to Use Multiple Representations and Engage in Mathematical Discourse

"Excellence in education is when we do everything we can to make sure they become everything that they can"-Dr. Carol Ann Tomlinson

When teachers enact ambitious mathematics instruction, they are providing students the opportunity-to-learn by implementing teaching practices that foster students' deep conceptual understanding of standards-based mathematics concepts (Newmann & Associates, 1996). Ms. Mack, Ms. Cohen, and Ms. Bellamy enacted ambitious instruction on a frequent basis during my observations. Table 5.3 displays each teacher's average composite M-Scan scores for the three mathematics lessons that I observed for my study.

M-Scan Score	**Ms. Mack**	**Ms. Cohen**	**Ms. Bellamy**
Observation #1	3.667	3.889	4.444
Observation #2	3.556	3.444	4.000
Observation #3	3.667	4.222	3.778
Average Composite M-Scan Score	3.630	3.852	4.074

Table 5.3 M-Scan Scores for the 2018-2019 School Year

The teachers' M-Scan scores were fairly consistent across all three observation cycles. Their average composite scores are relatively high in comparison to other novice teachers in the larger study. To better understand the ways that teachers enacted ambitious mathematics instruction across the entire lessons that I observed, I focused on patterns of teacher and student actions. My findings describe the ways that teachers appropriated elements of ambitious instruction mathematics instruction by focusing on their enactment of teaching practices.

During each classroom observation, my field notes illuminated the use of representations and the presence of mathematical discourse. Representations and discourse are central to the enactment of ambitious mathematics instruction. For reference, Table 5.4 displays each teacher's M-Scan scores for all nine dimensions across all three observations of teachers' lessons. I illustrate this point in a discussion of each

Domains of M-Scan	***Dimensions of M-Scan***	**Ms. Mack**			**Ms. Cohen**			**Ms. Bellamy**		
		O1	**O2**	**O3**	**O1**	**O2**	**O3**	**O1**	**O2**	**O3**
Tasks	*Cognitive Demand*	3	4	4	4	3	5	5	4	3
	Problem Solving	3	3	3	4	3	3	5	5	3
	Connections & Applications	4	3	3	3	3	4	3	4	4
Representations	***Use of Representations***	**4**	**4**	**4**	**4**	**5**	**4**	**5**	**5**	**5**
	Students' Use of Mathematical Tools	3	4	3	1	1	4	1	1	1
Discourse	***Mathematical Discourse Community***	**4**	**4**	**4**	**4**	**3**	**5**	**5**	**4**	**3**
	Explanation and Justification	3	2	3	4	3	4	2	2	4
Coherence	*Structure of the Lesson*	4	4	4	5	5	5	4	6	6
	Mathematical Accuracy	5	4	5	6	5	5	7	5	5

Table 5.4 Observation Scores for the Nine Dimensions of M-Scan
* Note. O = Observation

teacher's enactment of number sense routines as well as other components of their mathematics lessons. Furthermore, I assert that teachers' enactment of ambitious mathematics instruction does not seem to be strongly associated with the ways that they planned their mathematics lessons. Rather, my findings will suggest that teachers are influenced by several factors as they enact their mathematics lessons.

Use of Representations and Mathematical Discourse Community in Ms. Mack's Classroom

During each of my observations of Ms. Mack's mathematics lessons, students translated between representations. For example, her number sense routine vignette characterizes students translating between symbolic and verbal representations of equations. During my observations, students also used tools (i.e., physical representations) to count and express equations and number sentences. Sometimes, students translated between more than two types of representations. For example, in a lesson that focused on related facts, students used dominos to represent numbers (i.e., visual representations) and write equations (i.e., symbolic representations) with their partners. The partners then translated the equations using related facts (i.e., verbal representations). These types of representations seemed to be common in Ms. Mack's lessons that focused on addition and subtraction standards for first grade.

As students solved tasks that incorporated the use of multiple representations, they often engaged in a mathematical discourse community. During whole group instruction, Ms. Mack tended to initiate discourse in the classroom. In these components of her lesson, she noted in her pre-observation prompt that she would "lead discussion." For two of the three lessons that I observed, she also facilitated activities where students were working in pairs and expected to engage in discourse with one another. For example, during the related facts lesson, students determined what the related facts were and then took turns writing equations on the whiteboards.

Ms. Mack's lessons included the use of representations and mathematical discourse in almost all components of her lessons that I observed. However, it was noticeable that behavior management impacted the extent to which she and her students engaged in ambitious instruction. In her vignette, there were times during her transitions and enactment of her lessons where instruction stopped in order to focus on students' behaviors in the classroom. Sometimes students were out of their seats or talking off task. This potentially limited the extent to which students could engage in the lesson.

Use of Representations and Mathematical Discourse Community in Ms. Cohen's Classroom

As previously noted, Ms. Cohen dedicated the majority of her time to whole group instruction during the lessons that I observed. During whole group instruction, the teacher and students translated between representations. Typically, students translated between visual and verbal representations of mathematical concepts and at times they used symbolic representations. For example, in my second observation of her instruction, the class was focused on ordering decimals. As Ms. Cohen modeled a strategy for ordering decimals, she showed students how the place value would help determine which decimals were larger than one another. She would line up the place values and then she would read the digits out loud, e.g., "zero tenths and eight tenths." Then, a student came up to the board and ordered the decimals 0.002, 0.202, 0.020, and 0.222. The student stated the decimals as she moved them using a touch screen feature on the board. In this same lesson, the class practiced comparing decimals using symbols of greater than, less than, or equal to using the strategy that was previously modeled on the board for ordering decimals.

Although Ms. Cohen never mentioned that she explicitly incorporated the use of multiple representations into her lessons, she noted the use of multiple strategies in describing what students would do during the lesson in pre-observation prompts. Furthermore, she did not strategically implement discourse into her lessons but students typically had opportunities to share their strategies for solving problems with one another. During whole group instruction, Ms. Cohen tended to initiate the conversation by posing questions to the class. When students had opportunities to engage with partners or students in their group, their discussion was focused on the topic at hand. As seen in the number sense routine vignette, Ms. Cohen typically debriefed with her class about students' use of mathematical discourse. The debriefs potentially supported students' steady engagement in partner and whole-group discussions.

Use of Representations and Mathematical Discourse Community in Ms. Bellamy's Classroom

As was evident in the structure of Ms. Bellamy's mathematics lessons, she regularly incorporated partner activities. During this time, students worked together on activities that incorporated the use of multiple representations. For example, in the first lesson that I observed, students were sharing the solutions to multiplication problems using visual and symbolic representations. Using a strategy called "the box method," students set up three-digit by two-digit multiplication problems and then solved them using partial product equations. In the other two lessons that I observed, Ms. Bellamy's students engaged with visual representations of patterns and described each pattern using a number sentence. Ms. Bellamy tended to model the representations for students in her whole group lesson that focused on strategies that supported the use of multiple representations. At times, she also asked students to explain their representations. In a pattern lesson, for example, partners explained how they found the pattern by filling in a form on the computer.

Students' engagement with the use of multiple representations seemed to provide opportunities for students to participate in mathematical discourse. In each of Ms. Bellamy's partner activities, she asked students to discuss certain topics. For example, in the partial products lesson, she asked students to share their strategies for solving 444 times 44 with one another. Next, when the class came together to share their strategies and solutions, she placed two students' strategies side-by-side and asked students, "So I am not saying these are right or wrong, I want to hear what you were thinking?" This question provided students an opportunity to explain their strategies and to see that there was more than one approach to solving a problem; both of the students' solutions were correct for the question that Ms. Bellamy asked but they set up their boxes differently. During her lessons she often asked why and how questions to facilitate discourse.

Although Ms. Bellamy typically asked students to share their thinking in her mathematics lessons, she often asked procedural questions that had known correct answers. For example, when teaching a lesson about patterns she said, "Does everyone see that we start with two diamonds here?... then what do we do?... what do I need to put next?" These types of questions called for student input but they limited the extent to which students could share their mathematical thinking and engage in mathematical discourse.

The Association Between Teachers' Planning and Enactment of Ambitious Mathematics Instruction

My fourth assertion states that teachers' enactment of mathematics lessons provide students opportunities to use multiple representations and engage in mathematical discourse. In every lesson that I observed for each teacher, there was evidence of the use of multiple representations. Ms. Mack's case was unique in that students sometimes used up to three representations when solving problems. And in Ms. Bellamy's case, students sometimes had opportunities to explain how they translated between representations. Both of these teachers had pre-planned approaches that supported students' use of representations at times, but Ms. Cohen did not. For example, sometimes Ms. Bellamy developed computer-based materials for her lessons that specifically called for students to represent content in multiple ways.

None of the teachers seemed to formally plan in ways that supported a mathematical discourse community. In my interviews with teachers, they sometimes indirectly described planning in ways that reflected the use of multiple representations and mathematical discourse. Overall, however, teachers' lesson plan artifacts and their interview statements about their planning seemed to have little direct connection to their enactment of ambitious mathematics instruction. Rather, teachers' enactment of ambitious mathematics instruction seemed to be influenced by other factors. In the following sections, I will broadly describe how teachers seemed to enact ambitious instruction by examining how they drew on (a) their beliefs about teaching mathematics, and messages about mathematics instruction associated with (b) school-wide expectations, and (c) professional development activities. As suitable, I will also note when these factors seemed to be associated with teachers' planning .

Ms. Mack's Enactment of Ambitious Mathematics Instruction

School-wide expectations. Ms. Mack implemented her mathematics instruction in accordance with the school-wide expectations at HES. For example, there was a school expectation that components of mathematics instruction ought to be enacted in a specific order. The components of her mathematics lessons were always planned for and taught in the same order. However, these components of her mathematics block seemed disconnected at times and this seemed to influence the overall coherence of her lessons.

In accordance with school-wide expectations, certain components of her mathematics lessons tended to be representative of ambitious instruction. For example, Ms. Mack was expected to use number talks into her daily lessons and during these activities students tended to incorporate the use of multiple representations and engage in mathematical discourse. Additionally, Ms. Mack was expected to incorporate centers based on a resource called "Kathy Richardson" at the beginning of her lessons. During centers, students had opportunities to engage in discourse with their peers. Number talks and centers were pre-planned activities that were developed within the school's pacing guide. As such, Ms. Mack did not formally plan for these activities but she did enact them in accordance with HES' expectations.

Professional development activities. The various professional development activities that Ms. Mack attended in the summer seemed to be associated with her enactment of ambitious mathematics instruction. Topics of the professional development activities that she engaged in aligned with school-wide expectations (e.g. number talks and Kathy Richardson). The Kathy Richardson professional development offered suggestions for developing center activities. Both of the professional development activities focused on building students conceptual understanding of number concepts. As such, the topics seemed to support students' opportunities to represent content in multiple ways and engage in mathematical discourse. More specifically, in my observations of the Kathy Richardson centers, students were mostly situated at their desks in groups of four to five and they focused on number concepts. Students used manipulatives to represent numbers and they wrote number sentences and solutions to various problems on a worksheet and they were consistently talking about mathematics in their groups.

Beliefs. As previously noted, Ms. Mack believed that mathematics ought to be taught using a concrete, representational, and abstract approach. She developed this belief about teaching mathematics during her teacher preparation program. Ms. Mack often noted how this belief conflicted with her school's expectations. Although she and her grade-level team submitted formal lesson plans together, she tended to select new tasks for her whole group instruction in accordance with her beliefs about teaching mathematics.

The tasks that she implemented in her classroom during whole group instruction offered students opportunities to use multiple representations during each of my observations. However, Ms. Mack did not formally plan for the use of multiple representations. The tasks that she selected based on her beliefs seemed to lend themselves to the use of multiple representations. The extent to which students engaged in mathematical discourse seemed to vary during her whole group instruction. Sometimes, students were asked to answer questions with a partner and at other times

Ms. Mack facilitated the classroom conversation. For example, in a lesson on related facts, students completed a turn-and-talk and answered questions on a whiteboard that they shared with their partner.

Summary. Various factors seemed to be associated with the ways in which Ms. Mack's enacted ambitious mathematics instruction. She seemed to appropriate ideas about ambitious instruction from school-wide expectations and professional development activities, and she drew on her beliefs about teaching more than the formal lesson plans that she developed with her grade-level colleagues. Although she often noted her frustration with school-wide expectations, such as the order in which she was directed to teach her lessons, certain components of these expectations seemed to support students' use of multiple representations and mathematical discourse. Furthermore, her beliefs about teaching mathematics seemed aligned with the mathematics tasks that she selected and enacted in her classroom. She often noted that her beliefs and the tasks she selected were supported by the grade-level colleague next door However, it seemed that she only appropriated these factors in the enactment of ambitious instruction at a surface level. When she described her lessons our interviews, Ms. Mack did not seem to be purposefully embedding the use of multiple representations or discourse into the lesson at hand. Additionally, there was little evidence to suggest that the tasks she selected on her own were standards-aligned.

Ms. Cohen and Ms. Bellamy's Enactment of Ambitious Mathematics Instruction

School-wide expectations. Ms. Cohen and Ms. Bellamy seemed to enact their mathematics instruction in accordance with the recommendations of their MES and their district. Specifically, the teachers were encouraged to follow the order of the pacing guide, enact number sense routines, and incorporate the use of technology. The teachers' enactment of number sense routines seemed to exemplify ambitious instruction because they provided students opportunities to use multiple representations and engage in mathematical discourse. Ms. Cohen noted that she planned for the number sense routines in the moment but Ms. Bellamy seemed to formally plan for these activities. Ms. Bellamy's approach seemed to result in coherent lessons. This meant that the topic of her number sense routine connected to the topics of other parts of her lessons.

Both teachers noted that they followed the order of the pacing guide and I saw the use of technology in their instruction. As previously noted, in my third observation of Ms. Bellamy's instruction students were sharing solutions to problems in various ways during a computer-enhanced activity. For the most part, however, there seemed to be little association between these recommendations in the pacing guide and teachers' enactment of ambitious instruction.

Professional development activities. Ms. Cohen and Ms. Bellamy's experiences in professional development activities seemed to be associated with their enactment of ambitious instruction. The school's recommendation for enacting number sense routines was supported by professional development and it seemed to support the teachers' conceptualization of the activities. In an interview, Ms. Bellamy noted that she learned how to facilitate her selected number sense routine during a recent professional development activity (Interview, Bellamy, December 17, 2018). Her number sense routine vignette is representative of this professional development activity. Further, as previously noted, her number sense routines provided students opportunities to share their representations of mathematical problems and engage in discourse and were formally planned.

Furthermore, professors from Robin University provided professional development sessions that Ms. Cohen and Ms. Bellamy attended. Ms. Cohen noted in an interview that these professional development sessions focused on the use of strategies for enacting mathematics instruction. This seemed to be evident in the ways that teachers facilitated discourse in their classrooms. For example, in my observations of Ms. Cohen's instruction the mathematical discourse remained constant throughout entire lessons. In my first observation, Ms. Cohen debriefed an activity with students by focusing on their "glows and grows" related to discourse. In my final observation, she allowed students to provide feedback to one another based on the way that they presented a solution to the whole class.

Beliefs. Ms. Cohen and Ms. Bellamy seem to draw on their beliefs about teaching mathematics in the enactment of their mathematics lessons. Their experiences at Robin University supported a belief that mathematics lessons ought to encourage students to use multiple strategies. In my observations, the teachers encouraged students to use various strategies when solving problems which often implied the use of multiple representations. Sometimes, however, students were simply using different strategies to represent content. For example, in one of Ms. Bellamy's lessons, students were able to use different strategies for solving a multiplication problem but they seemed to all use similar pictorial representations in their solutions.

Furthermore, teachers selected tasks based on other beliefs about teaching mathematics. Ms. Cohen's instruction seemed to be oriented toward what students would need to master for standardized test purposes. Ms. Bellamy's instruction seemed to be oriented toward what was fun and engaging for students. Teachers seemed to spend the most time planning based on these beliefs. However, these beliefs did not seem to be associated with the enactment of ambitious instruction. There was little evidence to suggest that the tasks that teachers selected for whole group instruction were standards-aligned. Furthermore, the teachers tended to ask rhetorical questions when modeling instruction and this seemed to influence the extent to which students could engage in mathematical discourse. Ms. Cohen described her questioning as on-the-spot thinking and that it had always been her teaching style (Interview, Cohen, November 13, 2018).

Summary. Various factors seemed to be associated with the ways in which Ms. Cohen and Ms. Bellamy enacted ambitious mathematics instruction, including MES' recommendations about teaching mathematics, professional development activities, and their own beliefs about teaching mathematics. Teachers' beliefs seemed to be in agreement with the school's recommendations and professional development activities seemed to support students' use of representations and the mathematical discourse community that was present in their classrooms.

The strategies that Ms. Cohen and Ms. Bellamy learned in their professional development activities seemed to support students' efforts to share their mathematical thinking throughout my observations. However, they did not seem to intentionally plan the types of questions that they asked students in ways that seemed to be associated with ambitious mathematics instruction. Rather, Ms. Mack and Ms. Cohen tended to think of questions on the spot during their whole group instruction. In terms of uses of representations that were present in my observations, Ms. Bellamy once noted in an interview that she was purposeful in the way that she modeled representations for students (Interview, Bellamy, December 3, 2018). And although there seemed to be evidence in her observations that she formally planned for the tasks she enacted, neither she nor Ms. Cohen seemed to use tasks that were standards-aligned. Furthermore, the teachers did not seem to be purposefully embed particular instructional strategies in their lessons. As such, similar to Ms. Mack, it seemed that they drew on various factors in enacting ambitious instruction at a surface level. Despite the fact that teachers' beliefs seemed to be aligned with their school's recommendations and their professional development activities, the teachers did not discuss their appropriation of ideas about teaching mathematics based on these factors in our interviews.

Chapter Summary

In this chapter of findings, I presented two assertions that focused on teachers' enactment of ambitious mathematics instruction. All three teachers facilitated number sense routines and, generally speaking, their mathematics lessons were implemented according to school-wide expectations, professional development activities, and own unique set of beliefs. When I examined teachers' mathematics instruction more closely, it was evident that they incorporated the use of representations and mathematical discourse. When examining observations of their instruction and their interview data, it did not seem that the teachers' purposefully planned by considering standards-based teaching practices. Rather they drew on various factors in enacting their lessons. As such, I argue that despite the fact that these novice teachers were capable of enacting ambitious mathematics instruction, they do not seem to be intentional in their use of standards-based practices. This conclusion has implications for future research. In my final chapter, I will further discuss my research questions and assertions in relation to my problem of practice and prior literature.

CHAPTER 6: DISCUSSION AND IMPLICATIONS

My problem of practice states that schools do not always meet the needs of students. Teachers' enactment of ambitious mathematics instruction provides students opportunity-to-learn by allowing them to engage in standards-based tasks that promote deep conceptual understanding of mathematical ideas (Newmann & Associates, 1996). All teachers are responsible for providing students opportunity-to-learn. However, novice teachers arguably face the greatest challenges in enacting ambitious mathematics instruction as they are navigating various factors that can affect their instruction while still developing their skill set. There is a dearth of literature that has focused on how novice teachers plan and enact mathematics instruction in ways that promote conceptual understanding. In light of this, I argue that the examination of novice teachers' instruction is essential to understanding how teacher preparation programs, school districts, and schools can better support teachers in providing students the opportunity to engage in deep learning. Rather than focusing solely on teachers' instruction, I designed my study to consider various factors that seemed to be associated with both novices' planning and their enactment of ambitious mathematics instruction.

My findings suggest that novice teachers are capable of enacting ambitious mathematics instruction. Furthermore, I explained how various factors (e.g., beliefs, school-wide expectations, and interactions with grade-level colleagues) seemed to influence their planning and enactment. At the same time, the novice teachers in my study seemed to lack a sound vision of planning and enacting standards-based instruction associated with providing students opportunity-to-learn (Newmann & Associates, 1996).

From large-scale studies, such as *The Opportunity Myth* (TNTP, 2018), which have focused on the enactment of standards-based instruction, it is evident that providing students opportunity-to-learn is a nation-wide dilemma. In order to understand the problem of practice at a micro-level in a way that could have practical implications for teacher preparation programs, districts, and schools alike, I deliberately focused on a set of novice elementary teachers who tended to enact ambitious instruction and who were part of a larger study. Furthermore, I attended to both their planning and implementation of mathematics instruction in order to understand how various factors seemed to influence their enactment of ambitious teaching practices. By selecting teachers who scored relatively high on the M-Scan (Berry et al., 2017) instrument that measures teaching practices, I was able to focus on novice teachers' capabilities while also describing the challenges these teachers seemed to face in negotiating various factors that potentially affected their planning and enactment of mathematics instruction.

The purpose of my study was to examine the factors that affect three novice teachers' planning and enactment of ambitious mathematics instruction. My research study was embedded within a larger longitudinal mixed-methods study called the Development of Ambitious Instruction study. I developed a multiple case study design to supplement findings from the larger study by identifying patterns of planning and instruction that seemed to be associated with teachers' enactment of ambitious mathematics instruction.

My specific research questions were:

RQ1: How do novice elementary teachers plan mathematics instruction?

RQ2: What factors seem to influence novice elementary teachers' selection and implementation of mathematics tasks?

RQ3: How is novice elementary teachers' planning associated with ambitious instruction?

I conducted interviews and observations of teachers' instruction in three cycles of data collection. Additionally, teachers submitted pre-observation prompts that focused on the ways that they prepared for a given lesson and they also shared copies of their lesson plans. Using three cycles of coding (i.e. deductive, inductive, and pattern codes), I developed four assertions related to teachers planning and enactment of ambitious mathematics instruction. In the following sections of this chapter, I describe each of the assertions in relation to prior literature and I identify implications for practice. Then, I describe recommendations for future research as well as limitations to my study.

How Novice Teachers Planned Mathematics Instruction

Related to my first research question, assertion one states that teachers negotiate school-wide expectations for planning based on their beliefs about teaching mathematics and opportunities to engage in professional development activities. Ms. Mack, Ms. Cohen, and Ms. Bellamy all developed beliefs about teaching mathematics based in part on their experiences in teacher education programs. Similar to the cases presented in Grossman et al. (2000) study, these novice teachers drew upon these beliefs when designing their lessons. Each teacher in my study addressed various factors as part of their lesson planning. For example, teachers tended to describe the ways that school-wide expectations and opportunities to engage in professional development activities were associated with their lesson planning.

In the case of Ms. Mack, there was an apparent tension between school-wide expectations for planning and her preferred approach. Teachers at Halas Elementary School (HES) were expected to plan and teach in structured formats. In support of the expectations set forth at HES, the school provided professional development support for teachers that focused on components of the mathematics block which were non-negotiables for planning. These professional development activities included number talks and center activities. School-wide expectations and professional development activities sometimes conflicted with Ms. Mack's preferred approach to lesson planning that she developed in her teacher preparation program. Specifically, the way that her grade-level team developed lessons did not seem to align with the concrete, representational, and abstract approach that she learned at Oriole University. Grade-level planning was a requirement at Ms. Mack's school. As a result, she felt pressure to implement the plans that were developed with her grade-level team and she often noted frustrations with this approach. She commonly spent additional time planning in order to revise lesson plans to incorporate tasks that aligned with her desired approach to teaching mathematics.

In contrast, the planning expectations at Ms. Cohen's and Ms. Bellamy's school were more flexible. The teachers developed similar beliefs in their teacher preparation programs at Robin University; specifically, they believed that mathematics instruction should support the use of multiple strategies. As such, the teachers did not describe tension between McCaskey Elementary School's (MES) expectations for planning and their own approaches. The teachers incorporated their school's recommendations for planning which included the inclusion of number sense routines and technology. These recommendations seemed to promote these teachers' beliefs and they also aligned with professional development activities that the school and district offered.

Implication 1: Novice Teachers Could Benefit From School-Wide Expectations and Professional Development Activities That are Aligned With a Standards-Based Vision for Teaching Mathematics

Findings from *The Opportunity Myth* (TNTP, 2018), a nation-wide study which featured over 1,000 classroom observations, suggest that the alignment among school-wide expectations, professional development activities, and teachers' beliefs seem to be key to providing students opportunity-to-learn. However, the authors noted that this alignment necessitates a strong vision for instruction. In the case of Ms. Mack, the tension between her school's expectations and her beliefs about planning seemed to pose obstacles in her efforts to enact ambitious mathematics instruction. On the other hand, there was less tension between teachers' beliefs and school-wide expectations at MES. Similarly, however, these teachers seemed to face obstacles in enacting ambitious mathematics instruction. This is potentially because MES lacked a standards-based vision for teaching mathematics. As such, Ms. Cohen and Ms. Bellamy seemed to plan their instruction based on their own personal beliefs (i.e. the use of multiple strategies) but a focus on the use of multiple strategies did not guarantee that their instruction was standards-aligned.

Prior research indicates that the extent to which teachers implement ambitious mathematics instruction seems to be associated with the ways that they purposefully plan, particularly when they select standards-aligned tasks that provide students the opportunity to problem-solve in real-world contexts (Smith, Steele, & Raith, 2017). Studies have shown that teachers are capable of enacting ambitious instruction (Boaler & Staples, 2008; Boston & Wilhelm, 2017). It is also understood, however, that novice teachers could benefit from support in developing standards-aligned instruction (Amador & Lamberg, 2013; Chizik & Chizik, 2018; Kazemi, Franke, & Lampert, 2009). Standards-aligned expectations set forth by schools and districts for planning as well as opportunities to engage in streamlined professional development activities could support teachers in enacting elements of ambitious mathematics instruction (Boston & Madler, 2017).

When school-wide expectations conflict with teachers' beliefs about planning lessons, this can pose an obstacle that they must navigate in order to enact ambitious mathematics instruction. In each of the cases presented in my study, teachers' beliefs took precedent when planning lessons. This finding also has implications for both schools and teacher preparation programs. If novices are likely to draw upon the beliefs that they have developed in their teacher preparation programs, as was the case in my study, then it is vital that their experiences are aligned with standards-based teaching practices because they will likely negotiate their planning practice according to what they believe is best for students. Notably, however, teacher preparation programs face challenges of their own with providing pre-service teachers adequate opportunities to engage in approximations of practice that are transferable to their classroom settings as teachers of record (Grossman et al., 2009).

On the other hand, if teachers' beliefs conflict with school-wide expectations then the result tension could create an additional obstacle for novices who are still developing their skill set (Feiman-Nemser, 2001). Professional development activities could help resolve such a conflict by supporting schools and teachers with frameworks for developing ambitious mathematics instruction. Across all three cases in my study, professional development activities supported teachers in meeting school and district expectations.

Ms. Cohen and Ms. Bellamy had a unique opportunity to participate in professional development activities that were implemented by their former university. However, the teachers described these activities as being more focused on strategies for teaching rather than what Grossman et. al (2009) label as a core set of practices. These core practices (e.g., leading classroom discussion) aim to connect "theoretical knowledge and teachers' practical work in classrooms" (p. 276). And although Ms. Mack identified a tension between her beliefs and her school's expectations, she drew upon previous professional development activities when designing her lessons. She often strayed from her school's expectations in designing her whole group instruction to align with her beliefs about teaching mathematics. Ms. Mack's emphasis on a concrete, representational, and abstract approach to teaching mathematics was a principle that she learned in her teacher preparation program and that was supported by standards documents such as the CCSSM (2010). However, the professional development activities and school-wide expectations at HEM seemed to focus more on designing lessons for standardized assessment performance rather than for authentic learning experiences (Newmann & Associates, 1996). Studies suggest that alignment between a standards-based vision for teaching, school-wide expectations, and professional development activities can support both teacher and student performance (Newmann & Associates, 1996; TNTP, 2018).

How Novice Teachers Selected and Implemented Mathematics Tasks

Related to my second research question, assertion two states that teachers' interactions with grade-level colleagues seemed to influence their appropriation of standards-based mathematics tasks. Collaborative planning seems to support teachers in planning and implementing ambitious mathematics instruction (Boston & Madler, 2017; Stein & Smith, 2011). Grade-level colleagues' collective interpretation of the standards seems to be associated with the tasks that teachers select and use in their planning (Amador, 2016; Boaler & Staples, 2008). As such, teachers' collaboration with grade-level colleagues could be associated with the tasks that teachers select and enact in their mathematics classrooms.

The novice teachers in my study seemed to describe differences in the ways that they interacted with grade-level colleagues. In the case of Ms. Mack, she collaborated with her colleagues to plan for her mathematics instruction in two phases. First, she met with her grade-level team to develop lesson plans. Then, she met with her grade-level colleague next door to revise the lesson plans in accordance with their shared beliefs about planning. The dual-phased approach to lesson planning was time-consuming for Ms. Mack. She noted that she was fearful of what her administration would think if she wasn't enacting the grade-level team's plans. However, the interactions that she had with her grade-level colleague in the classroom next door seemed to help her resolve this tension because they both shared similar beliefs about teaching mathematics. Having the support of her grade-level colleague seemed to substantiate her decisions to veer from HES' mandated lesson plans.

Whereas the expectations at MES were less structured, Ms. Cohen and Ms. Bellamy interacted with their grade-level colleagues based on their preferred approaches to planning. Ms. Cohen tended to confer with her grade-level colleagues on an as needed basis for lesson suggestions. She noted that this was because she tended to reuse most of her lessons from previous years. When Ms. Cohen wanted ideas for synthesizing lessons she would meet informally with her grade-level colleagues. Ms. Cohen felt that her planning time was best spent each day by preparing materials or grading. In contrast, Ms. Bellamy formally met with her team teacher on a weekly basis to plan lessons. She felt that the collaboration with her colleague would ensure that students were receiving the same instruction regardless of what classroom they were in. School-wide expectations at MES tended to be flexible. As such, Ms. Cohen and Ms. Bellamy's interactions with grade-level colleagues seemed to support their decisions with regard to the selection and implementation of mathematics tasks.

Implication 2: Interactions With Grade-Level Colleagues Could Influence the Extent to Which Novice Teachers Select and Implement Standards-Based Mathematics Tasks

My findings suggest that there seems to be a "too loose" and "too strict" approach to lesson planning expectations. Neither approach increased the likelihood that teachers were planning or enacting ambitious mathematics instruction. In the case of Ms. Mack, she tended to collaborate with one specific colleague as a way to navigate around strict school-wide expectations. This approach was time consuming and frustrating for her. On the other hand, Ms. Cohen and Ms. Bellamy planned with colleagues based on their preferences. At neither school did these expectations ensure that teachers were prepared to enact ambitious mathematics instruction. Furthermore, when teachers were asked to describe their interactions with colleagues, their conversations did not seem to be focused on ambitious mathematics instruction (e.g., teaching practices).

Teachers’ interactions with colleagues seemed to affect the tasks that they selected and implemented in their classrooms. However, none of the teachers described their purpose for planning in relation to a school-wide vision or broader purpose. This finding seemed evident in the ways that they described planning with their grade-level colleagues as well as the lack of cognitive depth that the tasks offered students. When teachers described what students would do during a mathematics lesson, they tended to note surface-level duties. For example, in teachers’ pre-observation prompts they often noted that students would work with a partner or complete an activity sheet. When considering the Standards for Mathematical Practices (SMPs), or student practices aligned with the standards, the teachers did not describe planning or collaborating with colleagues in ways that promoted standards-based instruction.

The tasks that teachers select and implement in their classrooms seem to be associated with students’ opportunity-to-learn (Stein, Grover, & Henningsen, 1996). When lesson planning lacks a focus on standards-based teaching, then it is less likely that teachers will enact ambitious mathematics instruction (Stein & Smith, 2011). In all three cases, teachers developed learning goals and selected mathematics tasks by first considering the school’s pacing guide. Despite the fact that each teacher noted that the pacing guides defined what standards ought to be taught, there was no evidence in my study that suggested the teachers were purposefully selecting tasks to align with the standards. This is consistent with other research that describes the ways in which teachers “lower the bar” by selecting tasks that are not aligned with state standards (Stein, Grover & Henningsen, 1996; TNTP, 2018).

In Ms. Mack’s case, her grade-level team collaboratively selected mathematics tasks but then she sometimes selected new tasks for her students. When she selected different tasks to enact in her classroom, she did not formally plan for them. Rather she simply conferred with her grade-level colleague. Their purpose for selecting different tasks was to align them with a concrete-representational-abstract approach. Those conversations with her colleagues seemed to provide opportunities for students to engage in conceptually-focused mathematics tasks but they did not guarantee that the tasks were standards-aligned. Rather, the tasks were aligned with a specific approach to teaching mathematics that may not have been based on standards. Had the tasks been more strategically aligned to the standards, the teacher may have referenced the ways that students would use tools, or how they would make sense of problems, as examples (i.e., more direct reference to SMPs).

In the case of Ms. Cohen, she examined the pacing guide to see what standards ought to be taught but her lesson plans only reflected the extent to which she selected tasks. There was no evidence to suggest that she was purposefully selecting tasks that were standards-aligned. Of the three cases, Ms. Bellamy’s descriptions of planning with her grade-level colleague seemed to align most closely with standards-based instruction. Ms. Bellamy and her grade-level colleague considered the school’s pacing guide and its suggestion for tasks. They also commonly reviewed the state department of education’s website to select tasks. However, she and her grade-level colleague tended to design lessons for their students that, in their view, were "fun." This meant that they were revising tasks. Sometimes they revised tasks to incorporate technology and at other times they reconceptualized tasks based on ideas they found on websites such as Pinterest or Teachers Pay Teachers. However, the teachers processes did not seem to suggest that they were planning standards-aligned instruction. For example, rather than considering how students would model their understanding of comparing decimals, Ms. Cohen implemented a lesson that was previously developed by her and her colleagues which emphasized the ways students would answer decimal questions appropriately on the computer; in that lesson, the use of technology ensured that students would efficiently select responses to mathematical problems on a standardized assessment.

Teachers' interactions with grade-level colleagues seemed to influence the tasks that they selected and implemented in their classrooms. If mathematics tasks are to be implemented in ways that support students' opportunity-to-learn, it is helpful to teachers to be able to collaborate with colleagues in ways that promote standards-aligned instruction. There must be norms set for planning that align with a standards-based vision for teaching mathematics (TNTP, 2018). This is consistent with Boaler and Staples (2008) study; in that study, the authors noted that teachers' planning seemed to benefit from a standards-aligned vision for teaching mathematics at their school. The authors' findings suggested that teachers seemed more likely to select high-cognitive demand mathematics tasks in comparison to a different school where similar support was not available. Although Ms. Mack's school-wide lesson plan template seemed most closely aligned with a standards-based approach to teaching mathematics, there was no evidence to suggest that she and her grade-level colleagues planned together in that way. The same held true for Ms. Cohen and Ms. Bellamy's interactions with their grade-level colleagues. It seemed that the teachers in my study lacked an understanding and shared vision of ambitious instruction which could have influenced the ways that they planned. Newmann & Associates (1996) describe a thriving professional community as one where "teachers assume that all students can learn at relatively high rates" (p. 181). However, the ways that teachers collaborated with colleagues and altered tasks in my study seemed to suggest that they did not understand the importance of planning for instruction or that they did not know how to engage in ambitious mathematics instruction.

How Novice Teachers Enacted Mathematics Instruction

Enacting standards-based mathematics teaching practices can provide students opportunity-to-learn by focusing instruction on the types of tasks, representations, and discourse that "promote their ability to make sense of mathematical ideas and reason mathematically" (NCTM, 2014, p. 5). In relation to my third research question, my third assertion states that teachers enacted number sense routines according to school-wide expectations, professional development activities, and their own set of beliefs. In other words, this assertion suggests that the extent to which teachers enacted ambitious mathematics instruction was dependent upon school-wide expectations, opportunities to engage in professional development activities, and their beliefs about teaching mathematics was not primarily depending on their planning.

Novices in my study did not conceptualize their mathematics lessons based on a set of teaching practices. Rather, it was common across all three cases that the scope of teachers' planning and instruction was narrowed to what they believed ought to be taught in accordance with school-wide expectations. Professional development activities offered ways for teachers to interpret and enact the school's expectations. Teachers commonly interpreted their school's pacing guides as what students would need to know for district or state assessments. As such, this is what they believed students ought to be taught and they instructed according to those topics. Their daily lessons seemed to focus on one topic after another rather than teaching an entire standards-driven unit. Researchers associate this interpretation of pacing guides with a procedural approach to teaching mathematics (Amador & Lamberg, 2013). When teachers plan for mastery of procedures, they are less likely to enact ambitious practices.

My fourth assertion states that teachers' enactment of mathematics lessons provides students opportunities to use multiple representations and engage in mathematical discourse. Teachers tended to enact those teaching practices most often in my observations. In the cases of Ms. Cohen and Ms. Bellamy, they believed that mathematics lessons ought to support students' use of multiple strategies. This belief seemed to enhance their lessons because students often had opportunities to use multiple representations. Sometimes, however, it translated into students sharing different procedures in the lesson, rather than rich mathematical discourse around a topic. For Ms. Mack, she tended to structure certain components of the lesson more procedurally. For example, her small group lessons focused on counting procedures so that students mastered counting to 110 for their district assessment. On the other hand, her whole group instruction often provided students opportunities to use multiple representations and this seemed to be associated with her beliefs about teaching mathematics.

Across all three cases, teachers implemented number sense routines that aligned with school-wide expectations for teaching mathematics and incorporated ambitious teaching practices. During the number sense routines, students tended to share their thinking about a mathematical problem in various ways. Students explained their representations and sometimes the class as a whole or the teacher translated between representations to show how students' strategies related to one another. For this reason, it seemed that various factors seemed to be associated with teachers' enactment of ambitious instruction, rather than lesson planning itself.

Implication 3: When School-Wide Supports and Professional Development Activities Focus on Ambitious Teaching Practices, Novices Will Likely Enact Them

Teachers' ability to foster a mathematical discourse community is important to the enactment of ambitious instruction because the success of a lesson depends on whether or not students feel comfortable sharing their understandings and misunderstandings as a means of problem solving (Sharma, 2015). In each of the classrooms that I observed, students seemed comfortable sharing their mathematical thinking. For that reason, it seems imperative that students have opportunities to engage in cognitively-challenging mathematics tasks in order to build deep understanding of mathematics concepts. As reiterated by TNTP's (2018) findings that focused on students ability to engage in standards-based instruction, the authors stated that "when students did have the chance to work on content that was appropriate for their grade, they rose to the occasion more often than not" (p. 05). For this reason, I argue that school-wide efforts and professional development activities could better support teachers in enacting ambitious teaching practices.

For Ms. Cohen and Ms. Bellamy who had more autonomy in designing their lessons, there seemed to be missed opportunities to enact ambitious instruction because they were relying on their own beliefs and knowledge when they implemented mathematics lessons which were not necessarily standards-driven. In contrast, the strict expectations in Ms. Mack's school seemed to work against efforts to enact ambitious instruction because of the pressure that Ms. Mack felt to comply with policies rather than what she understood to be best for students. The teaching and learning principle that was a focus of my research suggests that teaching practices ought to be at the center of both the planning and enactment phases of instruction (NCTM, 2014; Smith, Steele, & Raith, 2017). When specifically probed in interviews, however, teachers did not indicate that they strategically enacted standards-based tasks, discourse, or the use of multiple representations. Considering that various factors seemed to influence the ways that the teachers enacted ambitious instruction, a stronger focus on actual teaching practices in the expectations set forth by schools could benefit novices' implementation of mathematics lessons.

This third implication argues that a common vision of teaching and learning could benefit teachers' enactment of ambitious mathematics instruction. It implies that novices could benefit from a school-wide vision that is centered upon a core set of teaching practices that relate theory and practice. Newmann and Associates' (1996) large-scale study that focused on 24 restructured K-12 schools over a span of three years suggested an association between school structures and student performance. Using case studies, the authors described how various school structures provided a sense of purpose for both teachers and students alike by focusing not only on standards of learning but also standards of pedagogy (e.g., the construction of knowledge, disciplined inquiry, and value beyond school). These various pedagogies were infused within visions of teaching and learning as well as professional development activities.

Prior studies (e.g., Newmann & Associates, 1996) as well as practitioner-based literature (e.g., Smith, Steele, & Raith, 2017) draw attention to the value of a standards-based vision of teaching and learning. Smith, Steele, and Raith (2017) argued that a focus on ambitious instruction is necessary to enact standards-based instruction and reiterated that school-wide professional development activities should focus on a core set of teaching practices. It is also understood from the literature that the enactment of ambitious instruction is challenging. Even if the teachers in my study were able to articulate stronger visions of mathematics teaching in their schools, they would have to negotiate many factors in planning and enacting their instruction. For example, all of the teachers needed to consider multiple subjects during their planning time. Ms. Cohen and Ms. Bellamy attempted to complete their lesson plans during the school day which meant that they were limited in the amount of time they could focus on specific subjects. As a different example, Ms. Mack faced challenges with behavior management. These factors seem to be related to what Feiman-Nemser (2001) describes as "central tasks of learning to teach" (p. 1050) i.e., they were challenges that novices faced in enacting ambitious mathematics instruction. As such, school-wide expectations and professional development activities are factors that seem to influence novice teachers' enactment of mathematics instruction, although they do not guarantee their overall success.

Limitations

My macro problem of practice states that teachers do not always meet the needs of their students. This problem of practice is broad and has been heavily researched during the standards-based reform movement. In order to address this problem in a practical sense, my micro problem of practice focused on a construct called ambitious instruction that emphasizes mathematics teaching practices (Newmann & Associates, 1996). By focusing on ambitious instruction, I aimed to understand how novice teachers selected mathematics tasks and planned for their implementation. I began to understand the problem of practice by focusing specifically on novice teachers given that the research literature has not focused on their capabilities. As such, the extent to which my study is transferable depends on the reader's interests and the extent to which they can relate to novice teachers' planning and enactment of ambitious mathematics instruction.

At the task level, there is an abundance of literature that focuses on Stein, Grover, and Henningsen's (1996) mathematical tasks framework (MTF). The MTF suggests that high-cognitive demand mathematics tasks are essential to the enactment of standards-based instruction. Researchers have expanded the MTF to focus on factors that seem to be associated with teachers' enactment of high-cognitive demand tasks. My study built on this research by considering broader factors that seem to influence teachers' planning and enactment of mathematics instruction. Interestingly, I found that teachers' instruction generally seemed to omit standards-based mathematics tasks. However, my findings do not deeply address the extent to which teachers' lessons were standards-aligned. To better understand the extent to which lessons were standards-aligned, it would have been advantageous to examine various settings more in depth. For example, it could have been helpful to observe teachers planning in the moment or to more specifically focus on the extent to which students engaged in the SMPs during my lesson observations.

Additionally, my study was limited in its understanding of learning goals. Learning goals are an important phase of planning as they tend to suggest a pathway between the standards and the tasks that teachers select for their mathematics lessons (Stein & Meikle, 2017). Teachers in my study tended to focus on the pacing guide's suggestions for standards and learning goals to focus on but I believe there was a missed opportunity in my study to understand how teachers interpreted standards and learning goals. However, the teachers did describe their learning goals in their pre-observation prompts.

Finally, as I developed the research design for my Capstone study, I incorporated survey data related to each teacher's mathematical knowledge for teaching and mathematical content knowledge. At this time, however, I have been unable to identify patterns involving the survey, interview, and observation data for the teachers in my study. In addition, in order to better understand the patterns that emerged in my data collection it would be helpful to conduct more cycles of observations and interviews. Furthermore, it could be beneficial to extend the study to a larger sample of teachers, within a broader context than the state of Virginia.

Future Research

In mathematics specifically, ambitious instruction can be defined as a set of teaching practices that foster students' deep conceptual understanding of standards-based mathematics concepts (Newmann & Associates, 1996). I argue, similar to Stein and Smith (2011), that teachers must carefully plan in order to provide students the opportunity to engage in standards-aligned instruction. If teachers are to respond to the various needs of students, then they must consider the types of practices that will promote a deep conceptual understanding of math topics and ideas. If novices are to transfer and apply what they have learned in their teacher preparation programs then future research could benefit from continued study of how pre-service courses translate to the ways in which teachers plan and enact their mathematics instruction as teachers of record.

Furthermore, additional research is needed to understand the extent to which teachers are exposed to ambitious instruction in their pre-service experiences and through other venues. Although I used probing questions to understand how teachers planned in relation to teaching practices, I did not acquire a rich enough understanding of how teachers were taught to plan and enact lessons in their teacher preparation programs or whether or not their former relationships with mentors were influential. This is an important area to consider because it could be associated with how novices negotiate context-specific realities as teachers of record. Furthermore, the lesson planning templates at HES and MES differed. For Ms. Mack, the template seemed to be overwhelming; typically, the teachers' lesson plans were longer than ten pages. In contrast, Ms. Cohen and Ms. Bellamy hardly utilized the planning template at their school and their lesson plans tended to be one to two pages. Smith and Stein (2011) suggest a lesson planning template that supports the enactment of ambitious instruction. Up to this point, however, the extent to which these teachers have developed lesson planning skills is unclear. Future research could benefit from examining teachers' lesson planning processes in context.

Findings from my Capstone suggest that professional development activities can help teachers and schools align their beliefs and expectations for enacting ambitious instruction mathematics instruction. To my knowledge, however, few research studies have focused on the ways that messages about standards-based mathematics teaching from curricula and professional development activities shape teachers' planning and enactment of ambitious mathematics instruction. Hence, future research could benefit from understanding the ways that a sound standards-based vision for teaching mathematics is associated with teachers' planning and enactment of ambitious mathematics instruction.

Conclusion

"Classroom teachers are already doing everything they know how to do" – John V. Antonetti and James R. Garver

If novice teachers are to translate what they have learned in their teacher preparation programs into their classroom contexts, researchers and practitioners could benefit from continued study of factors that seem to influence their planning and enactment of mathematics instruction as teachers of record. My goal as a mathematics educator and researcher was to design a study that would add to the literature and benefit practitioners alike. In my research, I have sought to depict positive portrayals of novice teachers as it is my belief that beginning teachers, at both the pre-service and in-service levels, are capable of enacting ambitious instruction. The art of teaching is challenging, and as Feiman-Nemser (2001) so eloquently stated, "new teachers have two jobs – they have to teach and they have to learn to teach" (p. 1026). For this reason, it is most critical that novice teachers are supported in developing ambitious teaching practices in order to better meet the needs of all students.

Throughout the standards-based reform movement, research has commonly reiterated the types of instruction that “do not work” by focusing on the factors that seem to hinder students’ opportunity-to-learn. I posit that future research will benefit by changing the narrative in order to understand how schools and teachers can meet the needs of all their students. These findings can be realized by seeking and describing effective examples of teaching that depict how mathematics ought to be taught. For example, the National Council of Teachers of Mathematics’ (NCTM) texts, which served as guiding resources throughout my Capstone research, tend to include vignettes that depict teachers as capable of enacting standards-based mathematics teaching practices.

Notably, teachers in my study did not serve as an ideal representation of ambitious mathematics instruction. Teachers were negotiating school-wide expectations for planning with the support of grade-level colleagues and sometimes tensions existed between the expectations of their colleagues and those of their school. At other times, teachers simply did not seem to consider cognitively-challenging tasks in the design of their lessons. These findings focused on the realities of novice teaching which seemed most important to incorporate. My findings also suggested that despite the fact that teachers planned and enacted their mathematics instruction differently, there were patterns in their teaching practices that were observed to be high-quality. For this reason, I consider my Capstone worthwhile and one that provides a starting point for continued research. All students deserve the opportunity-to-learn. And as Boaler and Staples’

(2008) findings suggest, “when there are many ways to be successful, many more students are successful” (p. 630).

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APPENDICES
Appendix A

M-Scan Scoring Rubric Example

Mathematical Discourse Community

6. Mathematical Discourse Community: The extent to which the classroom social norms foster a sense of community in which students can express their mathematical ideas openly. The extent to which the teacher and students "talk mathematics," and students are expected to communicate their mathematical thinking clearly to their peers and teacher, both orally and in writing, using the language of mathematics. NOTE: There is a "high bar" on this dimension because there is an expectation for students to have an active role in promoting discourse; this should not be only the teacher's role. This is in contrast to Explanation/Justification. The rating does take into account whether discourse focuses on mathematics content but not the cognitive depth of that content.
***Mathematical Thinking** = processes, strategies, and/or solutions.

	Low (1, 2)	Medium (3, 4, 5)	High (6, 7)
Teacher's Role in Discourse	The majority of math discussion in the classroom is directed from the teacher to the students.	Some of the math discussion in the classroom includes student participation, but some is teacher-initiated.	Throughout the math discussion in the classroom, students consistently participate.
	Students' ideas, questions, and input are rarely or never solicited.	Students' ideas, questions, and input are sometimes solicited.	Students' ideas, questions, and input are frequently solicited.
Sense of Mathematics Community through Student Talk	Student to student talk rarely or never occurs. When students talk, they rarely share mathematical thinking* and language.	Student to student talk sometimes occurs. When students talk, they sometimes share mathematical thinking* and language.	Student to student talk frequently occurs. When students talk, they often share mathematical thinking* and language.
Questions	Most of the teacher's questions have known/correct answers, and rarely encourage mathematical thinking*.	Some of the teacher's questions have known/correct answers, and some encourage mathematical thinking*.	Few of the teacher's questions have known/correct answers, and many encourage mathematical thinking*.

Appendix B

Third-Year Teacher Consent Form

Project Title: A Study of Elements of Teacher Preparation Programs that Interact with Candidates' Characteristics to Support Novice Elementary Teachers to Enact Ambitious Mathematics Instruction

Third-Year Teacher Informed Consent Agreement

Please read this consent agreement carefully before you decide to participate in the study.

Purpose of the research study: The purpose of the study is to examine how elementary teachers' characteristics interact with their learning opportunities in teacher preparation courses and student teaching to affect their mathematics and English language arts (ELA) instruction.

What you will do in the study: You will be asked to participate in 6 classroom observations and complete up to 3 surveys during your third year of full-time teaching for this study. When you answer the survey questions, you can skip any question that makes you feel uncomfortable and you can stop taking the survey at any time. You might also be asked to participate in 3 or 4 interviews. When you answer the interview questions, you can skip any question that makes you feel uncomfortable and you can stop participating in the interview at any time

Time required: The time required for each observation will be 45 minutes to an hour. The time required for each survey will be about 30 minutes. The total amount of time required to participate in the 6 observations and complete 3 surveys for this project is 5 hours and 30 minutes. If you are asked to participate in 4 interviews, the total amount of time require to participate would be 7 hours and 30 minutes.

Risks: The survey, observation, and interview data in this study will be de-identified; thus, there are no anticipated risks in this study.

Benefits: There are no direct benefits to you for participating in this research study. The study may help the research team understand factors that influence elementary teachers' instructional practices in mathematics and ELA.

Confidentiality: The information that you give in the study will be handled confidentially. Your information will be assigned a code number. The list connecting your name to this code will be kept in a locked file in an office in Bavaro Hall at University of Virginia. When the study is completed and the data have been analyzed, this list will be destroyed. Your name and the name of your university will not be used in any report.

Voluntary participation: Your participation in the study is completely voluntary. You may elect not to participate without any penalty or loss of benefits to which you would otherwise be entitled. If you participate at first, but later discontinue participation, you will not be subject to any penalty or loss of benefits. You are free to not answer certain survey questions without penalty or loss of benefits.

Right to withdraw from the study: You have the right to withdraw from the study at any time without penalty.

How to withdraw from the study: If you want to withdraw from the study, please notify Dr. Peter Youngs at University of Virginia at pay2n@virginia.edu. There is no penalty for withdrawing. You will still receive full payment for the study. If you would like to withdraw after your surveys have been submitted, please contact Dr. Peter Youngs.

Payment: You will receive a $25.00 payment for each observation you participate in, each survey you complete, and each interview you participate in for this study.

IRB-SBS Office Use Only		
Protocol #	2015-0095	
Approved	from: 10/11/18	to: 3/09/19
SBS Staff		

Appendix C

IRB Approval Form

UNIVERSITY of VIRGINIA

OFFICE OF THE VICE PRESIDENT FOR RESEARCH
INSTITUTIONAL REVIEW BOARD FOR THE SOCIAL AND BEHAVIORAL SCIENCES

In reply, please refer to: Project # 2015-0095-00

November 14, 2018

Peter Youngs
CISE (Curriculum, Instruction & Special Ed)
PO Box 400273

Dear Peter Youngs:

The Institutional Review Board for the Social and Behavioral Sciences has approved your Nobember 6, 2018 modification request to your research project entitled "A Study of Elements of Teacher Preparation Programs that Interact with Candidates' Characteristics to Support Novice Elementary Teachers to Enact Ambitious Mathematics Instruction." You may proceed with this study.

This project # 2015-0095-00 has been approved for the period November 13, 2018 to March 9, 2019. If the study continues beyond the approval period, you will need to submit a continuation request to the Review Board. If you make changes in the study, you will need to notify the Board of the changes.

Sincerely,

Tonya R. Moon, Ph.D.
Chair, Institutional Review Board for the Social and Behavioral Sciences

Appendix D

Initial Structured Interview Protocol (Adapted from larger study)

"The purpose of this interview is to understand what mathematics instruction looks like in your classroom. I want to learn about the types of curricula you may implement in your classroom, your school and district's mathematics instruction expectations, how you plan, and characteristics of your class and your students as well as your views about teaching mathematics. Our will help set the stage for subsequent interviews that will particularly emphasize your planning processes."

1. **Please describe your teaching schedule, what subjects you teach, your time blocks, and any other commitments you may have at your school?** (Probe for planning periods, weekly meetings, etc.)
2. **Please describe the mathematics curricula at your school and in your district. How were you instructed to use these curricula? What curricula resources were you given?** (Probe for district or school directive, familiarity with curriculum, etc.)
3. **How are you learning/ how have you learned to implement the mathematics curricula at your school?** (Probe for professional development, use of textbook or teacher's guide, university methods courses, interactions with mentor, other school-based colleagues, principal, instructional coach, etc.)
4. **How would you describe the expectations in your school regarding mathematics instruction?** (Probe for sources of expectations)
5. **What principles or beliefs guide your mathematics instruction? What influences/has influenced these guiding principles or beliefs?** (Probe for mathematics methods courses, research, policy, experiences as a student in undergraduate mathematics courses, K-12 mathematics)
6. **What resources are available in your school or district to help you teach mathematics? Which have you used / how often have you used them?** (Probe for professional development, interactions with mentor, other school-based colleagues, principal, math instructional coach.)
7. **Please describe the students in your mathematics classroom. What influences the views of you hold of your students?** (Probe for the students themselves, other teachers or administrators, families, etc.)
8. **How do the views you hold of your students influence your mathematics instruction?** (Probe for differentiated instruction, strategies/interventions, small-group work, etc.)
9. **Please describe what mathematics instruction would look like if someone were to observe in your classroom tomorrow? Does this description characterize a typical lesson? Why or why not? (**Probe for environmental structures, structure of the math block, a-typical days, etc.)
10. **Please describe how you have planned or will plan for your mathematics instruction tomorrow? Does this description characterize the way you typically plan? Why or why not?** (Probe to understand whether or not the teacher plans at the unit level, curricula used, whether or not instruction is planned individually or with grade-level team, ask for a copy of a lesson plan if available)

Appendix E

Post-Observation Semi-Structured Interview Protocol (Adapted from Bieda et al., 2017)

The purpose of this interview is to learn more about the process you went through to plan the lesson I observed today. I'm not just referring to something that you wrote down to organize your thoughts about today's lesson. Planning involves anything you did to prepare for the lesson I observed. It could involve asking a colleague a question, reviewing your pacing guide, or going online to some internet resources, for example.

1. **What were the goal(s) of this lesson?** Probes:
   - Did state standards influence the goals? If so, how so? If not, why not?
   - Did knowledge of your students influence the goals? If so, how so? If not, why not?
   - Did school or district expectations influence the goals? If so, how so? If not, why not?
2. **I'd like you to walk me step-by-step through how you prepared for teaching this lesson. Please try to be as specific as possible.** Probes:
   - How did you start?
   - How did you decide what content to focus on?
   - What resources did you use when you planned this lesson and why? Where did the resources come from or how they were obtained?
   - How did you decide to use these resources? If you created anything for the lesson, did anything form how your development process?
   - When did you do the planning of today's lesson? Is this the time frame you usually use for planning your lessons?
3. **Did you meet or talk with colleagues/other teachers in your school to talk about preparing for math lessons?** Probes:
   - If yes -
   - o What did you talk about?
   - o How did this discussion influence your planning/preparation?
   - o Was this meeting organized by your school or district or did you set it up on your own as a group of colleagues?
   - If no –
   - o Why didn't you talk with your colleagues/other teachers about your lesson?
4. **Did you write anything down as part of your lesson planning process?**
5. **When you were planning, were you intentional about the questions you would ask students? If so, how? Were you intentional about the ways that students would represent their solutions? If so, how?**
6. **Please describe what students did during the lesson and how you anticipate they will be instructed to do so?** Probes:
   - What did the structure of your math lesson look like?
   - Is this how you usually instruct mathematics?
   - How much time did students spend on various parts of the lesson?

Appendix E

Post-Observation Prompt

Name: **Date:**

Study of Elementary Mathematics Instruction

1. What is/are the goal(s) of your lesson?

2. How did you prepare for the lesson?

3. Did state, CCSS-M, or NCTM standards influence the goals and/or preparation of your lesson? If so, how?

4. What materials/resources do you plan to use during the lesson?

5. Please describe what students will do during the lesson.

6. Please describe what you will do during the lesson.

Appendix G

Deductive Codebook

Codes	Descriptions	Examples
Ambitious Instruction	References to or observations of standards-based teaching practices	[Mack_Year3_Interview4] I: Were you intentional about the ways that students would represent their solutions today? And if so how? T: Yes. So they had to be able to draw a picture of what they were doing and then put their number sentence…
Appropriation	Statements that focus on the enactment of teachers' mathematics instruction.	[Cohen_Year3_Interview2] I: were you intentional about the ways that students would represent their solutions. If so, how? T: Yes, when we were first talking about comparing and ordering we did it using a base ten block or drawing a base ten block on the board so then we used from that strategy to where we stack them. We moved to see how the values help us. So I did- that's what they did today on the whiteboards when they did it and that's what they did when they did on the cut and paste too. We talked about how that's the most efficient strategy to do in real life.
Colleague(s)	Statements about interactions with grade-level partners and classrooms aids. These are sometimes inferred by "we" statements	[Bellamy_Year3_Interview1] I: Okay. All right. If you could walk me step by step through how you prepared for teaching this lesson and if you could be as specific as possible. T: OK, so I always plan with the other fourth-grade teacher who teaches math. And we- started by looking at the pacing guide to make sure that they didn't remove or add anything to the standards for patterns that we need to cover this year because there have been some revisions. And then we went on the VDOE and looked at the SOLs and looked at the specific skills we needed to cover and they also offer like examples that we could give the kids and that's kind of where I got the examples on my slides. And those are coming from the previous standards

		or SOL tests. Those are questions pulled from there so they start to feel comfortable with the question stems and what they might see on the SOL test. So then we just thought of a fun way they can continue practicing these questions and that's how we came up with the envelopes and I made puzzles on the computer that would solve a riddle gradually as they answered the questions.
Coherence	References to or observations of the organization of the mathematics lesson	[Bellamy, Year3_Observation2] T: Class finishes number sense routine and transitions to a different activity… Everyone has to start with number one, you can ot go out of order because after you show your answer for number one you are going to go to Google classroom and go to a google form that’s called pattern puzzle. On there it's going to ask you to put the number you got for number one in. You are going to type your answer on the computer because it's going to give you a piece of the puzzle.
Discourse	References to or observations of the teachers and/or students communicating mathematically	[Bellamy_Year3_Observation2] T: Nice job thank you X for being Brave You may give your house a point for courage. What feedback do we have for X? Remember things that she did well and things you think she could work on.
Identity	Statements that focus on teachers beliefs about teaching mathematics and/or understanding of students	[Cohen_Year3_Interview1] I: The next question will ask what principles or believes guide your mathematics instruction and what has influenced these guiding principles or beliefs? T: So I definitely think that kids- if you have them doing the math themselves, I think my first year I didn’t focus on that as much and it was kind of me showing them and then them doing practice and it wasn’t as much um, like hands on for them. And I think that I saw that a lot of students struggled. Just the ones who can’t listen to somebody and learn it. That’s not how everybody learns. But then on the flip side I had students who were given a task and have to figure it out on their own get really frustrated because that’s not how they learn and it confuses it more. I’ve kind of

		learned that you have to have a good balance of both where there is sometimes that you need that whole group and sometimes it's much needed to have kids hands on. I also think- I really started to see the value of playing different math games in the classroom just to focus on skills, place value, and different number sense aspects because those lend themselves to so many other areas in math where that has become very important because it's repetition and help on the concrete and foundational skills that they need.
Mentor and/or Instructional Coach	Statements about school or district personal that are assigned to interact with teachers	[Mack_Year3_Interview1] I: How does the math lead- how does she support, or he support, your instruction or planning? T: Well she's always available and she's approachable because she used to teach first-grade. So I feel like I can go to her and ask things whereas some of the other people like they've been in the classroom like 20 years ago and they're kind of like- they don't understand what it's like. She will like pre-fill a lot of the lesson plan for us. It's like a very lengthy lesson plan, it's like 10 pages or something. So like she'll fill out like what are- what are the benchmarks. What are the main things they have to know. Like that kind of stuff. And then she'll give feedback on what we fill out as a team.
Other	These statements include common reference to topics that substantiate them from other codes which includes: - Strategies - Number Sense Routines - Tensions - Etc.	[Cohen_Year1_Interview3] I:Right. And have there been any professional developments that you've attended this year that have supported your planning of mathematics instruction? … T: I would say in general yes. There was one that I went to that I really liked about number talks and I know that I think in the past you've seen me do one of those and I don't do them every day. They're really called number sense routines. But. Yeah I've been to a couple that have been helpful.

Planning	Statements about the ways that teachers prepared for their lesson which includes: - Developing Goals - Decisions related to knowledge of students - Decisions to use resources - Deciding what content to focus on - Description of planning meetings - Planning practices associated with ambitious instruction - Structure of the lesson - What didn't go as planned	[Mack_Year2_Interview2] I: … so can you describe a little more in detail a recent lesson within the unit? And once again what resources did you draw upon to design this lesson in particular? T: Um yeah so the, with the paper, the cup one. We did that on Tuesday. Um we talked about, you know I think I showed, there was a Cookie Monster Youtube thing about Cookie Monster like is trying to buy Girl Scout cookies and there's boxes but they're not equal, but he keeps eating too many. So he keeps trying to make them equal and then he ends up eating all of them and they're like yeah that's still equal. So there's none left. They were very into that. I: Did you find that yourself? T: Yeah. (Laughs). I: Cool I bet that was helpful. T: So we watched that and then I showed them how the scale worked with the little paperclips and they had a worksheet and they did it with a partner. And it was a true or false like sort. So it was like 4 plus 8 equals 1 plus 2. So they would do that on both sides of it and see if it was equal or not. And then some of them, like my higher ones, were like well this isn't equal but it looks equal on the scale, because it was like one away from it. So I was like well that doesn't surprise me that they figured that out. So we talked about how like you can solve both sides to check to see if the scale is right.
Professional Development	Statements about teachers' opportunities-t0-learn that focus on specific topics. This could be in school, within the district, or other opportunities	[Cohen_Year3_Interview1] I: How are you learning to implement the mathematics curricula? T: Sometimes we have county training where we will go to schools and meet with different math people. We had one this year actually after school where we had somebody, I think from JMU, came and did a presentation about different math strategies to use and this was specifically around math workshop and learning that into the classroom. The head of our math, kind of, I guess, a math chair of the

		school goes to um, monthly meetings where she meets with all of the math chairs and she will bring back stuff. So it's kind of word of mouth or professional development that we have to go to for school purposes.
Representations	These are references or observations of the ways that the teachers and/or students evidence their understanding of mathematical concepts	[Mack_Year3_Observation1] T: I've got five cubes. You have to tell me how many are hiding. I've got five, how many am I hiding? Can you write it? How did you know that S1: two and three T: Two and three make five, just like you wrote.
School-wide Expectations	These are inferences or direct statements about mandates related to planning and/or implementation of mathematics instruction. These mandates are provide by the state, district, and/or school administrators.	[Cohen_Year3_Interview1] I: How would you describe the expectations in your school regarding mathematics instruction? T: So, one of the big expectations is that it is very student driven. So it's a lot more student talking going on, student interactions, then just the teacher standing up and teaching. They do recognize that there are some times that you have to do that to introduce that or go over something. For the most part it should be student driven. Students talking, up out of their seats, or they are collaborating on games that are practicing math or different problem solving tasks. Um, so it's really just more interactive for the students and less interactive for the teachers. I: Ok. And um, were these expectations guided by your administrators or the district? T: Um, I would say it's from administrators and the district as a whole. Our new superintendent, this is not his second year, he is very student focused and has really gone away from a lot of pressure from the SOLs and pressure from teacher lecturing so it's been very um, I don't know, it's just been a change of pace and it just feels like the whole county is moving toward the student centered and up and moving and collaboration. I would say it's really forced upon us though.
Settings	Statements that focus on the	[Mack_Year3_Interview1]

	environment that teachers plan and enact mathematics instruction.	I: OK. And what are the expectations in your school regarding lesson planning? For math. T: They want us to plan as a team. And. We all kind of fill out that lengthy lesson plan together. It's difficult because we all have different styles and some of us have taught for a long time and think things should be done in a certain way. And. I'm kind of more open to new stuff. It's hard because I felt I kind of feel like. When I was just planning for myself like last year and the year before like they've never made us turn in lesson plans before. And I think some people weren't doing it. I've always been doing it. I like I like to tailor things to my own class and I kind of feel like I'm bound to do whatever the team has come up with whether or not it's my favorite thing or not. That makes sense?
Task Selection	Statements related to resources available and/or chosen for mathematics instruction. These include: - Text resources - Online resources - Pacing guides	[Cohen_Year3_Interview1] I: What resources are available in your school or district to teach mathematics. Which have you used and how often? T: Okay so we have the Envision program that the school has purchased. The textbook has a student workbook and then it has some online videos. Last year I probably used the workbook one time. I haven't used- actually we didn't even purchase the workbooks for fifth-grade this year because it's a waste. I used the video one time last year as well. Never opened the textbook. I haven't done any of that this year. We also have a Google Drive for the county where there is a bunch of math resources that had been added through different Professional Development or different things that teachers have created. Kind of like a big sharing bank and there is specifics for each grade. So, I have access to the fifth-grade math folder and have assessments, activities, notecards, notes, videos, it's like a bunch of different stuff that we can use. And then just sharing within our school we created kind of a fifth-grade math thing were if I make something I put it in the

		folder and then the other two teachers can use it or vice versa, I can use their stuff.
Teacher Education	Statements related to teachers' opportunities-to-learn in teacher preparation programs and/or student teaching.	[Bellamy_Year3_Interview2] I: And when you were planning today, how is this similar or different than what you learned about planning and your teacher prep program? T: So I remember taking a class on backwards design. I believe that's the name of it. And we do do that. We roughly use that idea. We think about our end goal and how are we going to get there and that's how we use the SOLs and the curriculum framework. So backwards design I guess is something that-
Tools	Statements that focus on the instructional practices, strategies and resources that teachers plan for and/or with.	[Mack_Year3_Interview3] I: OK. And then with your dominoes activity where did that idea come from? T: I think that's OK. Well one of my teammates uses this game Domino parking lot and so I have that I've had that in a tub for a little while and so they kind of familiar with that. And so then we were thinking well to do the domino parking lot like let's just do related facts with dominoes.

Appendix H

Parent Consent Form

Study of Ambitious Instruction
Information for Parents

Dear Parent,

We are conducting research on the ways in which beginning elementary teachers' teacher preparation program experiences, personal characteristics, and school environments seem to influence their instructional practices. For this study, we are observing 100 beginning teachers in Connecticut, Michigan, and Virginia over a two-year period. Our research team includes researchers from University of Connecticut. Michigan State University, and University of Virginia.

In 2018-19, we will visit your child's classroom on 6 occasions to observe her or his teacher's mathematics and reading/language arts instruction, including 3 observations in each subject. Each observation will last about 45 minutes to an hour. The purpose of the observations will be to learn about the instructional strategies that your child's teacher uses when she or he teaches mathematics and reading language arts. We have received permission from your school district to carry out these observations. We plan to video record these observations in order to best analyze the data. Our filming will focus on the teacher and your child will not be video recorded. Your child will not do anything outside of his or her normal classroom activities and there is no risk to your child. Your child's participation in this study will not affect his or her grade.

If you desire further information about this research, you may contact Dr. Peter Youngs at: Curry School of Education, University of Virginia, 324 Bavaro Hall, 405 Emmet Street S, Charlottesville, VA 22904, pay2n@virginia.edu, 434-924-1752.

Sincerely,

Peter Youngs, Professor
University of Virginia
Curry School of Education

Appendix I

Example of HES Lesson Plan Template

Week Nov. 5-7, 2018 (3 days) Week 2 Nov. 12-16, 2018

Teacher:	
Unit Lesson:	1.1 1.2 1.5 Number Sense- Strand: Number Sense - 1 ½ Weeks
Week of:	Quarter 2 Wk 1-2 (Week 10-11 Instructional Sequence)
Standards of Learning:	1.1 The student will a) count forward orally by ones to 110, starting at any number between 0 and 110; b) write the numerals 0 to 110 in sequence and out-of-sequence; c) count backward orally by ones when given any number between 1 and 30; and d) count forward orally by ones, twos, fives, and tens to determine the total number of objects to 110. 1.2 The student, given up to 110 objects, will a) group a collection into tens and ones and write the corresponding numeral; b) compare two numbers between 0 and 110 represented pictorially or with concrete objects, using the words greater than, less than or equal to; and c) order three or fewer sets from least to greatest and greatest to least. 1.5 The student, given a familiar problem situation involving magnitude, will a) select a reasonable order of magnitude from three given quantities: a one-digit numeral, a two-digit numeral, and a three-digit numeral (e.g., 5, 50, 500); and b) explain the reasonableness of the choice. **Second Grading Period** • Count objects through 110. • Write numerals through 110.
Essential Knowledge and Skills:	**The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to:** **1.1** • Count forward orally, by ones, from 0 to 110 starting at any number between 0 and 110. (a) • Use the oral counting sequence to tell how many objects are in a set. (a) • Write numerals 0-110 in sequence and out of sequence. (b) • Count backward orally by ones when given any number between 1 and 30. (c) • Count forward orally by ones, twos, fives, and tens to determine the total number of objects to 110. (d) **1.2** • Group a collection of up to 110 objects into sets of tens and ones. (a) • Write the numeral that corresponds to the total number of objects in a given collection of up to 110 objects that have been grouped into sets of tens and ones. (a)

	• Identify the place and value of each digit in a two-digit numeral (e.g., in the number 23, the 2 is in the tens place and the value of the 2 is 20). (a) • Identify the number of tens and ones that can be made from any number up to 100 (e.g., 47 is 47 ones or can also be grouped into 4 tens with 7 ones left over). (a) • Compare two numbers between 0 and 110 represented pictorially or with concrete objects, using the words greater than, less than or equal to. (b) • Order three or fewer sets, each set containing up to 110 objects, from least to greatest and greatest to least. (c) **1.5** • Select a reasonable order of magnitude for a given set from three given quantities: a one-digit numeral, a two-digit numeral, and a three-digit numeral (e.g., 5, 50, or 500 jelly beans in jars) in a familiar problem situation. (a) • Explain why a particular estimate was chosen as the most reasonable from three given quantities (a one-digit numeral, a two-digit numeral, and a three-digit numeral), given a familiar problem situation. (b)				
Week 1	**Monday (DAY 1)**	**Tuesday (DAY 2)**	**Wednesday (DAY 3)**	**Thursday (DAY 4)**	**Friday (DAY 5)**
Essential Vocabulary:	count, number, numeral, how many, greater than, less than, more, fewer, same, equal, compare, order, greatest, least, estimate, digit, place, value				
Guiding Questions:	**Counting** • How can we use tools (counters, objects, number lines, hundred charts) to help us count to 110? • How do we know what numbers come before and after a certain number? • What is zero? When do we use zero? • How many ways can we represent a number (written form, place value representation)? • How can we use tools (counters, objects, number lines, hundred charts) to help us skip count? • What patterns occur when we count by ones? ... twos? ... fives? ... tens to 110? • What is different when counting backwards (between 1-30)? **Grouping and Counting** • How could we count objects in a set? • How does grouping by tens and ones help us tell how many? • How does grouping by tens and ones help us say and write numbers? • How does the position (***place***) of a digit in a number affect the ***value*** of that digit? • How do we compare numbers (presented concretely) through 30 using words (greater than, less than, equal to)? • How can we compare numbers (presented concretely) through 110 using words (greater than, less than, equal to)? • How can I order sets of objects? **Estimation** • What is an estimate? • How can I describe why my estimate is reasonable? • How do we decide whether an estimate should be a one-, two-, or three-digit number?				

Common Misconceptions:	• Students often struggle to recognize that for each object in a set, one number word is associated with one object. (one-to-one correspondence) • Students often don't understand the last number named tells the number of objects counted. (cardinality) • Students may not remember the number they counted to when counting a collection of objects or count past the desired number when counting a specified amount out of a larger group. This means that the student's attention was not on the quantity but on the act of counting. (conservation of number) • Students may not realize that the number of objects is the same regardless of the arrangement or the order in which they were counted. (conservation of number) • Students often struggle to recognize there is a digit for nothing (0). • Students may have misconceptions involving conservation of number. When asked to compare two quantities, students may say a group has more because the objects in that group are spread out over a larger area or the objects themselves are physically larger. Encourage students to develop one to one correspondence when comparing and ordering groups of objects. • Students may not understand that each consecutive number refers to a quantity that is one more. • Many of the teen numbers don't follow language conventions that other numbers follow. In numbers beyond 20, the tens digit is read first (twenty-one, fifty-seven) but with the teen numbers this is not the case. Eleven, twelve, thirteen and fifteen are even more confusing because they follow a different convention than the other teen numbers (sixteen and seventeen) in that they are not read one-teen, two-teen, three-teen and five-teen. • Students who are comfortable with the counting sequence may still struggle with counting on from numbers other than 1. • Students may struggle counting back from numbers other than 10 either because the sequence is not firmly established or because they have not yet thoroughly conceptualized the one less than idea. • Students should experience counting actual objects by twos, fives and tens along with rote counting activities. Frequently students do not realize they must select or move two items at a time when they are counting by twos. • When working with materials grouped to represent a two digit number, some students count all objects by ones rather than understanding that ten ones is the same as one group of ten. • Some students confuse the place to record the tens and ones when writing the number. • Students may struggle more with understanding the magnitude of 3 digit numbers due to a lack of experience with large numbers.

LESSON					
Blooms Verbs					
Remember Tell, List, Describe, Relate, Locate, Write, Find, State, Name, Identify, Label, Recall, Define, Recognize, Match, Reproduce, Memorize, Draw, Select, Write, Recite	**Understand** Explain, Interpret, Outline,Discuss, Distinguish, Predict, Restate, Translate, Compare,Describe, Relate, Generalize, Summarize, Put into your own words, Paraphrase, Convert, Demonstrate, Visualize	**Apply** Solve, Show, Use, Illustrate,Construct, Complete, Examine, Classify, Choose, Interpret, Make, Put together, Change, Apply, Produce, Translate, Calculate, Manipulate, Modify	**Analyze** Analyze, Distinguish, Examine, Compare, Contrast, Investigate, Categorize, Identify, Explain, Separate, Advertise, Take apart, Differentiate, Subdivide, Deduce	**Evaluate** Judge, Select, Choose, Decide,Justify, Debate, Verify, Argue, Recommend, Assess, Discuss, Rate, Prioritize, Determine, Critique, Evaluate, Criticize, Weigh, Value, Estimate, Defend	**Create** Create, Invent, Compose, Predict, Plan, Construct, Design, Imagine, Propose, Devise, Formulate, Combine, Hypothesize, Originate, Add to, Forecast

Objective(s) & Learning Targets What should the student be able to do so that you know there is mastery? Also include "I can" statement here	**Teacher Workday**	**Conference Day**	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.
Student Engagement, Supporting Resources, & Materials ***Technology***: Websites, Digital media (movies, music, etc.), Digital manipulatives, etc. Format it will be used: Whole group, Small group, Intervention, Differentiation ***Manipulatives*** and other materials ***Teaching and Instructional Practice*** Active Engagement Strategies for Lesson	**Teacher Workday**	**Conference Day**	**From One to One Hundred** by Terri Sloat Find groups of ten in the illustration. **One Hundred Hungry Ants** by Elinor J. Pinczes Counting to 100 and grouping objects into friendly numbers in preparation for skip counting. **A Fair Bear Share** by Stuart J Murphy Encourage your child (or students) to retell the story. Use check marks to record the nuts, berries and seeds that the cubs have collected. Circle the groups of 10. Counting to 120 Flipchart Count to 120 BrainBreak (can be done various times throughout the day/week) Welcome to the Zoo counting BrainBreak count to 120 (can be done various times throughout the day/week) GoNoodle Count to 100 (can be done various times throughout the day/week) Illuminations 10-frame Math and Movement Counting Lesson Activities/Ideas Landmark Numbers 120 chart		
Check for			1st Grade Number Talks		

Understanding and Review (10-15 minutes) □ A. Cumulative Review (10 min) □ Spiral review questions □ Calendar Math □ Problem of the Day □ B. Number Talk ((5-10 min) □ C. Basic Fact Review (5 min) □ D. Homework Check (5 min) □ Opportunities for students to share thinking *not all can be completed daily but should be included weekly	Teacher Work Day	Conference Day	Number Talk **Counting All/Counting On: Number Sentences** Pg. 106	Number Talk **Counting All/Counting On: Number Sentences** Pg. 106	Number Talk **Counting All/Counting On: Number Sentences** Pg. 106
	ONGOING REVIEW ● Explore parts of numbers-name parts & wholes ● Dot patterns/ten frames ● Problem solving ● Counting objects ● Writing numbers ● Comparing numbers ● Calendar experiences ● Data collection/ graphing ● Patterns *1.1, 1.2 Counting objects and writing numerals to 110 will be assessed this grading period.				
Opening (Anticipatory Set) Activates prior knowledge Hooks the student to the lesson Connects to previous learning experiences and real world experiences	**Teacher Workday**	**Parent Teacher Conference**	How can we use tools (counters, objects, number lines, hundred charts) to help us count to 110?	How can we use tools (counters, objects, number lines, hundred charts) to help us count to 110?	How can we use tools (counters, objects, number lines, hundred charts) to help us count to 110?
Delivery process (flow of the lesson) Direct teaching (I do) Guided practice (We do) Independent practice (You do)	**Teacher Workday**	**Parent Teacher Conference**	Practice counting to 110 using the hundreds chart or using a technology link. Model the Race to 110 game. Students will play the game with a buddy.	TTW model counting a bag of objects (30 to 110) showing the students how to move one object at a time. TSW practice counting bags of objects (30 to 110) with a buddy and writing corresponding number on a dry erase board.	TTW model counting two bags of objects (30 to 110) reviewing how to move one object at a time, and write the corresponding number.. Then, compare the two groups to determine more/less. TSW work with a buddy to count 2 bags of objects, write the corresponding number and label which is more/less.
Small Group & Stations Teacher small group - guided practice? intervention? re-teaching? enrichment? Stations	**Teacher Workday**	**Parent Teacher Conference**			
	Independent Stations: **Part-Part-Whole** **Writing Equations Independently** ***(9 weeks)*** *Focus on target number with + and - symbols* ● Shake and Spill ● The Tub Game, p. 58 ● Writing Equations with Counting Boards, p. 38 ● Writing Stories To Match Equations, p. 40		● Counting Boards, Level 2, p. 86 ● Number-Shape Arrangements, Level 2, p. 87 ● Number Shapes: Using Number Cubes, Level 2, p. 89 ● Number Trains: Using Number Cubes, Level 2, p. 93 ● Number Trains Arrangement Level 2, p. 92 ● Target Number Grab Bag Addition ● Target Number Grab Bag Subtraction		
Assessment short term formative tools long term summative tools how students can self-evaluate own learning Re-teaching/remediation opportunities for the classroom teacher to revisit if students do not understand	Checklist/Observation	Checklist/Observation	Checklist/Observation	Checklist/Observation	Checklist/Observation
End of Unit CCPS Assessment	**Progress Monitoring Checklists:** ● Counting/Comparing, Fractions, Ordinal #s Checklist - 2nd Grading Period		**CCPS Assessments:** ● Counting Student Interview - 2nd Grading Period ● Writing Numbers to 110 Assessment - 2nd Grading Period		
Closure (5 min) Closure that revisits the learning targets and allows students to self-evaluate □ Discussion (student led) □ Written □ Students share their thinking	**Teacher Workday**	**Parent Teacher Conference**			

Week 2 Nov. 12 - 16	Monday (DAY 1)	Tuesday (DAY 2)	Wednesday (DAY 3)	Thursday (DAY 4)	Friday (DAY 5)
Essential Vocabulary:	count, number, numeral, how many, greater than, less than, more, fewer, same, equal, compare, order, greatest, least, estimate, digit, place, value				
Guiding Questions:	**Counting** • How can we use tools (counters, objects, number lines, hundred charts) to help us count to 110? • How do we know what numbers come before and after a certain number? • What is zero? When do we use zero? • How many ways can we represent a number (written form, place value representation)? • How can we use tools (counters, objects, number lines, hundred charts) to help us skip count? • What patterns occur when we count by ones? ... twos? ... fives? ... tens to 110? • What is different when counting backwards (between 1-30)? **Grouping and Counting** • How could we count objects in a set? • How does grouping by tens and ones help us tell how many? • How does grouping by tens and ones help us say and write numbers? • How does the position (***place***) of a digit in a number affect the ***value*** of that digit? • How do we compare numbers (presented concretely) through 30 using words (greater than, less than, equal to)? • How can we compare numbers (presented concretely) through 110 using words (greater than, less than, equal to)? • How can I order sets of objects? **Estimation** • What is an estimate? • How can I describe why my estimate is reasonable? • How do we decide whether an estimate should be a one-, two-, or three-digit number?				
Common Misconceptions:	• Students often struggle to recognize that for each object in a set, one number word is associated with one object. (one-to-one correspondence) • Students often don't understand the last number named tells the number of objects counted. (cardinality) • Students may not remember the number they counted to when counting a collection of objects or count past the desired number when counting a specified amount out of a larger group. This means that the student's attention was not on the quantity but on the act of counting. (conservation of number) • Students may not realize that the number of objects is the same regardless of the arrangement or the order in which they were counted. (conservation of number) • Students often struggle to recognize there is a digit for nothing (0). • Students may have misconceptions involving conservation of number. When asked to compare two quantities, students may say a group has more because the objects in that group are spread out over a larger area or the objects themselves are physically larger. Encourage students to develop one to one correspondence when comparing and ordering groups of objects.				

	• Students may not understand that each consecutive number refers to a quantity that is one more. • Many of the teen numbers don't follow language conventions that other numbers follow. In numbers beyond 20, the tens digit is read first (twenty-one, fifty-seven) but with the teen numbers this is not the case. Eleven, twelve, thirteen and fifteen are even more confusing because they follow a different convention than the other teen numbers (sixteen and seventeen) in that they are not read one-teen, two-teen, three-teen and five-teen. • Students who are comfortable with the counting sequence may still struggle with counting on from numbers other than 1. • Students may struggle counting back from numbers other than 10 either because the sequence is not firmly established or because they have not yet thoroughly conceptualized the one less than idea. • Students should experience counting actual objects by twos, fives and tens along with rote counting activities. Frequently students do not realize they must select or move two items at a time when they are counting by twos. • When working with materials grouped to represent a two digit number, some students count all objects by ones rather than understanding that ten ones is the same as one group of ten. • Some students confuse the place to record the tens and ones when writing the number. • Students may struggle more with understanding the magnitude of 3 digit numbers due to a lack of experience with large numbers.				
LESSON					
Blooms Verbs					
Remember Tell, List, Describe, Relate, Locate, Write, Find, State, Name, Identify, Label, Recall, Define, Recognize, Match, Reproduce, Memorize, Draw, Select, Write, Recite	**Understand** Explain, Interpret, Outline,Discuss, Distinguish, Predict, Restate, Translate, Compare,Describe, Relate, Generalize, Summarize, Put into your own words, Paraphrase, Convert, Demonstrate, Visualize	**Apply** Solve, Show, Use, Illustrate,Construct, Complete, Examine, Classify, Choose, Interpret, Make, Put together, Change, Apply, Produce, Translate, Calculate, Manipulate, Modify	**Analyze** Analyze, Distinguish, Examine, Compare, Contrast, Investigate, Categorize, Identify, Explain, Separate, Advertise, Take apart, Differentiate, Subdivide, Deduce	**Evaluate** Judge, Select, Choose, Decide,Justify, Debate, Verify, Argue, Recommend, Assess, Discuss, Rate, Prioritize, Determine, Critique, Evaluate, Criticize, Weigh, Value, Estimate, Defend	**Create** Create, Invent, Compose, Predict, Plan, Construct, Design, Imagine, Propose, Devise, Formulate, Combine, Hypothesize, Originate, Add to, Forecast
Objective(s) & Learning Targets What should the student be able to do so that you know there is mastery? Also include "I can" statement here	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.	I can count objects to 110 or more.I can count objects to 110 or more. I can read a numeral to 110 or more. I can count to 110, starting at any number between 0 and 110. I can write numerals to 110 or more.

Student Engagement, Supporting Resources, & Materials ***Technology***: Websites, Digital media (movies, music, etc.), Digital manipulatives, etc. Format it will be used: Whole group, Small group, Intervention, Differentiation ***Manipulatives*** and other materials ***Teaching and Instructional Practice*** Active Engagement Strategies for Lesson	**From One to One Hundred** by Terri Sloat Find groups of ten in the illustration. **One Hundred Hungry Ants** by Elinor J. Pinczes Counting to 100 and grouping objects into friendly numbers in preparation for skip counting. **A Fair Bear Share** by Stuart J Murphy Encourage your child (or students) to retell the story. Use check marks to record the nuts, berries and seeds that the cubs have collected. Circle the groups of 10. Counting to 120 Flipchart Count to 120 BrainBreak (can be done various times throughout the day/week) Welcome to the Zoo counting BrainBreak count to 120 (can be done various times throughout the day/week) GoNoodle Count to 100 (can be done various times throughout the day/week) Illuminations 10-frame Math and Movement Counting Lesson Activities/Ideas				
Check for Understanding and Review (10-15 minutes) □ A. Cumulative Review (10 min) □ Spiral review questions □ Calendar Math □ Problem of the Day □ B. Number Talk ((5-10 min) □ C. Basic Fact Review (5 min) □ D. Homework Check (5 min) □ Opportunities for students to share thinking ***not all can be completed daily but should be included weekly**	1st Grade Number Talks				
	Pg. 106 Counting All/Counting On: Number Sentences 6 + 4, 6 + 6, 6 + 8, 6 + 9	**Pg. 106 Counting All/Counting On: Number Sentences** 6 + 4, 6 + 6, 6 + 8, 6 + 9	**Pg. 106 Counting All/Counting On: Number Sentences** 6 + 4, 6 + 6, 6 + 8, 6 + 9	**Pg. 106 Counting All/Counting On: Number Sentences** 6 + 4, 6 + 6, 6 + 8, 6 + 9	**Pg. 106 Counting All/Counting On: Number Sentences** 6 + 4, 6 + 6, 6 + 8, 6 + 9
	ONGOING REVIEW • Explore parts of numbers-name parts & wholes • Dot patterns/ten frames • Problem solving • Counting objects • Writing numbers • Comparing numbers • Calendar experiences • Data collection/ graphing • Patterns				

	*1.1, 1.2 Counting objects and writing numerals to 110 will be assessed this grading period.				
Opening (Anticipatory Set) Activates prior knowledge Hooks the student to the lesson Connects to previous learning experiences and real world experiences	How does the position (***place***) of a digit in a number affect the ***value*** of that digit?	How do we know what numbers come before and after a certain number?	How can we compare numbers (presented concretely) through 110 using words (greater than, less than, equal to)?	How can we use tools (counters, objects, number lines, hundred charts) to help us count to 110?	What patterns do you notice when writing numbers to 110?
Delivery process (flow of the lesson) Direct teaching (I do) Guided practice (We do) Independent practice (You do)	TTW will compare 12 and 21 and count the number of objects to determine that place value is important. She will model picking a 2 digit number and counting that number of objects and write the number. Review how to move one object at a time. TSW work with a buddy to pick a 2 digit number and count the objects and write the corresponding number.	TTW discuss how the place value of the numbers in a 2 digit number can make a big difference in the actual number. Model picking 2 and 5 to make 25 and count 25 objects. Then, switch the numbers to make 52 and count that number of objects. Compare these two numbers to determine more/less. TSW will work with a buddy to pick 2 digits and make both numbers possibilities. Compare.	TTW model how to look at two 2-digit numbers and determine which is more/less by looking at the hundreds chart. TSW do the Kagan Activity Say-Say-Trade to compare two 2-digit numbers to tell which is more/less. TSW will work with a buddy to pick 2 digits and make both numbers possibilities. Compare.	TTW model using a 120 chart to count objects (30 to 110) using this visual. TSW will work with a buddy to count bags of clear counters on a 120 chart and write the corresponding numbers. When working w/ a buddy they will both be counting the objects out loud.	TTW use a book/technology to practice counting to 120. TSW write the numbers from 1 to 120 w/o visuals to determine understanding and growth.
Small Group & Stations Teacher small group - guided practice? intervention? re-teaching? enrichment? Stations					
	Independent Stations: **Part-Part-Whole** **Writing Equations Independently**		• Counting Boards, Level 2, p. 86 • Number-Shape Arrangements, Level 2, p. 87		

	(9 weeks) *Focus on target number with + and - symbols* • Shake and Spill • The Tub Game, p. 58 • Writing Equations with Counting Boards, p. 38 • Writing Stories To Match Equations, p. 40		• Number Shapes: Using Number Cubes, Level 2, p. 89 • Number Trains: Using Number Cubes, Level 2, p. 93 • Number Trains Arrangement Level 2, p. 92 • Target Number Grab Bag Addition • Target Number Grab Bag Subtraction		
Assessment short term formative tools long term summative tools how students can self-evaluate own learning Re-teaching/remediation opportunities for the classroom teacher to revisit if students do not understand	Checklist/Observation	Checklist/Observation	Checklist/Observation	Checklist/Observation	Checklist/Observation
End of Unit CCPS Assessment	**Progress Monitoring Checklists:** • Counting/Comparing, Fractions, Ordinal #s Checklist - 2nd Grading Period		**CCPS Assessments:** • Counting Student Interview - 2nd Grading Period • Writing Numbers to 110 Assessment - 2nd Grading Period		
Closure (5 min) Closure that revisits the learning targets and allows students to self-evaluate □ Discussion (student led) □ Written □ Students share their thinking	Say say trade #'s to 120	What's missing in the 120's chart (write it or say it)	Movement to 120	Brain Break	Brain Break

Appendix J

Example of MES Lesson Plan Template

December 3-7, 2018 - Week 4 Multiplication

Math: 8:40-10:10 & 11:30-1:00

Monday	Tuesday	Wednesday	Thursday	Friday
Lesson Topic: Introduce 3-digit by 2-digit multiplication with expanded algorithm. **SOL/Essential Knowledge:** 4.4b **Content Obj:** I can solve a 2-digit by 3-digit multiplication problem. **Language Obj:** I can explain my process when solving a 2-digit by 3-digit multiplication problem and justify my thinking. **Sentence Frame:** **Vocabulary:** product, factor, multiply, digit, array, repeated addition, expanded algorithm,	**Lesson Topic:** Continue 3-digit by 2-digit multiplication with expanded algorithm. Introduce standard algorithm. **SOL/Essential Knowledge:** 4.4b **Content Obj:** I can solve a 2-digit by 3-digit multiplication problem. **Language Obj:** I can explain my process when solving a 2-digit by 3-digit multiplication problem and justify my thinking. **Sentence Frame:** **Vocabulary:** product, factor, multiply, digit, array, repeated addition, expanded algorithm,	**WRE 9:40-10:10** **Lesson Topic:** Review of multiplication **SOL/Essential Knowledge:** 4.4b **Content Obj:** I can solve a double digit multiplication problem. **Language Obj:** I can explain my process when solving a double digit multiplication problem and justify my thinking. **Sentence Frame:** **Vocabulary:** product, factor, multiply, digit, array, repeated addition, expanded algorithm, standard algorithm	Multiplication Quiz	**Field Trip to Forbes Center** Remediation of Quiz from yesterday
Number Sense Routine	**Number Sense Routine**	**Number Sense Routine**		
New Teaching Procedure: -In student notebooks, teach students how to solve 3-digit by 2-digit multiplication problems using the partial product method (expanded using values).	**New Teaching Procedure:** -In student notebooks, review with students how to solve 3-digit by 2-digit multiplication problems using the partial product method (expanded using values). Teach students how to use the standard algorithm.	**New Teaching Procedure:** 1. Set purpose: Today we are going to practice everything we've learned for multiplication. 2. Read learning goal together. 3. Review with students how to solve multiplication problems using the expanded and standard algorithms.		
Partner Activity: **Santa Beard:** Students will work together to solve 3-digit by 2-digit multiplication problems. The problems will then be rolled up and glued on a Santa beard.	**Partner Activity:** **Santa Beard:** Students will work together to finish solving and putting together their Santa Beard.	**Small Group Procedures:** **2 30-minute rotations** **-Classroom Teacher:** Remediation for double digit multiplication **-Extra Teacher:** Breaking down word problems. **-Computer group:** IXL Lesson D.18		

December 3-7, 2018 - Week 4 Multiplication

Problem Solving Task: -Students will use their notebooks to solve the following problem: "Rex's class raised frogs from tadpoles. The class has 21 students, and each raised 6 tadpoles. All but 8 of the tadpoles grew into frogs. Write a number sentence and solve to show how many frogs the class has."	**Exit Ticket:** -Give students an exit ticket to determine groups tomorrow			

Appendix K

Ms. Bellamy's Computer Based Recording Sheet

Input/Output Tables

Directions: Use the dominoes to fill in each table. Find the rule and complete the sentence frame.

**Hint: In some tables, there is a missing number. Use the rule to determine the missing number.

#1 Rule:

The rule for this table is ____________________. I know this because

____.

#2 Rule:

	?