Four Preservice Teachers' Use of Mathematical Knowledge during Lesson Planning and Instruction in the Field Experience

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FOUR PRESERVICE TEACHERS’ USE OF MATHEMATICAL KNOWLEDGE DURING LESSON PLANNING AND INSTRUCTION IN THE FIELD EXPERIENCE

A Dissertation Presented to
The Faculty of the School of Education
Learning and Instruction Department

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

By
Margaret M. Swearingen
San Francisco
December 2014
Four Preservice Teachers’ Use of Mathematical Knowledge during Lesson Planning and Instruction in the Field Experience

The field experience of a teacher education program offers the opportunity for authentic practice in lesson planning and instruction for preservice teachers prior to their transition into their teaching career. However, preservice teachers often struggle applying their developing knowledge and skills because of the multifaceted nature of the field experience context. This complexity is particularly true in mathematics instruction since it includes simultaneously understanding mathematical concepts and mathematical procedure standards during instruction.

This study used mini-case studies to examine how four preservice teachers used their developing mathematical knowledge learned in the teacher education program while lesson planning and teaching within the context of the culminating field experience. Data were collected about the preservice teachers’ use of mathematical knowledge and the influence of personal background, prior mathematical knowledge, and the field experience context on their instructional choices. The instrumentation for data collection included two questionnaires, lesson plan analyses, interviews, observations, field notes, and student assessment.

The results from this study revealed that preservice teachers used their mathematical knowledge developed in the teacher education program during lesson planning and instruction at varying levels. One prevalent influence on lesson planning and instructional decisions was the learning needs of students. The most prominent
influence on the preservice teachers was the mentor teachers’ educational philosophies and perceptions that determined the amount and type of opportunities the preservice teachers had to practice instructional strategies. Two preservice teachers were observed comfortably using their mathematical knowledge and several instructional strategies after receiving encouragement and guidance from the mentor teachers. Two preservice teachers used their mathematical knowledge, but were limited in their use of instructional strategies by the mentor teachers.
This dissertation, written under the direction of the candidate’s dissertation committee and approved by the members of the committee, has been presented to and accepted by the Faculty of the School of Education in partial fulfillment of the requirements of the degree of Doctor of Education. The content and research methodologies presented in this work represent the work of the candidate alone.

Margaret M. Swearingen
Candidate
December 11, 2014

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December 11, 2014

Kevin Oh, Ph.D.
December 11, 2014

Caryl Hodges, Ed.D.
December 11, 2014
DEDICATION

This dissertation is dedicated to my family—Tom, Bill, and James—and to all teachers past, present, and future. May we continue to learn and teach with kindness and respect throughout our lives.
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Many people helped me reach this goal. I was amazed by people’s patience and kindness as I struggled and grew during the doctoral program and the dissertation process. I owe Dr. Robert Burns so much gratitude for his guidance and support as my committee chairperson. He kept the momentum going throughout the process. Dr. Burns consistently gave me rigorous and supportive feedback that kept me focused and able to hone the study into a manageable document. Thank you for sharing your wisdom.

In addition, I would like to thank Dr. Kevin Oh and Dr. Caryl Hodges for their work as my dissertation committee. Their feedback was insightful and encouraging. Our committee discussions inspired me to dig deeper and think broader about teacher education and teacher knowledge. Thank you for sharing your knowledge.

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The support of my friends and colleagues was greatly appreciated. There are too many to name. You showed understanding as I juggled my schedule. Thank you!

Finally, I owe a huge ‘thank you’ to my family. I love you all so much! You rode the doctoral rollercoaster with me. Thank you to my sons, Bill and James, who continued to buoy me up when I would start to doubt myself. Thank you to my daughter-in-law, Anya, who asked about my study, listened patiently, and shared her calming way to my life. The three of you gave me love and encouragement that kept me working toward the goal. Your own determination, humor, and sense of justice inspired me. Last, but not least, I owe my heart to my husband, Tom. Your love sustained me. Thank you for the endless supply of creativity, patience, laughter, hugs, kisses, and Dove Dark Chocolates!
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CHAPTER ONE

STATEMENT OF THE PROBLEM

The field experience of a teacher education program is considered an integral part of developing teacher knowledge and skill (Cochran-Smith & Zeichner, 2005; Darling-Hammond & Bransford, 2005; Wilson, Floden, & Ferrini-Mundy, 2001). This culminating experience in teacher education provides preservice teachers with a venue to apply the theories and practices learned in methodology courses (Grossman, Hammerness, & McDonald, 2009). Exposure to and interaction with actual students prepares preservice teachers to gain insight into the practice of teaching and to experiment with newly acquired instructional skills (Hollins & Torres-Guzman, 2005). The preservice teacher is equipped with the theories and skills gained from the methodology courses and supported by an experienced mentor teacher and a university program supervisor. The field experience is often the first time that preservice teachers have an opportunity to interact authentically with students and a teaching community. However, research decomposing preservice teachers’ transfer of methodological knowledge and teaching practice, particularly mathematical knowledge, in the field experience is minimal compared to research examining other characteristics, behaviors, and settings (Anderson & Stillman, 2013; Clift & Brady, 2005).

Research examining teacher education programs often focus on preservice teachers’ attitudes and beliefs and not on the specific learning or transfer of skills that occurs during the program (Anderson & Stillman, 2013; Ball & Forzani, 2009; Clift & Brady, 2005; Wilson et al., 2001). There is little information regarding the use of knowledge across the disciplines, and mathematical knowledge was selected as a focus.
for this study. Mathematics instruction involves knowing and applying mathematical practice standards and mathematical content standards that often challenges preservice teachers (Ball et al., 2009; California Department of Education, 2013). Examining preservice teachers’ application of the mathematical knowledge and skills acquired from methodology courses requires decomposing and probing the factors that influence the selection and use of resources and instructional strategies practiced during the field experience (Cochran-Smith & Zeichner, 2005; Hammerness, Darling-Hammond, Grossman, Rust, & Shulman, 2005). Opportunities for practice and informative feedback support preservice teachers’ ongoing development of teaching skills within the complexity of the field experience (Grossman, Compton et al., 2009; Grossman, Smagorinsky, & Valencia, 1999). Furthermore, describing how and why preservice teachers select resources and strategies while using their curricular evaluation skills in mathematics instruction will support teacher educators in developing meaningful course assignments (Hammerness et al., 2005).

Despite the recommendations of the National Council of Research and recent reforms in many teacher education programs, research still indicates that preservice teachers struggle with the practice of curricular evaluation and lesson planning techniques in mathematics (Stein, Engle, Smith, & Hughes, 2008). The National Council of Research (2001) stressed the important role of lesson planning in student learning by advising that the “planning needs to reflect a deep and thorough consideration of the mathematical content of a lesson and of students’ thinking and learning” (p. 424). However, Stein et al. (2008) described that novice teachers were often surprised by student responses and unable to address the topic due to inadequate lesson preparation.
Preservice teachers often focus on student activities and time management without evaluating the materials for the appropriate pedagogy relating to the concepts and context (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006). Clarity is lacking in the research examining the specific struggle of preservice teachers’ field experience application of pedagogical knowledge acquired in mathematics methodology courses during the practice of lesson planning (Ball, Sleep, Boerst, & Bass, 2009; Cochran-Smith & Zeichner, 2005).

Equally lacking in the research are descriptions of the connection between what the preservice teacher learns in methodology courses and what knowledge and skills preservice teachers select to put into practice (Cochran-Smith & Zeichner, 2005). In a meta-analysis of research investigating aspects of mathematics methodology courses, most studies did not examine what was taught in the mathematics methodology courses, and few studies followed preservice teachers into their field-experience classrooms to look at their practices (Clift & Brady, 2005). Instead, many studies recorded how teacher beliefs, reflective practices, or attitudes towards equity changed from the beginning to the end of a teacher education course. This paucity of information about the struggle preservice teachers confront during the field experience leaves teacher educators uninformed about how to support the application of pedagogical knowledge into practice, specifically in mathematical lesson planning and instruction. This study used the conceptual framework of mathematical knowledge for teaching (Ball, Thames, & Phelps, 2008) to examine preservice teachers’ application of their mathematical knowledge for teaching in lesson planning and instruction during the field experience.
Recently, researchers point to a focus on reflection and strategy investigation in methodology courses, but notice a lack of focus in teacher education on the integration of knowledge with foundational instruction practices in mathematics and other disciplines (Ball & Forzani, 2009; Ball et al., 2008; Grossman & McDonald, 2008; Grossman, Compton et al., 2009; Lampert, 2010). Practice in a profession not only refers to the skill used to carry out certain activities, but the strategies used in preparing for and the performance of the activities (Shulman, 1998). The practice observed in the field experience is authentic to professional learning and is not as closely supported as the practice in the methodology courses. When viewed as a continuum of practice, the field experience would occur near the end of the continuum where short intervals of practice and frequent feedback are replaced by a continuous multifaceted, real-time event with unpredictable student responses and interactions (Boerst, Sleep, Ball, & Bass, 2011).

Although a research base for effective practices in mathematics methodology courses is limited, researchers over the past few decades worked to conceptualize the mathematical knowledge required for teaching (Ball & Bass, 2002; Grossman, 1990; Hill, Schilling, Ball, 2004; Shulman, 1986, 1987). Mathematical knowledge for teaching is the conceptualization of the content knowledge and pedagogical knowledge required for mathematics instruction (Grossman, 1990; Hill, Ball, & Schilling, 2008; Hill, Schilling, Ball, 2004; Shulman, 1986). The construct of mathematical knowledge for teaching extends Lee Shulman’s (1986) conceptualization of pedagogical content knowledge, or the integration of content knowledge or knowledge of the subject matter with pedagogical knowledge or knowledge of how to engage learners and address student misunderstandings of the content (Hill et al., 2008; Kuntze, 2012; Shulman, 1986, 1987).
Mathematical knowledge for teaching describes the knowledge necessary for teachers to comprehend the mathematics content while using specialized knowledge of students’ mathematical conceptual understandings and misunderstandings when preparing and implementing lessons (Ball et al., 2008; Hill et al., 2008).

Mathematical knowledge for teaching combines teachers’ knowledge of mathematics with their knowledge of how to teach students mathematical reasoning and mathematical representations. This type of knowledge includes teachers recognizing students’ mathematical misconceptions or conceptions before, during, and after a mathematics lesson. Research has thus far conceptualized four areas within the mathematical knowledge for teaching framework: common content knowledge, specialized content knowledge, knowledge of content and students, and knowledge of content and teaching (Ball et al., 2008; Hill et al., 2008). Two areas have been defined, but are yet to be conceptualized within the research: horizon content knowledge and knowledge of content and curriculum (Hill et al., 2008).

Mathematical knowledge for teaching is applicable to this study since this type of teacher knowledge is presented during mathematics methodology courses in preparation of the planning and instructional tasks that are required during the field experience (Ball et al., 2009). The first three areas, common content knowledge, specialized content knowledge, and horizon content knowledge are characterized in the research as types of subject-matter knowledge used in teaching to reason through the content, but do not contain knowledge of students or pedagogy. The latter three areas, knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum are characterized in the research as types of pedagogical content knowledge
used in teaching to reason through pedagogical decisions about conceptual instruction that accurately represents the mathematical concepts in ways that are understandable to students.

During mathematics instruction in the field-experience classroom, the expectation is that preservice teachers use their mathematical knowledge for teaching at a level that benefits student learning of mathematical concepts, practices, and reasoning (California Department of Education, 2013). The preservice teacher should be able to identify challenging topics for learners, identify what conceptions and misconceptions students hold, and determine appropriate instructional strategies to address all learning needs and situations (Ball & Forzani, 2009; Ball et al., 2008; Grossman, 1990; Hiebert & Morris, 2009; Hiebert, Morris, Berk, & Jansen, 2007; Shulman, 1986). For preservice teachers, the pedagogical knowledge used to evaluate both mathematical concepts and mathematical practices contained in elementary mathematics curriculum is not fully developed (Ball et al., 2009). Identifying the aspects of practicing lesson planning and instruction that challenge preservice teachers will inform methodology course curriculum, and, therefore, provide stronger learning support earlier in the teacher education program (Ball & Forzani, 2009; Grossman, Compton et al., 2009).

In summary, the importance and value of the field experience in the preparation of teaching knowledge and teaching practices prompts the need to examine more closely the challenges preservice teachers encounter during this culminating portion of their development (Cochran-Smith & Zeichner, 2005; Darling-Hammond & Bransford, 2005). Methodology courses teach content knowledge, pedagogical knowledge, and the practice of evaluating curricular materials (Boerst et al., 2011; Cochran-Smith & Zeichner, 2005;
Darling-Hammond & Bransford, 2005). Unfortunately, the research points to preservice and novice teachers’ frequent struggles implementing lessons that may indicate a fault in their lesson planning (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006; Stein et al., 2008). Furthermore, a lack of information exists in the current literature about the connection between preservice teachers’ use of mathematical knowledge for teaching when engaging in the practice of mathematical curricular decisions for lesson planning (Cochran-Smith & Zeichner, 2005). Therefore, this study examines and describes the factors influencing preservice teachers’ application of their mathematical knowledge for teaching during lesson planning and instruction in the culminating field experience. The mathematical knowledge for teaching framework previously discussed informed the method selected to address the research question.

**Purpose of the Study**

The purpose of this study was to examine and describe preservice teachers’ use of their developing mathematical knowledge for teaching in the practice of lesson planning and instruction during the field experience. Within preservice teachers’ knowledge, mathematical knowledge for teaching contributes to evaluative skills when planning mathematics lessons (Hiebert & Morris, 2009; Hiebert et al., 2007). The field experience setting occurs within the contexts of the school district and the teacher education program. The field experience provides an arena for preservice teachers to practice all aspects of teaching while guided by experienced, mentor teachers. Confronting authentic, but supported, lesson planning practice is one teaching aspect that occurs during the field experience of the teacher education program. Because lesson-planning skills are a developing practice for preservice teachers, the challenges and struggles for
Curricular and instructional decisions may be more apparent than the challenges and struggles of inservice teachers (Shulman, 1987). Identifying and describing the challenges and struggles during the practice of lesson planning will inform methodology course curriculum, and, therefore, provide stronger learning support earlier in the teacher education program (Ball & Forzani, 2009; Grossman, Compton et al., 2009).

Studying the practice of lesson planning and instruction was accomplished through a mini-case study design that consisted of four preservice teachers located at different field placements within the larger context of the same teacher education program. The descriptive nature of the research question and the bounded context of lesson planning and instruction within the teacher education program pointed to a research methodology that would examine the process as well as the experiences of and rationales for making pedagogical decisions using mathematical knowledge for teaching (Patton, 2002).

Four preservice teachers enrolled in the full-time, 15-week field experience of a graduate-level teacher education program at a private Northern California university volunteered to participate in this study. The full-time, 15-week field experience is the culminating portion of the teacher education program. This is the last step prior to the submission of the credentialing application, and eventually, become professional teachers. Their classroom placements were in three Northern California school districts. One preservice teacher was assigned to fourth grade, one was assigned to fifth grade, and two were assigned to sixth grade. Observing preservice teachers from similar grade levels kept the level of difficulty in the mathematics content, concepts, and pedagogies at about the same level.
Information regarding factors influencing the preservice teachers’ practice was gathered through two questionnaires, interviews, lesson plan document analysis, observations, field notes, and student assessments. The questionnaires provided information about the preservice teachers’ demographics, professional background, and educational background, as well as their mathematical knowledge at the upper-elementary grade levels. Written lesson plans from a single-concept lesson sequence were examined for aspects of mathematical knowledge prior to and after the pre-observation interview. The protocol for the pre-observation interview was designed to probe the rationale for the selection and use of resources and strategies for each component of the lesson plan: learning goals, materials, instructional techniques, activity sequence, and assessments. Each preservice teacher discussed the resources and rationale for lesson plans they used during their field placement for the interview. The university required the use of a lesson plan template by all preservice teachers that contains the components listed above.

Observations of the implementation of the lesson plans were conducted using a protocol. The observations were video recorded and field notes were written. After each observation, a post-observation interview that included a version of video-stimulated recall was conducted several hours after the observation. Whole-class student assessments were provided by the preservice teachers and prompted final reflections about the lessons during a final interview. These seven instruments collected data about how the preservice teachers used their mathematical knowledge for teaching during their lesson planning and instruction.
Significance of the Study

There are several reasons why this study is important. This study is important as it examined the use of mathematical knowledge for teaching from the perspective of *how* and *why* the preservice teacher made lesson planning and instructional decisions during the field experience. Much of the previous research has examined preservice teachers’ beliefs or attitudes towards curriculum materials, the content, or the field experience and has not focused on the actual practice of planning and instructional decisions during the field experience (Ball & Forzani, 2009). Less is known about factors that influence the preservice teachers’ decision about resources and foundational instruction strategies. Revealing preservice teachers’ use of their mathematical knowledge for teaching contributes to the information about the creation of supportive assignments and experiences that build lesson planning and instructional skills for the teacher education program (Grossman et al., 2000; Grossman & Thompson, 2008).

Furthermore, this study is important in identifying what factors influence the application of foundational knowledge during lesson planning prior to the transition from preservice to novice teacher. The evaluation of curriculum during lesson planning is a skill that may be applied to other content areas. Once identified, the foundational knowledge for a teaching skill may be taught to preservice teachers (Ball et al., 2009). Parsing out and articulating the essential teaching skills facilitate the instruction and practice of those skills (Grossman, Compton et al. 2009).

Finally, supporting the development of lesson planning skills, specifically the selection of curriculum resources and instructional strategies, facilitate the transition from preservice to inservice teaching. Undoubtedly, evaluating curriculum materials during
lesson planning is an important facet of teaching (Brown, 2009; Grossman & Thompson, 2008; Remillard, 2009; Valencia, Place, Martin, & Grossman, 2006). Transitioning from the support of a teacher education program into the solo-teacher classroom is challenging for the novice teacher. Confronted with the challenge of the multifaceted practice of teaching, many novice teachers abandon many skills learned in the teacher education program during the first year of teaching (Grossman, Compton et al., 2009). The novice teacher becomes reliant on the curriculum materials without evaluating the materials for relevance and value in the classroom or school context (Grossman & Thompson, 2008). Better equipping the preservice teacher with lesson planning skills would ease the transition into the solo practice as a novice teacher. Possession of established curricular evaluation skills would enable the novice teacher to focus on such things as the quality of instruction and meeting individual learners’ needs; something effective inservice teachers accomplish in their teaching practice over time (Ball et al., 2009; Grossman & McDonald, 2008; Grossman et al., 2000).

**Theoretical Framework**

This study investigated the factors that influence preservice teachers’ use of their mathematical knowledge for teaching when using their lesson planning and instructional skills during the field experience (Grossman, Compton et al., 2009; Hill et al., 2008; Shulman, 1986). The conceptual framework that informed this study is *mathematical knowledge for teaching*. The elements of mathematical knowledge for teaching are conceptualized in research and measurable (Hill et al., 2004). Specific aspects of mathematical knowledge for teaching are observable during preservice teachers’ lesson planning and instruction. The mathematical knowledge for teaching aspects relevant to
preservice teachers’ lesson planning and instruction are common content knowledge, specialized content knowledge, knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. These aspects of mathematical knowledge for teaching are used during lesson planning and instruction at all levels of teaching experience (Ball et al., 2008).

**Pedagogical Content Knowledge**

The intersection of content knowledge and pedagogical knowledge was described by Lee Shulman (1986) as pedagogical content knowledge or a teachers’ knowledge of how to instruct students in a specific content area. Specifically, teachers’ pedagogical content knowledge includes an understanding of the purpose and goals of the subject matter, knowledge of how learners interact with the subject matter, knowledge of the resources and representations needed for teaching the subject matter, and knowledge of methods and strategies for teaching the subject matter (Shulman, 1986, 1987).

Teachers use pedagogical content knowledge to engage learners, identify students’ conceptual understandings, and address student misunderstandings of the content (Hill et al., 2008; Kuntze, 2012; Shulman, 1986, 1987). Pedagogical content knowledge is used initially during the planning stages of the lesson, and is necessary when teachers interpret, evaluate, adapt, and interact with the curriculum (Beyer & Davis, 2012a; Lloyd & Behm, 2005; Remillard, 2005). Pedagogical content knowledge begins to develop during the coursework in the teacher education program (Grossman & Thompson, 2008). Preservice teachers possess pedagogical knowledge at a less developed level than inservice teachers do, and possess varying levels of content knowledge depending on educational background and experience (Collopy, 2003; Davis
& Krajcik, 2005). Teacher education coursework and the field experience support the
development of pedagogical content knowledge as well as mathematical knowledge for
teaching (Davis & Krajcik, 2005; Grossman & Thompson, 2008).

**Mathematical Knowledge for Teaching**

Pedagogical content knowledge integrates two separate components of teacher knowledge: pedagogical knowledge and content knowledge (Kuntze, 2012). Similarly, mathematical knowledge for teaching integrates two knowledge domains (Ball et al., 2008). Ball, Thames, and Phelps (2008) extended Shulman’s construct and proposed a model of mathematical knowledge for teaching that contains six aspects within two domains: pedagogical content knowledge and subject matter knowledge. The three aspects of the pedagogical content knowledge domain are *knowledge of content and students, knowledge of content and teaching,* and *knowledge content and curriculum.*

The three aspects of the subject matter knowledge domain are *common content knowledge, specialized content knowledge,* and *horizon content knowledge* (Figure 1).

![Figure 1](image.png)

*Figure 1.* Domain map of mathematical knowledge for teaching (Ball et al., 2008, p. 403).
Knowledge of content and students refers to knowledge of how students think and learn intertwined with mathematical content knowledge. Knowledge of content and teaching integrates mathematical content knowledge and knowledge of how to teach mathematical concepts and reasoning. Knowledge of content and curriculum is not yet conceptualized requiring further study, and is currently based on Grossman’s (1991) definition as knowledge of the curriculum materials and the pedagogy contained within the materials (Hill et al., 2008). These three aspects support the definition of pedagogical content knowledge as the intersection of knowledge about the content and knowledge about how to teach the content given information about students, the curriculum, and pedagogical skills (Ball et al., 2008).

The three aspects that support the definition of subject matter knowledge describe a teacher’s prior knowledge of the content, knowledge of how to share the content with students, and knowledge of how the content will connect in future topics (Ball et al., 2008). Common content knowledge refers to the mathematical knowledge that most educated adults possess. Specialized content knowledge is the mathematical knowledge that goes beyond common mathematical knowledge that teachers use when representing mathematical concepts, explaining procedures, and examining unusual learner solutions to mathematical problems (Ball et al., 2005, Hill et al., 2008). Horizon content knowledge is not yet conceptualized requiring further research, and is currently defined as a teacher’s orientation to the major structure of the broader discipline and connection of the content to that structure (Hill et al., 2008). Horizon content knowledge is not relevant to this study because preservice teachers are in the field-placement classroom for only half of the academic year. Instead, preservice teachers rely on the mentor teacher’s
lesson and unit sequencing decisions and long-term lesson planning. The mentor teacher’s previous long-term planning is used for guiding the preservice teacher’s short-term lesson planning.

Preservice teachers’ lesson planning during the field experience draw on knowledge obtained from previous school experiences, the teacher education coursework, the curriculum materials, and the mentor teacher (Grossman et al., 2000; Remillard, 2005; Rozelle & Wilson, 2012). Drawing on aspects of mathematical knowledge for teaching during lesson planning, the preservice teacher must identify and use the appropriate resources and/or tools to develop skills that present accurate and appropriate mathematical representations and conceptualizations for instruction (Ball et al., 2008; Hill et al., 2008).

**Background and Need**

Determining the key skills and abilities a person must possess for entry into the teaching profession has been a lengthy debate. In 1902, John Dewey wrote *The Child and the Curriculum* addressing the issue that teachers in public schools were instructing children in curricula that were disconnected from children’s experiences, disseminating information out of context, and focusing on children memorizing facts (Mirel, 2011). Dewey’s essay contributed to the progressive education movement that called for a change in curricula and an adjustment of teacher perspectives about the curricula to improve instructional quality. The implication that carried through the decades was that teacher education needed to redirect the preservice teachers’ beliefs about learning and the purpose of education while supporting the development of content knowledge and
pedagogical knowledge for lesson planning and instruction (Cochran-Smith, 2003; Darling-Hammond & Bransford, 2005; Mirel, 2011; Shulman, 1998).

Current reforms in many teacher education programs aimed to develop preservice teachers’ pedagogical content knowledge that is necessary for lesson planning and instruction. The methodology courses within teacher education programs instruct the preservice teacher on evaluating curricular materials, writing and implementing lesson plans, and on assessing students at the end of a lesson or series of lessons (Grossman & Thompson, 2008). Yet, lesson planning learned in methodology courses is often fragmented from and inauthentic to the actual practice of the teaching experience (Grossman & Thompson, 2008; Sherin & Drake, 2009). Ball and Forzani (2009) argued that the fragmentation of teacher education is due to the focus on beliefs and knowledge of learning and teaching and not on practicing the tasks of teaching. Research has suggested that this focus on beliefs contributes to preservice teachers’ lack of confidence in evaluating curricula, uncertainty about the changes needed when making curricular decisions, and reliance on published curriculum materials that may contain little support developing pedagogical knowledge (Grossman & Thompson, 2008; Grossman et al., 2000).

Preservice teachers with emerging pedagogical content knowledge often confront state-adopted published curriculum materials as they transition from the methodology courses into the field experience of the teacher education program (Beyer & Davis, 2012b; Grossman & Thompson, 2008; Sherin & Drake, 2009). Many state-adopted curriculum materials written to guide and support teachers during instruction are generic and do not support preservice teachers’ understanding of the rationale for the lesson
components or the pedagogical strategies (Beyer, Delgado, Davis, & Krajcik, 2009; Davis & Krajcik, 2005). Because the curricula materials suggested by the publishers may not support learning and practice, mentor teachers often prompt preservice teachers to use additional resources during lesson planning (Grossman & Thompson, 2008).

The mentor teacher is one prominent resource available to the preservice teacher. However, the type of support and influence varies in each mentoring situation (Rozelle & Wilson, 2012). Zeichner (1980) pointed out that simply placing a preservice teacher in a classroom with an experienced teacher does not necessarily benefit the preservice teacher’s learning and practice. He argued that in some cases field experiences served to merely socialize preservice teachers into the existing norms of teaching and learning and did not allow preservice teachers to practice the innovations taught in the methodology courses at the university. It is within this context that the quality of practice emerged as a major area of concern with researchers calling for an increase in the body of knowledge of practice as an element of teacher preparation programs (Cochran-Smith & Zeichner, 2005; Darling-Hammond & Bransford, 2005; Grossman, Compton et al., 2009).

**Teacher Practice**

Among the influential and challenging factors on learning the practices of teaching are that preservice teachers: (a) lack experience in the multifaceted classroom environment, (b) lack experience using curriculum materials, (c) lack confidence when evaluating and enacting curriculum materials, and (d) possess underdeveloped pedagogical content knowledge (Beyer & Davis, 2012b; Rozelle & Wilson, 2012). The preservice teacher often defers to the mentor teacher’s classroom style during the field experience, such as behavior management techniques, communication with students, time
management techniques, instructional techniques, and lesson planning. If the mentor teacher does not clearly share his or her pedagogical content knowledge decisions pertaining to lesson planning and instruction, the preservice teacher does not receive support developing their own pedagogical content knowledge to apply in practice (Valencia et al., 2006).

Second, preservice teachers often view published curriculum materials as authoritative and do not review the materials critically (Beyer & Davis, 2012b; Grossman & Thompson, 2008). The preservice teacher frequently does not evaluate the materials for school context needs, student needs, or appropriateness of pedagogical choices, but often focuses on student engagement during activities and instructional time management (Lloyd & Behm, 2005; Grossman & Thompson, 2008; Nicol & Crespo, 2006; Rozelle & Wilson, 2012). Finally, the curriculum materials are often generic and lack educative structure; information that would develop preservice teachers’ content knowledge and pedagogical knowledge (Grossman & Thompson, 2008; Valencia et al., 2006). When preservice teachers encounter curriculum materials that may be weak in content or pedagogy, they are unable to recognize the need to make appropriate modifications (Schwarz et al., 2008). Research describes that when preservice teachers practice evaluating and using the materials, they overcome some of the problems and they use specific knowledge to review the content and the pedagogy contained within the curriculum materials (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Valencia et al., 2006).

Studies on the relationship between teacher knowledge and practice have led Ball and her colleagues to assert that a need exists to understand what teachers do with their
acquired knowledge. Ball et al. (2008) identified mathematical teaching practices used daily by teachers. These practices used knowledge of the content and knowledge of teaching. Ball et al. (2009) argued that moving teacher education closer to the intersection of teaching knowledge and teaching practice should be a goal of teacher education. Ball and Forzani (2009) discussed the importance of “unpacking” professional practice in order to better support preservice teachers in their skill development. Yet, they acknowledged it is difficult for teacher educators and researchers to come to consensus on the identification of core activities and tasks used in effective teaching due to the multifaceted nature of teaching.

**Conceptions of Mathematics Curriculum**

Mathematics instruction is an example of the multifaceted nature of teaching. Mathematics instruction includes mathematical practice standards and mathematical content standards that often present challenges to preservice teachers (Ball et al., 2009; California Department of Education, 2013). Adopted in January 2013, the California Common Core State Standards for Mathematics (CCSS-Mathematics) proposed that student learning of mathematics needed to be accomplished through “real-world situations” while integrating the mathematical practice standards and the mathematical content standards. The mathematical practice standards contain both process and proficiency standards compiled from the National Council of Teachers of Mathematics and the National Research Council’s (2001) report *Adding It Up*. The mathematical content standards combine procedural standards that demonstrate a level of student understanding.
Curriculum publishers responded to the National Council of Teachers of Mathematics and the National Research Council’s call for mathematics instruction reform by adding pedagogical suggestions and activity extensions to teachers’ guides that support teachers during planning and instruction (Collopy, 2003; Lloyd & Behm, 2005; Nicol & Crespo, 2006). One difference between the traditional mathematics curriculum materials and the reform-oriented curriculum materials is the focus on mathematical reasoning and problem-solving activities (Remillard, 2000). A traditional mathematics lesson involves the teacher routinely introducing a mathematical concept, modeling an example of the concept application, and assigning problem sets for students to practice the concept. Little mathematical reasoning or problem solving may be contained in this type of lesson (Ball & Cohen, 1996; Collopy, 2003; Harbin & Newton, 2013; National Center for Education Statistics, 2003). Experienced teachers who are influenced by their prior beliefs about learning and about the curriculum continue to use traditional instructional practices. Traditional mathematics instructional practices continue despite reforms in mathematics standards, curricula, professional development, and teacher education that concentrate on creating situations allowing learners to engage in mathematical reasoning (Castro, 2006; Harbin & Newton, 2013; Lortie, 1975; Remillard, 2000; Remillard & Bryans, 2004). The influence of the experienced mentor teacher on the preservice teacher’s practices and promoting the reliance on traditional methodology is contained in the research (Lortie, 1975; Rozelle & Wilson, 2012).

Attempting to navigate state standards and the curriculum, preservice teachers rely on their mentor teachers. Their unfamiliarity with the curriculum materials and the mentor teacher’s influence often prompt preservice and novice teachers to rely on
published curriculum and past learning experiences with little to no variation used to strengthen student learning of the procedures or concepts (Grossman, Schoenfeld, & Lee, 2005; Lortie, 1975; Remillard & Bryans, 2004; Rozelle & Wilson, 2012). The intricacy of the mathematics discipline and the state standards may interfere with preservice teachers’ appropriate pedagogical content knowledge use when evaluating materials during lesson planning (Cochran-Smith & Zeichner, 2005; Grossman et al., 2005). Nevertheless, as the preservice teacher transitions into their career, they are expected to support students’ academic growth through the implementation of lesson plans based on the CCSS-Mathematics that emphasizes mathematical reasoning and proficiency.

**Research Question**

In order to examine preservice teachers’ use of knowledge at the end of the second field experience, the question posed for this study was:

> How do background and contextual factors influence preservice teachers’ use of mathematical knowledge in lesson planning and instruction during the field experience?

**Definition of Terms**

The terms defined in this section will assist the reader to understand the operational use of the words and phrases throughout this study. While there may be some disagreement of these terms and phrases, the use of the following definitions should be applied when reading this study.

**Curriculum:** The term is based on the definition in Section 51013 of the California Education Code and refers to the state-adopted, published units and lessons presented in a prescribed sequence to meet stated learning objectives for each subject-matter area.
Curriculum materials: The term refers to the resources provided in the state-adopted, published curricula. The materials are intended to support student learning and teacher practice (Forbes & Davis, 2008; Schwarz et al., 2008). The materials provided will vary from publisher to publisher, but generally contain a student textbook, a teacher’s guidebook, practice pages or workbooks, and assessment pages. This definition is similar to Section 60010(h) of the California Education Code.

Field experience: The term refers to the portion of a teacher education program that pairs a preservice teacher with an experienced inservice teacher for a required completion of mandated practice hours (Boyd, Grossman, Lankford, Loeb, & Wycoff, 2009; Feuer, Floden, Chudowsky, & Ahn, 2013). California Education Code (Section 44324) encourages teacher education institutions to provide a field experience during the teacher education program. The field experience is often used interchangeably with student teaching or teaching practicum in the research literature. The inservice teacher mentors the preservice teacher during the practice of all aspects of teaching. The preservice teacher is observed at intervals by supervisors from the teacher education program.

Foundational instruction practices: The term describes the teacher practices that support the mathematical teaching tasks identified by Ball et al. (2008). Teachers use the teaching tasks or practices throughout instruction. When teachers use foundational instruction practices, they use mathematical knowledge and pedagogical knowledge. For example, the teacher uses collaborative learning practices such as a problem-based activity to promote student communication of mathematical concepts and procedures.
**Inservice teacher:** The term refers to those teachers who possess a credential and are employed in the profession for more than three years based on the definition of *novice teacher* (Barrett et al., 2002). This term is often used interchangeably with *experienced teacher* in the research literature.

**Lesson plan:** The term refers to the planning for anticipated actions and responses that occur during instruction that include considerations of individual student needs, state and district requirements, and engagement of the students through relevant or real-world activities. The structure of the lesson plan varies, but generally contains learning standards and objectives, introduction to the topic, modeling of the central activity and/or opening a conceptual discussion, guided practice of the task or activity, students’ independent practice, closure or summarization, and an assessment of student learning toward the learning objectives (McCutheon, 1980; Peterson, Marx & Clark, 1978). During mathematics lesson planning, teachers consider students’ misconceptions and conceptions, common errors, mathematical reasoning, procedures, and multiple representations of the procedure (Ball et al., 2009).

**Mathematical knowledge for teaching:** The term refers to a conceptual framework describing the knowledge teachers use to comprehend the mathematics content while employing pedagogical knowledge to support and clarify the students’ conceptual understandings and misunderstandings (Ball et al., 2008; Charalambous & Hill, 2012; Hill et al., 2004).

**Mentor teacher:** The term refers to the experienced teacher who supports the teaching practice of the preservice teacher in the mentor teacher’s classroom during the field experience placement. Teacher education programs vary on the amount of
communication encouraged between the mentor teacher and university (Cochran-Smith & Zeichner, 2005).

**Multiple-subject credential:** The term refers to a teaching credential issued by the state of California that authorizes the holder to teach all subjects in a self-contained classroom, such as the classrooms in most elementary schools, in grades preschool, kindergarten through 12, or in classes organized primarily for adults (California Teacher Credentialing, http://www.ctc.ca.gov/credentials/leaflets/cl561c.pdf, 2014).

**Novice teacher:** The term refers to teachers that have received a preliminary credential and have been employed in the profession from their first year to their third year (Barrett et al., 2002). California supports newly credentialed, or novice, teachers through induction programs, California Beginning Teacher Support and Assessment Induction (BTSA) that are designed regionally and meet nine state standards for program quality (California Commission on Teacher Credentialing, http://www.ctc.ca.gov/educator-prep/STDS-common.html, 2011). The first three years of teaching are when the preservice teacher is transitioning into the profession. In 2003, the National Commission of Teaching and America’s Future reported that about one-third of beginning teachers leave the profession in three years.

**Pedagogical content knowledge:** The term refers to the integration of teacher content knowledge and pedagogical knowledge. Teachers integrate content knowledge or knowledge of the subject matter with pedagogical knowledge or knowledge of how to engage learners and address student misunderstandings of the content (Ball et al., 2008; Hill et al., 2008; Kuntze, 2012; Shulman, 1986, 1987).
Preservice teacher: The term refers to a person enrolled in a teacher education program that provides coursework and field experience that prepare the person for work in the teaching profession (Lloyd & Behm, 2005; Valencia et al., 2006). When all requirements are completed and approved, the person receives a teaching credential. This term is often used interchangeably with student teacher in the research literature.

Subject matter knowledge: The term refers to a teacher’s prior knowledge of the content, knowledge of how to share the content with students, and knowledge of how the content will connect in future topics (Ball et al., 2008)

Teacher education program: California Education Code (Section 44320) provides for the professional preparation of teachers at post-secondary education institutions. Used in this study the term refers to a post-baccalaureate program at an accredited college or university that provides coursework and field experience in the theory and practice of the teaching profession (Feuer et al., 2013). The research literature described other teacher education programs that are undergraduate programs, internships, and alternative credentialing pathways.

Summary

This section reviewed the background and need described in the research literature for an investigation into preservice teachers’ use of mathematical knowledge for teaching during mathematics lesson planning and instruction in culminating field experience. Shulman’s (1986, 1987) theory of pedagogical content knowledge along with Ball et al.’s (2008) extension of Shulman’s work to include mathematical knowledge for teaching form the theoretical framework for this study. The conclusion of this section included the research question posed for this study and the operational definitions of
relevant terms for reading this study. The next section reviews the literature on teacher practice and knowledge as it pertains to mathematics lesson planning and instruction.
CHAPTER TWO

LITERATURE REVIEW

Effectively evaluating curriculum materials for lesson planning is a key teaching practice that is learned initially in the teacher education methodology courses. The development of pedagogical content knowledge in the methodology courses supports curricular and instructional decisions. Pedagogical content knowledge guides the teacher to know what topic to teach, how to teach that topic, and why the topic and methods are important to use during a lesson. Pedagogical content knowledge and curricular evaluation skills generally strengthen over time during a teaching career. Mathematical knowledge for teaching, an extension of pedagogical content knowledge, similarly develops over time and supports effective curricular evaluation and pedagogical choices specific to mathematics curriculum materials. Research examining teaching tasks and activities continues to refine an understanding about the specific knowledge that is necessary to support the teaching of professional practice for lesson planning and instruction (Grossman, Compton et al., 2009). However, complicating the research of teaching practice is the current lack of a common curricula and pedagogies in teacher education programs (Darling-Hammond & Bransford, 2005).

Furthermore, the development and use of foundational instruction practices begins in the methodology courses of the teacher education program (Ball et al., 2008; Grossman, Compton et al., 2009). Preservice teachers most likely observed and experienced instructional practices as students earlier in their lives. However, identifying and using the instructional practices is multifaceted and often challenging when learning how to teach.
Research about *how* developing knowledge about lesson planning and instruction is used during the field experience may inform teacher educators about the best methods to support preservice teachers’ learning. Appropriate support of knowledge development would better prepare preservice teachers’ transition into their teaching careers. This chapter reviews literature pertinent to the framework of this study. Each section is organized in a chronological sequence to illustrate the continuous exploration into the aspects of the teaching phenomenon relevant to this study. The presentation of the literature in this section is not exhaustive. Rather, the literature is representative of the research that informed this study. The literature is presented in four sections: teacher education, situative perspective of practice, lesson planning and curriculum, and mathematical knowledge used in teaching practice.

**Teacher Education**

What knowledge and skills should be required and practiced in teacher preparation has been a topic of discussion and debate for more than 150 years (Borko, Liston, & Whitcomb, 2006; Levine, 2006). Historically, criticisms of teacher education have included the qualifications of teacher educators, the qualifications of preservice teachers, the structure of the institutions providing teacher education, the inconsistency of the curriculum in teacher education programs, and the gap between theory and practice (Darling-Hammond, 2010; Lanier & Little, 1986; Levine, 2006). John Dewey (1904/1965) argued for a laboratory approach to teacher education. William Russell (1936) called for teachers to create their own path to certification. James Conant (1963) proclaimed that teacher education programs were in disarray and lacking substance.
In 1983, *A Nation at Risk: The Imperative for Educational Reform* was published by the National Commission on Excellence in Education reported on the poor state of student achievement in the United States. The report generated a large wave of educational research that included among many topics the examination of teacher characteristics, teacher effects, curricula, and student characteristics. In 2009, the United States Secretary of Education Arne Duncan declared that many teacher preparation programs were doing a “mediocre job.” This most recent criticism placed teacher education in the forefront once again and ignited more research into teacher preparation. Recently, there has been a renewed charge that the teacher education curriculum focuses more on changing the beliefs and attitudes of preservice teachers and neglects the practice of applying core knowledge and skills (Ball & Forzani, 2009; Grossman, Compton et al., 2009; Lampert, 2010).

The traditional teacher education model issues certificates for 70% to 80% of over 150,000 new teachers annually in the United States (Feuer et al., 2013; National Research Council, 2010). The remainder of newly certificated teachers enters through one of the 130 alternative credentialing pathways offered in the United States (Feuer et al., 2013; Levine, 2006; National Research Council, 2010). The traditional model requires preservice teachers to complete courses on legal issues, theories in education, methodology courses, and some form of apprenticeship. The methodology courses cover topics about appropriate pedagogy for the subject matter and practicing the application of the knowledge and the skills using various instructional techniques. Later in the program, preservice teachers are assigned to separate classrooms and different school sites for the opportunity to authentically practice applying the newly acquired knowledge
and skills. The full-time, semester-length field experience is arranged as a partnership between the university and the school to support the preservice teacher’s apprenticeship. Each preservice teacher receives support from a mentor teacher, perhaps from other teachers in the grade level, and from the university supervisors.

While the traditional model is structured similarly throughout the United States, the subject matter addressing content and pedagogy and the length of the field experience vary greatly among the universities (Goodlad, 1990; Levine, 2006; Murray, 2008). Wilson et al. (2002) reported that teacher education programs have the freedom to create their own conceptual frameworks and structure while operating within the constraints of national and state accreditation guidelines. This often limits the generalizability of the research of teacher education programs with state-to-state or even program-to-program variability.

Teacher education programs are mostly state-regulated, which perpetuates the variance in teacher preparation throughout the United States (Boyd, Goldhaber, Lankford, & Wyckoff, 2007). In a survey of 709 members of the American Association of Colleges of Teacher Education (AACTE), Ludwig et al. (2010) found that 676 offered initial bachelor’s degrees and 540 offered post-baccalaureate initial education degrees. In an analysis of different pathways in teaching certification across the United States, Constantine et al. (2009) collected data from teachers in 20 districts located across seven states. The responses regarding teacher-education coursework hour requirements varied from 240 to 1,380 hours. The field experience requirements varied from 500 to 560 hours for bachelor’s-degree level requirements and 280 to 586 hours for master’s-degree level requirements in an AACTE survey of 767 member responses (AACTE, 2013).
Although the varying teacher education programs may contribute to varied experiences, many researchers argue that the structure of teacher education is not the primary influence on preservice teachers’ learning during their apprenticeship.

In his seminal book, Lortie (1975) noted multiple reasons why teacher education programs often have little influence on preservice teachers. Unlike many other professional preparation programs, preservice teachers have observed the teaching profession during their elementary and secondary education. Preservice teachers often set their teaching performance perceptions and standards based on their childhood experiences. Therefore, if the methodology course subject matter does not match their previous perception of teaching, many preservice teachers dismiss the material as unrealistic.

Furthermore, research about the influence of the knowledge from methodology courses on preservice teachers’ practice varies. In a review of 20 research projects published from 1995 to 2002 on mathematics methodology courses and field experience, Clift and Brady (2005) located 10 studies that reported mixed results, nine that reported positive influences, and one that reported negative results. Several of the positive influences included “beliefs about mathematics, abilities to write lesson plans, and demonstrating a knowledge of constructivist principles” (p. 318).

Ebby (2000), a mixed-influence study in the review by Clift and Brady, conducted an ethnographic study of three preservice teachers as they navigated their mathematics methodology course and teaching in the field experience. Two preservice teachers were able to reflect on their role as learners and incorporate it into their role as teachers. One of the two preservice teachers used knowledge gained about student misconceptions from
her methodology course and student responses to inform her lessons. However, one
preservice teacher who had identified herself as a poor mathematics student and exhibited
anxiety about mathematics, struggled to incorporate the inquiry-type mathematics
instructional techniques from the methodology course into her field experience. In
summarizing their review, Clift and Brady wrote, “In part, this [field setting
disillusionment] may be due to the fact that prospective teachers understandably have
difficulty integrating knowledge across domains in course work and integrating
propositional knowledge with practical knowledge in the field” (p. 332). The context or
situation where the practice occurred influenced preservice teachers’ development.

**Situative Learning Perspective of Practice**

Situative learning theory proposes that knowledge is linked to the context in
which it is acquired (Brown, Collins, & Duguid, 1989; Greeno & The Middle School
Through Applications Project Group, 1998). Teaching is shaped by the culture it is
located within (Stigler & Hiebert, 1999). There are tasks particular to the practice of
teaching that would be recognizable in any culture, such as planning a lesson. However,
many teaching practices are conducted in isolation from other teachers, but the practices
are still influenced by the people and society around them. Learning to enact teaching
practices is accomplished through an enculturation process that occurs during the
implementation of authentic activities (Brown et al., 1989). The theoretical foundations
learned in the university must ultimately integrate with practice used by a teacher in the
school environment (Shulman, 1998). Lortie (1975) described the school environment as
a cell-like structure that places teaching practices within an interactive system. The
structure may hinder knowledge growth among practitioners or it may encourage individual creativity depending on the particular environment.

As adults, preservice teachers have spent many years observing the practice of teaching in various school environments. Preservice teachers bring to their teacher education experience a highly developed perspective of teaching before the formal teacher education program of study begins. Lortie (1975) argued preservice teachers’ familiarity, while useful in some instances, often hinders their ability to observe particular aspects of teaching practice. Preservice teachers often begin using practices by mimicking those they observed in their youth, described by Lortie as the apprenticeship of observation. Of the teachers Lortie sampled, 90% expected that teaching would be easier than they experienced. Their expectations were based on the ease or routine of observed practices performed by experienced teachers. He claimed that preservice teachers enter teacher education programs with vast experiences and varied opinions about the professional practices based on earlier observations. Interaction with experienced and skillful teachers may facilitate less experienced teachers by sharing how and why practices are used in the educational community.

Lave and Wenger (1991) proposed that communities of practice support learning about how to participate within that professional community. Communities of practice are described as groups of people who share common goals or interests. Individuals within the group learn to perform activities and share knowledge with other members of the group. The concept of legitimate peripheral participation discussed by Lave and Wenger contends that new members in a community of practice develop knowledge, skill, and competence through their interactions with the community members. Over
time, participation in the community increases the learners’ experience with the expectations and practices of the group. As the learner acquires the tools necessary for participation in the community, that learner moves from the periphery to membership in the community. Likewise, preservice teachers move along a learning trajectory as they progress through the teacher education program and acquire the knowledge and skills of teaching practice from professors and mentor teachers.

Ball and Cohen (1999) focused on practice-based professional education when examining the complex interactions in teaching practice. They proposed the need to situate teacher learning within the context of authentic practice early in the teacher education program. Referencing Little (1990), Ball and Cohen acknowledged the challenge of learning how to teach is that many of the demonstrated or observable skills are known only to the skilled practitioner. They argued that supporting collaboration among teachers would support making the details of practice explicit. Practice-based professional education provides opportunities for preservice, novice, and experienced teachers to engage and expose the details of teacher practice.

Furthering the discussion about teacher practice, Putnam and Borko (2000) maintained that practices, such as lesson planning, intertwine with the teachers’ experience, the culture and structure of the classroom environment, specific learners, district policies, and state mandates. Citing situative learning theorists Greeno, Collins, and Resnick (1996), Putnam and Borko argued that professional practice is learned within the specific professional setting with the support and guidance of experienced practitioners. Preservice teachers learn and use the characteristic behaviors of teaching practice by interacting with, learning from, and approximating the behaviors of
experienced teachers (Chaiklin & Lave, 1996; Greeno et al., 1996). Putnam and Borko posited that using the situative learning perspective in teacher education would ground the learning of theories in the context of practice.

After examining her own teaching practice for one year in the context of a fifth-grade mathematics class, Lampert (2001) proposed what she referred to as an “elaborated model of teaching practice” that conveyed the complexity of instruction. In her complex model of teaching practice, Lampert cited a lengthy list of problems that teachers must address that included room preparation, daily scheduling, short- and long-term planning, engaging students, and assessing students. The practice of teaching appears overwhelming in Lampert’s model. She elaborated teachers must additionally address facets of their practice that extend into the future such as social relationships and relationships with the content. She argued:

Actions taken by the teacher in relation to individuals and groups are thus continuous, not only with what happens immediately prior, but with the entire history of relationships with all of the students in a class and all of the curriculum, across however many lessons the class has shared. (Lampert, 2001, p. 428)

Teaching such a complex practice to those entering the profession was the focus of a longitudinal study conducted by Grossman, Compton et al. (2009).

Grossman, Compton et al. (2009) proposed a conceptual framework of pedagogies of practice in professional education. The development of the framework was based on their examination of three professions that are situated in areas dealing with human relationships or human improvement: teaching, clergy, and clinical psychology. Situated in professional communities with ethical obligations to the people served by
members of the profession, the people in those professions educate new members about their practices (Chaiklin & Lave, 1996; Shulman, 1998). The framework described three central and interrelated components as elemental to the development of entry-level professional abilities to engage in the practice of the profession. These three central constructs are representations of practice, decompositions of practice, and approximations of practice.

Representations of practice are tools that are useful in portraying the professional practice to learners, such as video cases, narratives, and modeling. As Grossman, Compton et al. (2009) noted there is a great deal of variability in what is and what is not accessible to the learner in various representations of practice. For example, a video representation of a teacher enacting a mathematics lesson would not yield the same information as a teacher educator modeling a representation of a teacher thinking aloud about the pedagogical considerations of certain activities prior to the lesson. Decompositions of practice are the acts of dividing a complex practice into smaller portions to support the purposes of teaching and learning. Grossman, Compton et al. (2009) cautioned that the smaller divisions needed to maintain a sense of the whole practice to keep the characterization of the practice. Ultimately, the learner must bring all divisions of practice together in order to effectively approximate the actual practice.

Approximations of practice are conceptually most relevant to this dissertation. Simulated practice of a behavior in a setting that provides coaching and feedback to the learner often occurs in the university environment for professional education. In teacher education, the methodology courses allow the preservice teacher to practice lesson planning and instruction with their classmates who role-play as elementary students. In
this setting, the preservice teacher receives immediate feedback and guidance regarding their practice in the controlled environment of the university classroom. Ideally, the preservice teacher would be given another opportunity to implement the practice incorporating the earlier feedback.

As the preservice teacher progresses into the field experience, the practice occurs in the context of an elementary classroom under the guidance of the mentoring classroom teacher. Guidance and support at the varying levels of approximations of practice is one key feature of the framework. In the professions studied by Grossman, Compton et al. (2009), a continuum of approximated practice led the learner from the controlled university classroom to supervised practice in an authentic apprenticeship setting. A second feature of the approximations of practice is that the design focuses the preservice teacher’s attention on an essential aspect of a decomposed action from the authentic practice. On the continuum of approximated practice, earlier or less authentic practice is more elaborated than actual practice. Grossman, Compton et al. (2009) cited that experienced teachers rarely expand lesson plans to the level that is required of preservice-teacher practice in a methodology course, but the expansion gives the preservice teacher an opportunity to focus on the planning process and the rationales for the practice.

Lampert et al. (2013) applied the approximations of practice framework in their exploration of rehearsals in a mathematics methodology course in three teacher-residency programs. In a teacher-residency program, preservice teachers implement the lesson plan not long after their practice, feedback, and reflection occurred in the methodology course. The intention of the teacher-residency program design was to blend coursework and fieldwork closer in time. The mentor teachers participating in a teacher-residency
program are more deeply involved with the methodology courses than those in a traditional teacher education program. It should be noted that this dissertation focused on a traditional teacher education program, but the information regarding implementation of the approximations of practice framework is valuable to this dissertation. There is a longer time gap between practice and implementation in traditional preparation programs. The purpose of Lampert et al.’s (2013) exploration was to articulate the pedagogy of practice and not to examine what the preservice teachers learned from the practice.

Lampert et al. (2013) analyzed 90 rehearsal videos recorded over a 3-year period from the three teacher-residency programs. The learning cycle of rehearsals gave the preservice teachers opportunities to approximate teaching, receive feedback, and adapt their practice. The preservice teachers were able to focus on the key aspects of practice. Additionally, the preservice teachers focused on variations of the practice that related to particular aspects of learning and mathematical goals. Preservice teachers practiced a cycle of instructional activity planning that included approximating the practice of lesson planning.

**Lesson Planning and Curriculum Use**

A lesson plan organizes the instructional activities that may serve as a “memory-jogger” for a teacher prior to and during instruction (McCutcheon, 1980). In 1949, Ralph Tyler proposed a linear lesson plan model consisting of a four-step objectives-based process: (a) specify purpose or learning objectives, (b) choose appropriate learning experiences, (c) organize and sequence the experience, and (d) select evaluation procedures and make any revisions. Later research on lesson planning aimed to disprove Tyler’s linear planning model. Much of the research was often conducted in
isolation from other aspects of teaching practice. Lesson planning research in the following years included studies on such topics as knowledge transformation or expert-novice comparisons (Clark & Peterson, 1986).

The empirical studies of lesson planning in the 1970s and 1980s sought to document teachers’ planning practices using observations, surveys, interviews, think-aloud protocols, analyses of written plans, stimulated recalls, and ethnographies (Clark & Peterson, 1986; Shavelson, 1983). Many of the studies described that experienced teachers did not follow a linear planning model such as Tyler proposed. The learning objectives were seldom the starting point for teacher planning, and most teachers began by identifying the content and activities (McCutcheon, 1980, 1981). Repeatedly, studies of teacher planning described that teachers’ written plans did not consistently reflect the thinking that occurred during the planning and that not all of a teacher’s planning occurred during structured planning times well in advance of instruction (Clark & Peterson, 1986).

In their comparison of experienced and preservice teachers’ lesson planning, Borko and Livingston (1989) identified differences and similarities in lesson planning patterns. The research focused on lesson planning, implementation, and post-observation reflection. Observations and interviews of one elementary preservice teacher, two secondary preservice teachers and their mentor teachers took place over a one-week period of lesson planning and implementation.

In their study, Borko and Livingston described how experienced teachers articulated their unwritten or mental lesson plans in detail when interviewed. Their planning carefully considered how to introduce a topic or how to explain a concept. The
teachers selected several examples, representations, and/or problems for use during the lesson depending on students’ responses to the lesson material. One secondary-level experienced teacher self-reported mentally planning his instruction to include conceptual explanations, engaging learning through appropriate activities, and the pacing of each activity. Additionally, the experienced teachers in different grade levels focused on different issues in instruction: the secondary teachers often focused on explanations and presentation of content, while the elementary teacher often focused on various types of instructional activities.

Preservice teachers in Borko and Livingston’s study were selected based on their strong mathematics content knowledge and pedagogical knowledge. The data collection occurred toward the end of their field-experience placement. The above factors may explain why these preservice teachers shared certain similar traits with the experienced teachers when planning. For example, their lesson plans contained flexibility in timing, pacing, and selection of examples and mathematics problems. Unlike the experienced teachers, the preservice teachers were only able to conduct short-term planning because they considered their content knowledge to be too limited to plan extensively for a longer term. Additionally, they were challenged by knowing how to present the content appropriately to students, and their lesson plans relied heavily on the teacher’s curriculum manual. All three preservice teachers reported a lack of confidence in preparing for student reactions to the content, and were unable to adequately plan for and respond to student responses. The practice of lesson planning seemed to require a skill of flexibility when adapting plans prior to and during instruction for experienced and preservice teachers.
In their effort to identify useful lesson planning skills for preservice teachers, Kagan and Tippins (1992) compared lesson-planning practices of five elementary and seven secondary preservice teachers. The elementary preservice teachers’ field experience lasted 10 weeks, and the secondary preservice teachers’ field experience lasted 17 weeks. Kagan and Tippins requested that none of the mentor teachers require a particular lesson plan format of the preservice teachers during this study so they could observe the preservice teachers’ adaptations and choices using the available curriculum materials.

Prior to starting their field experiences, Kagan and Tippins requested that the preservice teachers use Tyler’s linear planning model at least twice, and advised them to modify the format as needed later in the study. The preservice teachers kept written journals of their experiences with lesson planning and instruction throughout the field placement. The differences between the secondary and elementary preservice teachers surfaced early on in the study. One secondary preservice teacher assigned to teach middle-school history and English quickly changed to planning formats that matched the complexity of the lesson. He used a variety of outlines, lists, and flowcharts with varying details about the sequencing of lesson events. Another preservice teacher teaching high school English used various lesson plan formats that grouped objectives, procedures, and evaluations used throughout a lesson. Her format eventually looked like a flowchart with each grouping contained in one box. The secondary preservice teachers wrote that managing large groups of adolescent behaviors led them to create more detail in the lesson plan to guide discussions and activities.
The elementary preservice teachers found the lesson plans burdensome since they were planning for multiple subjects throughout the day. All five of the preservice teachers stopped using the initial format within the first few weeks of the field experience. One third-grade preservice teacher after a few weeks used an outline format and by the end of the field placement omitted the objectives and the evaluation from her outline plan. Another preservice teacher in a third-grade field placement modified her lessons to focus on interrelated concepts and not on isolated skills. This stemmed from her belief that the teacher’s curriculum guidelines focused on implementing too many skills in one lesson. One kindergarten preservice teacher early on in the field experience switched to listing only the materials required for the lessons to be used at learning centers. All of the elementary preservice teachers referred to the lesson plans contained in the curriculum guides for the objectives and evaluations. Their plans became outlines for procedures that included identifying the variations or adaptations of the curriculum guide lessons. The elementary preservice teachers often wrote about particular children’s attitudes, behaviors, and progress in their journals. They did not necessarily focus on the child’s interaction with the content or lesson activities.

Kagan and Tippins argued that the context the teacher practices within the placement influences the planning. The secondary preservice teachers varied by subject matter and added more detail about content in the format they chose to plan. The elementary preservice teachers used less detail about content and focused on procedures and materials. The greatest contrast described by Kagan and Tippins was that secondary preservice teachers viewed their students as a class that required management of behavior and a mastery of the content. Thus, their lesson plan formats included more detail about
the subject matter. The elementary preservice teachers viewed their classes as individual students with lives outside of the classroom. Thus, their lesson plan formats included more detail about the interactions and spontaneous needs of students. The practice of lesson planning evolved within the context of teaching for both levels of preservice teachers.

Focusing on only elementary-level preservice teachers, Lloyd and Behm (2005) examined lesson-planning analysis within the context of a methodology course assignment. The preservice teachers did not have an opportunity to observe or participate in the implementation of the lessons. In a typical assignment for a methodology course, Lloyd and Behm examined 23 preservice teachers’ written analyses of two textbook lesson plans. Both lessons covered the topic of parallelograms, but used differing pedagogical formats. One lesson plan was referred to as a traditional format and the other as a reform-oriented format. The preservice teachers were not aware of the delineation between the two formats. The traditional format contained a teacher-centered discussion of the material with no communication of mathematical reasoning between students, no individual practice of mathematics problems after the teacher’s presentation of the concepts, and no extensions of the mathematical ideas beyond the general practice. The reform-oriented format contained a student-centered discussion about the material with opportunities for communication about mathematical reasoning between students, opportunities for the students to express their ideas in problem-solving tasks, and exploration of new ideas and extensions of those ideas.

The assignment asked the preservice teachers to analyze the textbook lessons for the following aspects: differences between the materials, descriptions and explanations of
the elements they liked or disliked about each lesson, and an explanation about the main ideas and mathematical understandings students would gain after the lesson. The preservice teachers preferred the traditional lesson format with 20 out of 23 explaining that the format was familiar to them. Only 16 preservice teachers described learning goals for the lessons, and 13 of those explained that the pedagogy in the reform-oriented lesson did not support children’s learning of the goal. A possible explanation of the preservice teachers’ analyses was the point in the teacher education program when the study was conducted. Lloyd and Behm conducted the study in the midst of the mathematics methodology course unlike the current dissertation, which will be conducted at the end of teacher education program. The preservice teachers need time to interact with and practice using the curriculum materials (Grossman & Thompson, 2008; Nicol & Crespo, 2006).

Examining the evaluation and use of mathematics curriculum materials by preservice teachers was the focus of research conducted by Nicol and Crespo (2006). Unlike Lloyd and Behm, the case study of four preservice teachers conducted by Nicol and Crespo occurred in both the mathematics methodology course and the field experience. The preservice teachers were asked to select and analyze 10 mathematics problems from a variety of sources as an assignment for the methodology course. All of the preservice teachers selected problems that would be meaningful and engaging for students, but none of the problems presented learning tasks with conceptual depth. One preservice teacher selected problems that focused on the procedures that required a single answer and few operational skills. The other three preservice teachers selected problems that included tasks focused on problem solving with several procedures possible, the
development of and connection to mathematical concepts, and the use of a range of operational skills.

A second assignment examined by Nicol and Crespo from the methodology course involved the adaptation of the 10 selected problems from the first assignment. All four preservice teachers made changes to the characters or settings of the problems to make the information connect to current people and events in students’ lives. Only two preservice teachers made adaptations that extended the complexity of the mathematical content, but did not make the extensions to all 10 problems. Only one preservice teacher on one problem discussed how she would get to student thinking by making the adaptation.

During the field experience portion of the study, Nicol and Crespo examined how the preservice teachers analyzed and implemented lessons from the textbooks used at the placement schools. The study did not name the textbook publishers nor if similar publishers were used in the field placements, but the study did specify that the textbooks contained traditional mathematics lesson methods. The preservice teachers expressed a perception that the textbook supported their teaching and their learning about mathematics instruction. One preservice teacher adhered to the textbook and made only superficial adaptations to the lessons. Two preservice teachers relied heavily on the textbook, but did elaborate or extend on some of the conceptual and contextual material. One preservice teacher used the textbook as one of many resources that informed her instruction, and she made conceptual and contextual adaptations.

Nicol and Crespo argued that textbooks support preservice teachers as they develop teaching skills. They suggested that preservice teachers require support in
learning with and learning from textbooks during coursework and the field experience. Factors identified from the data as influencing the preservice teachers’ interpretation and use of the curriculum was their familiarity with and understanding of the content. When questions arose for the preservice teachers about the curriculum content, each questioned their own understanding of the mathematical concepts rather than the textbook representation. The information reported in this study supports the question raised in this dissertation about how preservice teachers’ mathematical knowledge for teaching and the resources selected influences their lesson planning and instructional skills.

In Mutton, Hagger, and Burn’s (2011) longitudinal study of how teachers learn lesson-planning skills, observations and interviews of 17 participants occurred over a three-year period. The study began when the participants were preservice teachers in their field experience and followed them into their first and second years of novice teaching. Mutton and his colleagues analyzed 170 post-lesson interviews conducted with the participants. They described the differing contextual aspects of learning to plan lessons. The process and the participants’ learning from planning varied from the development of detailed plans to meet the concerns of a mentor teacher to the development of outlined plans as novice teachers. The process of planning for preservice teachers was similar to a script and did not allow for flexibility to respond to student learning needs.

As preservice teachers, the participants mentioned the process of planning 88 times during the post-lesson interviews. This number decreased in the first and second years of teaching to 71 and 40 instances respectively. The planning process was a priority to the preservice teachers due to the need to produce detailed lesson plans as
assigned. Mutton and his colleagues argued that the detailed plans produced by preservice teachers were a result of trying to adapt to the mentor teachers’ methods with the mentor teachers’ students. This distracted the preservice teachers from the knowledge about students and their needs when planning; the participants acquired this type of knowledge as they moved into their own classrooms in the following years.

Mutton and his colleagues posited that teacher educators should not assume that preservice teachers learn about the relationship between planning and student learning just by practicing planning in the methodology courses and the field experience. To ease the transition from preservice to novice teacher, teacher educators should assist preservice teachers to learn how to make lesson plans flexible. The skill of planning flexibility would assist the preservice teacher to adapt within the mentor teacher’s classroom and to practice the flexibility in his or her own classroom. Learning to plan flexibility into a lesson would support the development of pedagogical knowledge when anticipating student responses during a lesson.

**Mathematical Knowledge for Teaching**

The literature describing the development and use of mathematical knowledge for teaching spans several decades. Mathematical knowledge for teaching extended Shulman’s (1986) framework for teacher knowledge that included pedagogical content knowledge (Ball & Bass, 2002). Frameworks on teacher knowledge create a foundation for educational researchers who are investigating the phenomena occurring in the classroom. Teachers’ multifaceted practice is a challenge to decompose, making observing and describing the type of knowledge informing practice difficult (Ball & Bass, 2002; Hill & Ball, 2004).
In the 1980s, researchers saw the need to study the types of teacher knowledge that was most related to the practice of teaching (Hill & Ball, 2004). During this time, Shulman (1986) responded to the existing research that emphasized general pedagogical knowledge as a measure of effective teaching. Shulman argued that pedagogical knowledge and content knowledge should not be studied separately. He proposed the concept of pedagogical content knowledge as the integration of those two knowledge types. Pedagogical content knowledge supports teachers in knowing how to structure and present content to learners, know what conceptions and misconceptions learners hold about the content, and what instructional strategies would support all learners in a variety of situations.

Shulman’s (1987) theoretical framework of teacher knowledge included several categories of teacher knowledge. The first four categories were those widely used in research well into the 1980s to determine a teacher’s effectiveness. The four categories included: (a) general pedagogical knowledge with reference to those broad principles and strategies of classroom management and organization; (b) knowledge of learners and their characteristics; (c) knowledge of educational contexts; and (d) knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Shulman proposed three additional categories that represented three dimensions of content-related knowledge essential for effective teaching. Content knowledge referred to the amount and organization of knowledge the teacher possessed. Shulman suggested teachers must understand the content beyond common knowledge of the subject matter. Teachers should understand why a particular topic or rule is true. The
teacher must understand why particular topics and concepts are important and should be emphasized and why others are less important.

The second category proposed was curricular knowledge and, according to Shulman, often neglected by teacher education programs. Curricular knowledge included knowledge of the full range of programs and resources designed and available for teaching particular subjects and topics, the variety of instructional materials available, and the set of characteristics that guide educators in deciding whether or not to include particular materials as part of the curriculum. Curricular knowledge also included lateral curriculum knowledge, described by Shulman as the ability to relate the content of specific courses or lessons to topics from other subject areas. In addition, teachers must have vertical curriculum knowledge or an understanding of the topics that have been and will be taught in the same subject area during preceding and later years of school.

The third content-related category proposed was pedagogical content knowledge. Pedagogical content knowledge focused on the aspects of content knowledge related to the practice of teaching. Shulman maintained that pedagogical content knowledge included knowledge of the topics most regularly taught and the most useful forms of representation of the topics and concepts including the most powerful analogies, illustrations, examples, explanations, and demonstrations. Pedagogical content knowledge also included an understanding of what makes learning particular topics more difficult than learning other topics. This included the teachers’ understanding of the conceptions and misconceptions that students of differing ages and backgrounds commonly possess.
Grossman (1990, 1991) continued investigating the sources and descriptions of teacher knowledge. Grossman identified four components of pedagogical content knowledge: (a) conceptions of the purposes for teaching particular subject areas; (b) knowledge and beliefs regarding student understanding; (c) curricular knowledge; and (d) knowledge of instructional strategies and representations for teaching particular topics. Extending Shulman’s (1986, 1987) description of pedagogical content knowledge, Grossman placed curricular knowledge within pedagogical content knowledge. The component identified as conceptions of the purposes for teaching particular subject areas is supported by the other three components in Grossman’s description of pedagogical content knowledge.

Hiebert and Morris (2009) described the enactment of each knowledge category during lesson planning based on Grossman’s (1990) four categories of pedagogical content knowledge. The first category recognizing the purposes for teaching the material applied to preservice teachers’ understanding of the stated lesson goals and the rationale for the goals. The second category knowledge of student thinking applied to preservice teachers’ ability to think of and plan for probable and possible student responses to questions and tasks. The third category knowledge of the curriculum as a connected set of ideas applied to preservice teachers explicitly making connections between ideas, lessons, and materials. The fourth category knowledge of strategies and representations applied to preservice teachers using the appropriate pedagogical techniques to support student learning of the learning goals. The enactment of curricular decisions during planning is the integration of pedagogical content knowledge and practice (Grossman, Compton et al., 2009).
Ball and her colleagues (2005, 2008; Hill et al., 2008) extended Shulman’s (1986, 1987) and Grossman’s (1990, 1991) frameworks by describing specialized teacher knowledge for mathematics. Mathematical knowledge for teaching is described as the mathematical knowledge that teachers use to support instruction and student learning. Mathematical knowledge for teaching is comprised of interwoven components of knowledge within two types of teacher knowledge domains: subject-matter knowledge and pedagogical content knowledge.

Knowledge of the subject matter or content includes more than knowledge of the procedures. It includes knowledge of how to depict the procedures and how to recognize relevant representations of the concepts. In the subject matter knowledge domain, common content knowledge refers to the mathematical knowledge and skill possessed by most educated adults. Specialized content knowledge is the mathematical knowledge and skill used by teachers in their work but not generally possessed by most educated adults. Teachers use this knowledge to accurately represent mathematical ideas, provide mathematical explanations for common rules and procedures, and examine and understand unusual solution methods to problems (Ball et al., 2005). Horizon content knowledge refers to an orientation to and familiarity with the discipline that contributes to the subject matter. This knowledge provides teachers with a sense of the broader discipline and how the content is situated in and connected to that discipline.

In the pedagogical content knowledge domain, knowledge of content and students contains knowing about both mathematics and students. This knowledge is an integration of content knowledge with knowledge of what students think about, and how they know or learn a particular content (Hill et al., 2008). Knowledge of content and teaching includes knowing about both mathematics and teaching (Delaney, Ball, Hill, Schilling, &
It is content knowledge intertwined with knowledge of how best to support students’ mathematical thinking and/or how to address student errors. Ball and her colleagues do not offer a definition of knowledge of content and curriculum, but instead refer to Grossman’s (1991) work in defining this component of pedagogical content knowledge. Grossman defined knowledge of content and curriculum as knowledge of the curriculum materials and the pedagogy contained within the materials.

**Summary**

This review examined the literature pertinent to this study on the factors influencing preservice teachers’ use of mathematical knowledge and practice in lesson planning and instruction. Information about the structure and importance of teacher education programs was presented as the context for this dissertation. The field experience portion of the teacher education program varies in structure throughout institutions, but it continues to be a strong learning experience for preservice teachers. However, Lortie (1975) cautioned that preservice teachers are greatly influenced by teaching examples experienced during their elementary education. After decades of research, clarity is still lacking as to the learning that occurs in the teacher education program. In a review of research on learning in methodology courses and field experiences, Clift and Brady (2005) reported on 20 studies that described mostly mixed or positive results. From their review, Clift and Brady were unable to describe what practice occurred or the consequence of such practice in school settings based on the results reported in the research on preservice teachers’ learning.

The school setting for the field experience influences the learning and practice that occurs. Performing skills, such as lesson planning, in an authentic environment
supports the learning of professional practice (Lave & Wenger, 1991; Ball & Cohen, 1999; Grossman, Compton et al., 2009). A situative learning perspective embedded in the teacher education program gives focus to preservice teachers’ opportunity to learn and use the professional behaviors of the teaching practice by interacting with, learning from, and approximating the behaviors of experienced teachers (Putnam & Borko, 2000; Lampert, 2001). The aspect of *approximations of practice* within the *pedagogies of practice in professional education* framework illustrates the varying levels of practice necessary to support preservice teachers’ learning of teaching skills and behaviors in an authentic setting (Grossman, Compton et al., 2009).

Practicing lesson planning in an authentic setting benefits preservice teachers’ skill development as they learn how to address the multifaceted requirements of elementary teaching. The literature reviewed presented information that preservice teachers’ lesson planning practice is a developing skill that requires more detail in application than inservice teachers’ planning (Borko & Livingston, 1989). Even among preservice teachers, the lesson planning focus varies at differing grade levels (Kagan & Tippins, 1992). Behavior management and content coverage was the focus of secondary-level planning, while individual students and engagement was the focus of elementary-level planning. Planning and using curriculum materials presents challenges to preservice teachers who need time experiencing the material in order to add flexibility for student responses to the lesson into their plan and instruction (Lloyd & Behm, 2005; Mutton et al., 2011; Nicol & Crespo, 2006). Flexibility in lesson planning involves the use of particular teacher knowledge of content and learners that is taught in methodology courses (Mutton et al. 2011).
The literature reviewed on teacher knowledge focused on the framework for
*mathematical knowledge for teaching*, which is described as the specialized knowledge of mathematics content, pedagogy, and students that support teachers during planning and instruction (Ball & Bass, 2002). This framework extended the work of Shulman (1986, 1987) describing pedagogical content knowledge as the intersection of content knowledge and pedagogical knowledge implemented by teachers during planning and instruction. Additionally, the framework for mathematical knowledge for teaching extends the work of Grossman (1990, 1991) by incorporating teachers’ curricular knowledge as an aspect of pedagogical content knowledge (Ball et al., 2005). The aspects of mathematical knowledge for teaching assisted in the decomposition and description of the phenomenon of preservice teachers’ use of knowledge during mathematics lesson planning and instruction for this study.
CHAPTER THREE

METHODOLOGY

This chapter describes the study’s research design, the sample, the protection of human subjects, the instrumentation, the procedures, the pilot procedures, and the data analysis of the study.

Preservice teachers are often challenged when applying their developing skills during mathematics lesson planning and instruction (Lloyd & Behm, 2005; Nicol & Crespo, 2006; Stein et al., 2008). An understanding of how these skills develop during preservice education may help teacher educators design learning experiences that better support preservice teachers. Consequently, the purpose of this study was to observe and describe factors affecting preservice teachers’ use of their developing mathematical knowledge during lesson planning and instruction. This was done through a mini-case study design of four preservice teachers when they were completing their second of two field experiences. The decision to use a case study design was based on the descriptive nature of the research question (Yin, 2014):

How do background and contextual factors influence preservice teachers’ use of mathematical knowledge in lesson planning and instruction during the field experience?

Research Design

A multiple mini-case study design, hereafter referred to as case study, was selected to gather and examine data about the factors influencing preservice teachers’ use of subject matter knowledge and pedagogical content knowledge during lesson planning and instruction (Stake, 2005; Yin, 2014). Three aspects of case studies align with the
purpose of this dissertation. First, case studies are useful when describing phenomena, such as lesson planning and instruction, within a real-life context of the field-placement classroom. Second, case studies can provide insight and depth into a phenomenon that occurs in different contexts, such as the different field-experience school sites of the preservice teachers. Finally, case studies enable descriptions and comparisons of the participants’ individual thoughts and experiences across different situations and tasks enabling the researcher to triangulate data across contexts.

The data collection occurred over a four-week period from mid-April to mid-May of 2014 using seven instruments: (a) background questionnaire, (b) mathematical knowledge questionnaire, (c) lesson plan analyses, (d) interviews, (e) observations, (f) field notes, and (g) student assessment. Collecting the data near the completion of the full-time field experience allowed the preservice teachers the opportunity to become familiar with the school setting, the students, and the materials available to them at that site. In addition, the preservice teachers would have practiced writing a single-concept lesson sequence with their mentor teachers by this point in the field experience.

Each of the four preservice teachers participated in the data collection for one single-concept lesson sequence. A single-concept lesson sequence focuses on one topic or one skill, such as finding the volume of a rectangular prism. Typical lesson sequences contain three to four lessons. Generally, each lesson lasts one class period. Because class periods vary from school to school, shorter class periods extend a lesson over two days and longer class periods allow one or more lessons to be covered during that scheduled time.
The data collection began at the beginning of the scheduled lesson sequence, except for one lesson sequence that was a review of previous lessons. Two preservice teachers accomplished teaching the lesson sequence over two days, and two preservice teachers accomplished teaching the lesson sequence over three days. The interviews and observations occurred on consecutive teaching days for each preservice teacher. All preservice teachers reviewed the transcriptions during a one-week period after the completion of the data collection. Table 1 depicts a timeline of the data collection.

Table 1

<table>
<thead>
<tr>
<th>Data Collection Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1:</strong> (Initial meeting; about one week prior to Day 2)</td>
</tr>
<tr>
<td><strong>Day 2:</strong> (Pre-observation)</td>
</tr>
<tr>
<td><strong>Days 3-5:</strong> (Observations and post-observations)</td>
</tr>
<tr>
<td><strong>Day 6:</strong> (one week after last observation)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Background Questionnaire</th>
<th>Interview prior to first observation (audio recorded)</th>
<th>Observations of instruction (video recorded)</th>
<th>Student Assessment Interview (audio recorded)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematical Knowledge Questionnaire</strong></td>
<td>Interviews after observation--with video stimulated recall at the end of the school day (audio recorded)</td>
<td></td>
<td>Field Notes</td>
</tr>
<tr>
<td><strong>Lesson Plan Analyses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Field Notes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After the data were analyzed and the case studies described, the summaries of each case were sent to the applicable preservice teacher for a member check. Each participant concurred with the descriptions of the events and the field experience placements described in this study. Figure 2 depicts the case study procedures.
Figure 2. Case study procedure (adapted from Yin, 2014, p. 60).
Examining preservice lesson planning and instruction during their full-time field experience placement, within the last month of the completion of their teacher education program, was important for several reasons. First, there is little research about the use of preservice teachers’ mathematical knowledge in the culminating field experience. Second, this is a unique period in a preservice teachers’ education, a time during which the preservice teacher “takes over” the class for a period of 10 days or more and demonstrates the pedagogical skill they will most likely use during their first inservice teaching position. As a result, it is the best time to study the factors influencing the development of pedagogical skill.

Sample

The assistant director of the teacher education program located at the satellite campuses of a private Northern California university was contacted to assist in locating a group of participants that met the purposeful sampling criteria. The criteria called for preservice teachers in (a) a cohort enrollment in the teacher education program, (b) that participated in the same mathematics methodology course, (c) that were enrolled in the final full-time field experience, (d) that were placed in an upper-elementary grade classroom, and (e) paired with a mentor teacher. At the meeting with the assistant director, two satellite campuses were identified as meeting the criteria. Four preservice teachers from a satellite campus in the northern region for the university were sent an email briefly explaining the study and requesting a meeting to discuss the details of their possible participation. All four preservice teacher participants volunteered in April of 2014 for this study. The researcher met with the school administrators for permission to collect data at their school site. Then, the researcher met with the mentor teachers for
permission to collect data in their classrooms. The school administrators and mentor teachers approved the participation of the four preservice teachers that volunteered for this study. Descriptions of the teacher education program, the field experience schools, and the four preservice teachers follow.

**The Teacher Education Program**

The university’s teacher education program for multiple-subject credentialing consisted of 14 courses. The preservice teachers enrolled in the satellite campus completed the course sequence over four semesters. The coursework for the program contained methodology courses, theory courses, and two field experience courses conducted in two semesters in two placements. The most relevant courses for this study were the mathematics and science methodology course and the full-time field experience course.

The mathematics and science methodology course introduced the frameworks of pedagogical content knowledge and mathematical knowledge for teaching. The course was the fifth in the teacher education program course sequence. The course focused on the application of teacher knowledge during lesson planning, instruction, and assessment for mathematics and science. An earlier course titled *Teaching and Learning* introduced learning theories and applicable instructional skills. The methodology course expanded on the instructional skills by showing examples of instruction through instructor modeling or videos and giving opportunities to practice the instructional techniques through role-playing. The preservice teachers practiced asking questions and designing assessments that would inform them about student preconceptions and misconceptions.
The information assisted the preservice teachers in their selection of representations of the concept and/or procedures.

In addition, preservice teachers were given multiple opportunities to identify and explain multiple mathematical procedures. The explanations focused on mathematical reasoning and ways to communicate mathematics. Various collaborative learning skills were practiced that supported mathematical communication and reasoning. The preservice teachers also practiced designing lessons with multiple ways to represent the topic such as using manipulatives or illustrations to support student learning. Other instructional skills such as practice-based, problem-based, and inquiry-based learning were presented in the methodology course. Across all instructional techniques the preservice teachers learned to identify mathematical errors and explain the error, which supports student mathematical reasoning and problem solving. The culminating project required the preservice teachers to write a lesson plan, a single-concept lesson sequence, and an outline of unit incorporating single-concept sequences within a “big idea.” Finally, they selected one activity to role-play with the methodology class. This project was preparation for the field experience.

The two field experience placements occurred over two semesters with one placement in the lower-elementary grades (kindergarten to third grade) and the other placement in the upper-elementary grades (fourth to sixth grade). Each field experience was 15 weeks long. The first field experience required part-time participation in the classroom with a mentor teacher three mornings per week. During the part-time field experience, the preservice teachers observed only one or two content areas. The mentor
teacher performed most of the classroom tasks and gradually supported the preservice teacher in teaching a few lessons or working with small groups of students.

The full-time field experience required full-time participation in the classroom. During the full-time field experience, the preservice teacher gradually took on all classroom responsibilities under the supervision and guidance of the mentor teacher. Near the end of the full-time field experience, the expectation is that the preservice teacher takes control of all classroom responsibilities for a minimum of two weeks as if they were the solo teacher of record. The mentor teachers continue to guide the preservice teachers during the solo portions of the field experience.

The four field experience placements for this study were located in three Northern California school districts within the same geographical area as one of the university’s satellite locations. One participant taught in a fourth-grade classroom, one participant taught in a fifth-grade classroom, and two participants taught in sixth-grade classrooms. Three participants taught in a public school setting. One sixth-grade participant taught in a private, religion-based school. Selecting participants from the upper-elementary grade levels kept the mathematics curriculum similar in regards to the difficulty level of mathematics content, concepts, and pedagogies.

*The Schools*

The demographics of the four schools and field experience placement classes are displayed in Table 2. The preservice teachers’ pseudonyms are presented in the order of their placement grade level. Information is provided about the grade-level placements and whether the school is public or private. The mentor teachers’ pseudonyms and years of teaching experience are provided. The information for the school and the classes are
displayed for the following categories: student population, percentage of socio-economically disadvantaged students, English-language learners, and students with disabilities. The information about the three public schools was collected from the 2013 Academic Performance Index (API) reports on the California Department of Education website (http://www.cde.ca.gov/ta/ac/ap/). Information about the private school was obtained from the school administrator. The mentor teachers provided the information about the four classes.
### Table 2

**Demographic Overview of Schools and Classes**

<table>
<thead>
<tr>
<th>Participant Grade Level</th>
<th>School Type/Grades</th>
<th>Mentor Teacher (Years of Experience)</th>
<th>Population</th>
<th>Socio-Economically Disadvantaged School</th>
<th>English-Language Learners School</th>
<th>Students with Disabilities School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elsa</td>
<td>4th Grade</td>
<td>Kelly (6 years)</td>
<td>385</td>
<td>42%</td>
<td>19%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Public Charter/K – 6th</td>
<td></td>
<td>28 (14 boys)</td>
<td>42%</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>Viola</td>
<td>5th Grade, Public/K – 6th</td>
<td>Cheryl (29 years)</td>
<td>296</td>
<td>79%</td>
<td>59%</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28 (12 boys)</td>
<td>57%</td>
<td>21%</td>
<td>25%</td>
</tr>
<tr>
<td>Drake</td>
<td>6th Grade</td>
<td>Michaela (8 years)</td>
<td>334</td>
<td>99%</td>
<td>73%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Public/K – 6th</td>
<td></td>
<td>29 (15 boys)</td>
<td>86%</td>
<td>68%</td>
<td>13%</td>
</tr>
<tr>
<td>Rose</td>
<td>6th Grade</td>
<td>Laura (8 years)</td>
<td>235</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td></td>
<td>Private Religious/K – 8th</td>
<td></td>
<td>23 (12 boys)</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td>1%</td>
</tr>
</tbody>
</table>
The Four Preservice Teachers

The preservice teachers differed most in their academic backgrounds and prior experiences. It should be noted that none of the preservice teachers possessed academic degrees in mathematics. However, Rose’s bachelor’s degree and Drake’s master’s degree contain a strong mathematical focus in the subject matter. Elsa and Viola both possess bachelor’s degrees in English, but Elsa possesses an additional bachelor’s degree and a master’s degree. Furthermore, Elsa worked as a librarian at a public elementary school and as a tutor in an after-school program that involved lesson planning and instruction. Rose also had prior lesson planning and instructional practice working with small groups of students in her capacity as an instructional aide in a private religion-based school. Prior to entering the teacher education program, Rose was an instructional aide for her mentor teacher. Drake and Viola did not have prior work experience that involved lesson planning or instruction. Table 3 depicts a brief overview of the four participants’ ages, academic background, and prior lesson planning and instructional experience.

Table 3

**Demographic and Prior Experience Overview of Participants**

<table>
<thead>
<tr>
<th>Preservice Teacher</th>
<th>Age</th>
<th>BA/BS Degree Major and/or MA Degree Major</th>
<th>Prior Experience Lesson Planning/Tutoring/Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elsa</td>
<td>33</td>
<td>BA -English (Literature)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BA -Music History</td>
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<td></td>
<td></td>
<td>MA -English with a concentration in Irish Literature and Culture</td>
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<tr>
<td>Viola</td>
<td>25</td>
<td>BA -English</td>
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</tr>
<tr>
<td>Drake</td>
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<td>BA -Russian Literature</td>
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<td>MA -Landscape Architecture</td>
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<tr>
<td>Rose</td>
<td>50</td>
<td>BS -Chemical Engineering concentration in Biology</td>
<td>Yes</td>
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</tbody>
</table>
Protection of Human Subjects

An application to collect data was approved by the university’s Institutional Review Board for the Protection of Human Subjects (Appendix A). Every effort was made to conceal the identity of all participants in the study. The data collected for this study was kept confidential and stored in a secure place. All persons and places participating in this study were assigned pseudonyms for anonymity. No adverse effects occurred for the participants in the study. Their participation did not influence their performance evaluations in the field placement.

A request to collect data from the university’s Teacher Education Department was submitted to the Department Chair and the Assistant Director of Branch Campuses of the Teacher Education Program. Both the Department Chair and the Assistant Director of Branch Campuses signed the consent letter (Appendix A). When the preservice teachers were recruited from the Teacher Education Department, an informed consent letter was provided to the participating volunteers.

Consent to observe, audio record, and video record the preservice teachers at the field placement sites was obtained from the school administrators and the mentor teachers. They were informed that the observations focused on the preservice teacher and not the students, the mentor teachers, the curriculum, the school program, nor the district. Templates of the informed consent letters are provided in Appendix B.

All audio recordings were transcribed soon after each interview. After the transcriptions were completed, the preservice teachers were offered an opportunity to review the interview transcription for accuracy. Only one participant read the transcriptions thoroughly, the other three participants did not read the entire transcript.
The audio recordings were destroyed after acknowledgement was received from the participants. Pseudonyms for all names of people and places were used for anonymity in the transcriptions.

The observations were video recorded. After the video-stimulated recall interviews, the videos were transcribed. The preservice teachers were offered an opportunity to review the video transcriptions for accuracy. After the participants reviewed the transcriptions, all recording were destroyed. Only one participant confirmed that the recordings were destroyed. The transcripts from the video recordings do not contain any information identifying the preservice teacher, the mentor teacher, the students, the school, or the district; pseudonyms were used for all identifying names of people and places.

**Instrumentation**

Data regarding the preservice teachers’ practice were collected through seven instruments: (a) background questionnaire, (b) mathematical knowledge questionnaire, (c) lesson plan analyses, (d) interviews, (e) observations, (f) field notes, and (g) student assessment. The background questionnaire and the mathematical knowledge questionnaire provided information about the preservice teachers’ demographics, professional background, educational background, and mathematical knowledge. The preservice teachers’ lesson plans were analyzed for elements of mathematical knowledge for teaching and foundational instruction practices. The semi-structured interviews were conducted prior to and after the observation and provided information about the resources, rationale, and strategies for each component of a lesson plan: learning goals, materials, instructional strategies, activity sequence, and assessments. Video recordings
of the preservice teachers’ instruction were used during the post-observation interview to assist in the recall of their thinking at specific moments. Observations of the entire lesson were video recorded and field notes completed during the observations. Student assessments provided a prompt for the preservice teachers’ reflection on their lesson planning and instruction during an interview conducted about one week after the last observation. Frequently, the preservice teachers were asked questions during the interviews that reflected on their planning and instruction. Their reflection provided insight into what was influencing their decisions prior to and during instruction.

Multiple data sources provided a more holistic view of the influences on the preservice teachers’ lesson planning and instruction. Collecting data from multiple sources contributed to the validity and reliability of the information through the researcher’s triangulation of the perspectives of the observed phenomena (Patton, 2002). Further trustworthiness of the data was sought through allowing the preservice teachers to review the interview and observation transcripts as well as reviewing the researcher’s case study descriptions through a member check (Patton, 2002; Yin 2014).

One instrument, the reflective journal, was removed from this study. The research design originally planned to gather information from reflective journals kept by the preservice teachers as a course requirement for the seminar course in the teacher education program. By the time data collection began for this study, the preservice teachers were near the end of the semester and the course. Reflective journals were no longer required for their field experience in the corresponding seminar course, and excluded from this study. The lack of reflective journaling did not hinder the collection of reflective comments and insight from the preservice teachers during the interviews due
to their previous relationship with the researcher as their university instructor and their university supervisor.

**Questionnaires**

Two questionnaires were designed for this study to gather information about the preservice teachers’ backgrounds and their mathematical knowledge for lesson planning. The responses on the questionnaires were incorporated into the semi-structured interviews to assist the development of questions regarding the preservice teachers’ thoughts, resources, and pedagogical strategies. The background questionnaire and the mathematical knowledge questionnaire are located in Appendix C.

**Background Questionnaire**

The background questionnaire instrument was given to the preservice teachers individually at the initial meeting. The questionnaire was sent home with each preservice teacher so they could obtain their scores from the CSET. All background questionnaires were returned at the next meeting with the preservice teachers reporting that the questionnaire took less than 10 minutes to complete. The background questionnaire used short-answer written responses requesting demographic information, such as age, academic background, previous instructional or professional experience, and the preservice teacher’s score on the mathematical portion of the CSET.

**Mathematical Knowledge Questionnaire**

The mathematical knowledge questionnaire was completed at the initial meeting. The mathematical knowledge questionnaire was administered in a private, quiet location at the field-placement site per each preservice teacher’s request. All of the preservice teachers completed six multi-level multiple-choice questions on the questionnaire within
20 minutes. The questions were adapted from two sources to identify mathematical knowledge that was probed during the pre- and post-observation interviews. The first source was Ball’s (1990) questionnaire for probing mathematical understanding of elementary and secondary preservice teachers. The items ask participants to identify or generate appropriate representations of division of fractions. The second source was the Learning Mathematics for Teaching (LMT) survey developed by Hill, Schilling, and Ball (2004). The items selected were from the sample released in 2008 by the authors and used with permission. The mathematical level of the questions were within the fourth-grade and fifth-grade level of mathematics.

The sample items were not intended as a measurement of mathematical knowledge for teaching, but as prompts for pre- and post-observation interviews exploring mathematical thinking. The items asked the preservice teachers to identify student errors in mathematical operations and for identification of the appropriate representations of a mathematical concept. The mathematical knowledge for teaching constructs used in this questionnaire were common content knowledge, specialized content knowledge, knowledge of content and students, and knowledge of content and teaching. These constructs are used during the lesson planning stage of instruction that involves evaluating the curricular materials, concepts to be taught, and the representation of the concepts to address student needs.

**Lesson Plan Analyses**

Lesson plans for each single-concept lesson sequence were collected from each preservice teacher prior to the pre-observation interview. It was the intention of the researcher not to disrupt the lesson sequence in the class, and arrangements were made to
begin data collection at the start of a single-concept lesson sequence. Two of the single-concept lesson sequences contained two lessons while the other two single-concept lesson sequences contained three lessons. Each lesson plan was examined twice based on a protocol developed to identify the mathematical tasks and aspects of mathematical knowledge for teaching used in the lesson planning (Appendix D). The protocol was adapted from a lesson plan rubric developed by Ruys, Van Keer, and Aelterman (2012). In addition, information about the description of the mathematical task and the corresponding aspect of mathematical knowledge for teaching was used to develop the rating protocol based on research by Ball et al. (2008) and Hill et al. (2004).

**Interviews**

Semi-structured interviews were conducted during the study. According to Merriam (2009), semi-structured interview questions or topics may be designed in advance as prompts, but the participant’s responses guide the additional use of probing questions that may not have been anticipated prior to the interview. The wording or order of the questions changed depending on the responses given during the interviews. On average, the interviews were about 25 minutes in length. The interviews were audio recorded to ensure accuracy in the data collection, and the recording transcribed. The audio recordings were destroyed after transcription to maintain anonymity of the interviewees. The interview protocols were adapted from Burns and Lash (1988) (Appendix E).

Each preservice teacher was interviewed once prior to the start of the single-concept lesson sequence observations about their lesson planning. Then, each preservice teacher was interviewed at the end of the school day about the lesson observed earlier
that same day. During the post-observation interviews, an adaptation of video-stimulated recall was used to refresh the preservice teachers’ memory from the morning lesson. A final interview reflecting on student assessment and the connection to the lesson planning and instruction was conducted about one week after the last lesson observation.

Pre-Observation Interview

Each preservice teacher was interviewed individually about their strategies and rationales for the lesson plans. The questions probed the resources used and the rationale for structuring and sequencing activities. The interview occurred one teaching day prior to the start of instruction for the single-concept lesson sequence. One exception was a participant who had transportation constraints and was interviewed 30 minutes prior to class starting. All four of the preservice teachers opted to be interviewed at the placement-school site.

Post-Observation Interviews

The post-observation interviews were conducted at the end of the school day that the lesson was observed. The questions probed the rationale for differences between the observed and noted instruction and the written lesson plan. After the observation of instruction, the researcher reviewed the video recording of the lesson. Two to four segments were located on the video recording by the time notations made in the field notes where pauses or specific instructional practices were noted. The videos were recorded with a wall clock in the background to make finding the segments easier. The segments, lasting about 5 minutes, were replayed with the preservice teachers during the post-observation interview to refresh their memory of the moment in question. This procedure is adapted from video-stimulated recall procedures (Lyle, 2003).
Reviewing the videos elicited the preservice teachers’ thoughts, decisions, and rationales during instruction (Lyle, 2003). Most of the segments selected for review occurred during the mathematical modeling and/or the guided practice of mathematical procedures in the lesson. These segments contained more student responses and questions regarding the mathematical concept or procedure. The preservice teachers were confronted by unplanned student responses to the lesson and the preservice teachers made decisions to adjust to the unexpected student responses. Each preservice teacher viewed each segment and then related his or her thinking at that moment and the rationale for the response to the student or the choice of mathematical representation. The preservice teacher and the researcher could stop, re-play, and start the video recording if necessary.

The video recording stimulated the preservice teacher’s memory of the action. Lessons occur during a complex interaction between the preservice teacher, the curriculum, and the students. Without the video-stimulated recall, it would have been difficult for the preservice teachers to recall the decision without the visual and audio support of the moment in question. The video allowed the preservice teachers to relive the moment of decision during the lesson (Lyle, 2003). In addition, the preservice teachers’ recall was grounded in the evidence of the video allowing the memory to be reviewed and reflected upon with more accuracy.

**Observations**

Each preservice teacher was observed instructing each lesson plan in the single-concept lesson sequence. Two preservice teachers planned and instructed two lessons each, and the other two preservice teachers planned and instructed three lessons each.
The data from the observations informed the use of both domains of mathematical knowledge for teaching and foundational instruction practices addressed in this study. The preservice teachers’ use of the lesson plan, flexibility in response to students, and representations were visible during the observations. An observation protocol was used to reduce the researcher’s bias (Appendix F). The protocol was organized based on the university’s teacher education program lesson plan template.

Each observation was video recorded and the recording reviewed after the observation by the researcher. Segments were selected for viewing with the preservice teacher during the post-observation interviews to act as video-stimulated recall tool. After the interview, the video recording was transcribed, the transcription reviewed by the preservice teachers, and then the recording was destroyed. Field notes were written with the time indicated to synchronize the notes with the wall clock in the video recording for easy access during the interview. Reflective notes based on the researcher’s perceptions about the context of the observation were written immediately after the observation. All identifying information was removed from the note-taking process; the pseudonyms were used to conceal any identifying information.

**Field Notes**

Field notes were kept during the observations with the time indicated in the margin at varying intervals when there were natural pauses in the lessons. When a hesitation, pause, or unique student response was observed, the time on the wall clock was noted. Later, the time in from the field note was found on the video recording based on the recorded wall clock. Other notes were recorded during the observations about teacher-student and student-student interactions as well as observations about the tasks
and activities used during the lessons. In addition, reflective notes about the researcher’s perceptions of the field placement context and interviews were written immediately after the observations and/or interviews. All identifying information was removed from the note-taking process; the pseudonyms were used to conceal any identifying information.

**Student Assessment**

Planning student assessments is included in the university’s lesson plan template. The preservice teachers provided whole-class assessment information and did not reveal student identities. Most of the assessments were formative with only one summative assessment used from the textbook by a preservice teacher. During a final interview that occurred about one week after the last lesson observation, the preservice teachers were asked about their selection of and rationale for the planned assessments during the pre-observation interviews. In addition, the preservice teachers were probed regarding their selection of the assessments, their perception about student performance, their perception and reflection about students’ attainment of the learning objectives, and their use of the assessment information in future lessons.

**Researcher’s Training and Experience**

I received training from the California Peace Officers’ Standards and Training Board in interviews and investigations through three separate courses. For eight years, I interviewed witnesses, victims, and suspects as a patrol officer in two Northern California cities. Two of those years were spent as an investigator assigned to cases involving juvenile suspects, juvenile victims, and sexual assault cases. My training and experience taught me how to develop a rapport with someone involved in a difficult situation and put them at ease. I learned how to prompt the interviewee to discuss often uncomfortable and
frightening events. I used probing questions, but also knew when to let the person speak without interruption. This type of interview is similar to the semi-structured interviews used in research. The topics were outlined to guide my questioning, but the interviewee’s responses guided the in-depth follow-up questions.

In addition, I received training as a facilitator for conflict resolution from the California School-Law Enforcement Cadre. Furthermore, I received my undergraduate degree in management focusing on organization development and work-group communication. My training and experience from both sources included facilitating community meetings or observing group interactions during the meetings that were sometimes tense and/or hostile. Moreover, I facilitated and observed groups at regional meetings for the California School-Law Enforcement Cadre that involved school personnel and law enforcement personnel solving problems involving juveniles within a community. This training and experience supported my focus while observing and maintaining notations about the preservice teacher within the context of the classroom.

My most recent experience as an observer comes from my position as a teacher educator and supervisor. I completed over 35 observations of 16 preservice teachers in the last year and a half. As an observer, I notice when the preservice teacher appears confident or frustrated with the content, the materials, the activities, and the student behaviors. In addition, I observe if the preservice teacher varies from the written lesson plan. During the debriefing of the lesson observation, I probe the preservice teachers’ thoughts and perceptions about the lesson implementation, student learning, and student interactions.
My experience as a teacher-education supervisor and my previous training and experience were used throughout this study to probe and examine the preservice teachers’ thoughts and actions during lesson planning and instruction. My prior relationship with the preservice teachers, mentor teachers, the students in their field experience placement set the preservice teachers at ease when they reflected on their experiences for this study. Furthermore, the objectivity I learned through all my prior experiences supported my analyses of the data gathered from all instruments used in this study.

**Procedures**

After receiving approval for data collection from the university’s IRBPHS and the teacher education department, four potential participants meeting the selection criteria enrolled in a university satellite campus were contacted through email with a brief description of the study. All four upper-elementary preservice teachers volunteered for participation in this study. Individual meetings were scheduled to provide the preservice teachers with the informed consent information as a participant in a research study. The researcher then contacted the school site administrators and the mentor teachers by email to request meetings for their consent to collect data at their school sites.

Informed consent letters were given to the school site administrators and mentor teachers regarding the nature of the data collection (Appendix B). The letters re-stated that the procedures for video recordings were similar to the procedures required for the Teacher Performance Assessment (TPA) that the preservice teachers performed throughout their field-experience placement as a requirement for the California Commission on Teacher Credentialing. Every effort was made to assure the school administrator and the mentor teachers that the focus of the data collection, including the
video recording, were on the preservice teacher and not on the students, the mentor teachers, the school, the curriculum, nor the district. One school administrator required an additional letter to inform parents about the study (Appendix B).

During the meeting with the mentor teachers, it was stressed that the researcher was no longer performing the role of a university supervisor during data collection. The description of the researcher’s role clarified that the observation would not focus on a particular instructional strategy and that the preservice teacher’s performance would not be evaluated. In addition, it was clarified that the mentor teachers should conduct themselves and the class as if the researcher was not present. The researcher requested that the mentor and preservice teachers not do anything out of the ordinary with the daily schedule, lesson planning, instruction, and/or behavior management. It was during this meeting that questions were asked about the mentor teacher’s years of experience, lesson planning and instructional strategies, and their perception of the mentor-preservice teacher relationship. The meetings were accomplished over a two-day period and approval was received from the school administrators and the mentor teachers prior to the data collection.

Data collection began with the two questionnaires. At the introductory meeting, the preservice teachers were given the background questionnaire that requested demographic information, instructional experience, prior work experience, academic experience, and their score on the mathematics portion of the CSET. The background questionnaire was sent home with the preservice teacher so that the CSET score could be retrieved. The preservice teachers reported that it did not take more than 10 minutes to complete the background questionnaire that was returned to the researcher at the next
meeting. The preservice teachers completed the mathematical knowledge questionnaire containing six multiple-choice mathematical knowledge questions in a private, quiet location at the field-experience site. The mathematical knowledge questionnaire took about 20 minutes to complete. Interviews were not conducted during the introductory meetings.

After collaborating with the mentor teacher about the next single-concept lesson sequence, the preservice teachers scheduled a meeting for the pre-observation interview with the researcher one day prior to the first lesson observation at the beginning of the single-concept sequence. Each preservice teacher provided written lesson plans for a single-concept mathematics topic prior to the interview; two scheduled topics contained two lessons and two topics contained three lessons.

Each lesson plan was examined twice using the protocol designed to review the content of the plan. The first was prior to the pre-observation interviews for elements of mathematical knowledge for teaching and instruction practices in the plans that would guide interview questions. The second was after the pre-observation interview for additional elements of mathematical knowledge for teaching and instruction practices that were articulated by the preservice teacher during the interview.

All interviews, pre- and post-observation, were audio recorded with a digital recorded and later transcribed. The transcriptions were later offered to the preservice teacher for a review of the content, and the audio recording destroyed after the transcriptions were reviewed. Conversations were transcribed verbatim, but not every utterance was recorded since they did not contribute to the data in a meaningful way.
During the pre-observation interviews, each preservice teacher was prompted to articulate the resources, strategies, and rationale used for each lesson plan. The pre-observation interviews were each about 20 minutes in length. All four preservice teachers chose to conduct the interviews in private, quiet locations at the field-placement sites. Three pre-observation interviews were conducted the day before the observation, and one was conducted about 30 minutes prior to the first lesson observation due to a preservice teacher’s transportation issue.

The post-observation interviews were conducted on the same day as the observations. Mathematics lessons were scheduled at the beginning of the school day for all four preservice teachers. That allowed several hours for the researcher to review the video recordings and field notes prior to the post-observation interview. Each post-observation interview lasted about 30 minutes in length and occurred at the end of the school day. The post-observation interviews included an adaptation of video-stimulated recall. The video segments were about 5 minutes in length and focused on the modeling and/or the guided practice portions of the lessons. The researcher observed and noted that unexpected student responses, such as errors or misconceptions, occurred most often during the modeling and guided practice portions of the lessons. The video segments selected focused on the unexpected student responses, and the preservice teachers were asked to articulate the rationale for their pedagogical decisions made to address the student responses in the moment. The amount of segments used varied with one post-observation interview using two segments, three interviews using three segments, and the remaining six interviews using four segments.
Since the length of the single-concept lesson sequence varied, so did the number of post-observation interviews. Ten post-observation interviews were conducted: three each with Elsa and Drake and two each with Viola and Rose. A final interview was conducted one week after the completion of the observations to discuss the student assessments, ask for any further reflections, and to give each participant an opportunity to review the video and audio transcripts. Altogether, five interviews each were conducted with Elsa and Drake and four interviews each were conducted with Viola and Rose.

Observations of instruction were video recorded on an iPad propped up on a stand near the preservice teacher and focused on the front of the classroom with a wall clock in view of the recording device. The wall clock made it easier to find the segment noted by time of occurrence in the field notes. The iPad was set up prior to students’ arrival in the classroom. The researcher typed field notes on an electronic notebook while sitting at the back of the classroom. The researcher transcribed the video recordings each day after the post-observation interviews. The transcriptions were later offered to the preservice teacher for a review of the content, and the video recording destroyed after the transcriptions were reviewed. After a transcript review of the first observation of Viola, a request was made to remove the numerous behavior corrections from the transcript. Removal of the corrections did not delete any data relevant to this study. In addition to the video recording and field notes, the researcher wrote reflective field notes immediately after each observation regarding the context of the classroom and the interactions observed.

The lesson observations varied in length between the field placements. Observations of three 90-minute lessons were conducted in Elsa’s fourth-grade
placement. Observations of two 2-hour lessons were conducted in Viola’s fifth-grade placement. Observations of three 30-minute lessons were conducted in Drake’s sixth-grade placement. Observations of two 30-minute lessons were conducted in Rose’s sixth-grade placement. Both sixth-grade placements followed each lesson with 30-minute problem-set practice that were observed and noted, but not video recorded.

The preservice teachers provided whole-class data on student assessments at the final interview one week after the completion of the observations. It was proposed that the preservice teachers would reveal their thoughts about student attainment of the learning objectives based on the assessments. Instead, the assessments led the preservice teachers to reflect on their instruction and their intended use of the assessment information as well as student attainment of the learning objectives.

The cases did overlap during the data collection since each preservice teacher reviewed the transcripts and summaries and discussed the student assessments from the lessons after data collection concluded. The review by the preservice teacher for each case occurred while the next data set was being collected. This resulted in meeting with Elsa for a post-observation interview and then meeting with Viola for her review of the last transcript, summary, and student assessment. The same occurred for the first post-observation interview with Drake and Elsa’s final review as well as Rose’s first post-observation interview and Drake’s final review. Mathematics instruction was scheduled in the morning for all four preservice teachers so observations were completed for each case without any overlap. Data collections for the four case studies were completed in four weeks. Rose’s final review occurred three days after the last observation of her
instruction. The members check of the case summaries were completed after the data
analysis in September of 2014.

**Pilot Procedures**

The background questionnaire, interview protocol instruments, and the
observation protocol instrument were piloted prior to the data collection to ensure clarity
of the questions on each instrument. A teacher educator from another university
reviewed the instruments for appropriateness and clarity of the questions. Feedback
regarding clarity on the background questionnaire was given and the changes were made.
Next, the background questionnaire was administered to two preservice teachers in
second-grade field experience placements with positive feedback on the clarity of the
questions and the length of time spent on the instrument. One of the pilot participants
volunteered to pilot the observation protocol and interview protocols. Permission was
received from the mentor teacher for an observation of the preservice teacher that was not
recorded. The preservice teacher’s feedback on the interview protocols was positive
regarding the flow and clarity of the questions and the length of the interviews. The
observation protocol was difficult for the researcher to navigate during instruction.
Modifications were made to the format of the observation protocol to remove the
category sections and allow the notes to be written sequentially.

**Data Analyses**

This study’s data collection procedures generated four data sets, one for each
preservice teacher. Each set contained data collected from the six instruments. The
strategy for data analysis was to read through each data set multiple times. The data were
read through twice for each case in chronological order of the collection. Based on the
research question, notes were made about how the preservice teachers planned for instruction and the pedagogical skills they used during instruction. Notes from each data set were placed into two tables, lesson planning and instructional skills noted by instrument. Then, the notes were highlighted and color-coded into similar concepts. Next, each data set was read through based on the instruments to check if the color-coding still applied to the noted concepts. The color-coding depicted similarities and differences in the way the preservice teachers planned for instruction and the instructional skills they actually used during each lesson. Based on the initial passes through the data, two data codings were chosen that best described the preservice teachers’ behaviors: pedagogical skill and mathematical knowledge. Each coding is described below.

Instances of the preservice teachers’ use of pedagogical skills learned in the methodology course were noted for each case. The data sets contained instances when the preservice teachers: (a) anticipated students’ preconceptions or errors, (b) modeled mathematical procedures, (c) engaged students in discussions involving mathematical concepts and/or procedures, (d) used real-world and relevant representations from the curriculum, generated by the teacher, or suggested by students, (e) encouraged student communication of mathematical reasoning and procedures, and (f) used activities that supported student conceptual and procedural learning. The pedagogical skills inferred mathematical knowledge and examples of that knowledge were found in the data sets.

Examples of the preservice teachers’ use of their developing mathematical knowledge in both the subject matter domain and the pedagogical content knowledge domain were noted for each case. The data sets contained instances of subject matter knowledge when the preservice teachers: (a) accurately represented mathematical
concepts and procedures, (b) provided mathematical explanations for rules and procedures, and (c) recognized and understood student solutions and errors. Instances of pedagogical content knowledge were noted when the preservice teachers selected instructional strategies that: (a) supported the specific learning needs of their students, (b) connected the content to relevant and real-world examples from the students’ lives, (c) selected activities, tasks, and manipulatives applicable to the content and the students’ needs, (d) encouraged mathematical reasoning through procedures and/or errors, and (e) evaluated, adapted, and/or modified curriculum materials to meet student needs. After reviewing the data based on the preservice teachers’ pedagogical skill and mathematical knowledge described above, three categories were identified: (a) engaging students in mathematical reasoning, (b) using applicable and relevant examples, and (c) students communicating their problem solving or reasoning. Drawing on the literature, similar categories described by the National Research Council (2005) in *How Students Learn* were used to categorize the concepts.

Merriam (2009) argued the naming of categories may be generated by the researcher, the participants, or from the research literature. In order to categorize the data to tell the story of each case study across pedagogical skill and mathematical knowledge during lesson planning and instruction, the National Research Council’s (2005) framework of instructional principles from the literature provided category names that respond to the research question. The data were organized into three categories that encompassed the pedagogical skills and mathematical knowledge observed in each case. The three categories naming the preservice teachers’ use of mathematical knowledge during planning and instruction were: (a) *engaging students’ preconceptions*, (b)
connecting factual knowledge and conceptual frameworks for understanding, and (c) assisting students to develop a metacognitive approach for self-monitoring learning. The category names adhere to Merriam’s posited criteria that the names are: (a) responsive to the research question, (b) sensitive to the data contained within the category, (c) exhaustive in containing the data, (d) mutually exclusive with no overlap of data, and (e) conceptually congruent.

Each category contained concepts identified during the data analyses with no overlapping data. The first category, engaging students’ preconceptions, contained preservice teacher behaviors that: (a) anticipated, recognized, and understood students’ preconceptions, solutions, and/or errors, (b) selected activities that supported conceptual and procedural learning, (c) supported specific learning needs of students by selecting applicable activities, tasks, and manipulatives, (d) engaged students in mathematical reasoning discussions, and (e) evaluated, adapted, and modified the curriculum materials to meet student learning needs. The second category, connecting factual knowledge and conceptual frameworks for understanding, contained preservice teacher behaviors that: (a) accurately modeled and represented mathematical concepts and procedures, (b) used relevant and real-world representations from the curriculum, generated by the teacher, and suggested by students, and (c) provided accurate mathematical explanations for concepts and procedures. The third category, assisting students to develop a metacognitive approach for self-monitoring learning, contained preservice teacher behaviors that: (a) engaged students in mathematical reasoning through problem solving, and (b) encouraged student communication of mathematical reasoning. These three
categories contained the conceptualized data and meet Merriam’s criteria for category naming.

Furthermore, Merriam (2009) suggested three actions used in this study that strengthen the consistency, dependability, and credibility of the data analyses and the findings: (a) audit trail, (b) disconfirming information check, and (c) members checking. The audit trail described in this section described the data analysis of the four data sets, the identification of concepts, and the naming of three categories. The audit trail presented above strengthens the consistency and the dependability of the data analyses. A final pass through the data sets was conducted for disconfirming information that would not fit within the three categories or contradicted the categorizations; none was found. The disconfirming information was sought across all data sources to enhance the credibility of the findings. Throughout the study, the transcripts and data summaries were shared with the preservice teachers as a way for the researcher to check her understanding and interpretation of the data. In addition, the preservice teachers were offered opportunities to review summaries of the data and to clarify or expand any of the researcher’s interpretations or representations as a form of member checking to support the credibility of the findings. All comments received from the preservice teachers confirmed the interpretations and presentations of their behaviors in the field experience.

The data analyses produced rich descriptions of the four preservice teachers’ full-time field experience, as well as a set of pedagogical skills and mathematical knowledge elements that were used to characterize each preservice teacher’s planning and instruction. In addition, these analyses produced a format for the presentation of the case
studies through the use of categories identified in the literature by the National Research Council (2005).

**Summary**

This chapter presented the methods used to study the influence of background and contextual factors on preservice teachers’ use of mathematical knowledge during lesson planning and instruction in the culminating field experience. The case study design provided four data sets that provided a perspective of the multifaceted phenomena within the context of the field experience placement. Four preservice teachers enrolled in the full-time field experience volunteered to participate in this study. Precautions were taken to maintain anonymity and confidentiality for the participants, the mentor teachers, the students, and the school sites.

The instruments were designed to provide the researcher the opportunity to collect data from multiple sources to get a more holistic view of the preservice teachers’ lesson planning and instruction. Seven instruments were used for this purpose: background questionnaire, mathematical knowledge questionnaire, lesson plan analyses, interviews, observations, field notes, and student assessment information. The background questionnaire, interview protocols, and the observation protocol were piloted prior to the start of data collection. Changes were made to the background questionnaire to add clarity. In addition, changes were made to the observation protocol to ease the flow of note taking. After consent to collect data was received from each preservice teacher, each mentor teacher, and each school administrator, data collection began in the last month of the second field experience semester from mid-April to mid-May 2014.
Each preservice teacher was observed for a full single-concept lesson sequence. Two preservice teachers completed two-lesson sequences and two preservice teachers completed three-lesson sequences. The data collection lasted for one week per preservice teacher. Each case began with the background and mathematical knowledge questionnaires. An analysis of the lesson plans received from the preservice teachers for the lesson sequence and an audio-recorded pre-observation interview preceded the lesson observations. Observations of instruction were video recorded and followed by an audio-recorded interview after each lesson. Field notes were taken during and immediately after each observation. A final interview was conducted to review student assessment data and final preservice teacher reflections from the completion of the single-concept lesson sequence. Each preservice teacher reviewed the audio and video transcriptions for accuracy in the representation and interpretation of the information by the researcher.

The data sets were coded and analyzed using a constant comparison method; the coding began after the first data collection point and were constantly compared at each collection point. The data sets were read multiple times and sorted conceptually into three categories based on the National Research Council’s (2005) framework for instructional principles: (a) engaging students’ preconceptions, (b) connecting factual knowledge and conceptual frameworks for understanding, and (c) assisting students to develop a metacognitive approach for self-monitoring learning. A review of the data for disconfirming information that did not fit or contradicted the categorizations was conducted; none was found. In addition, a final members check was completed by allowing the preservice teachers the opportunity to review and comment on the summary of the researcher’s interpretations; no changes were needed.
Each individual case is described in Chapter Four. The information in each case includes the preservice teachers’ background, their prior mathematical knowledge, their subject matter knowledge and pedagogical content knowledge use in lesson planning, field placement context, and how they used their mathematical knowledge during instruction. After the description of the four cases, a cross-case comparison is presented pertinent to the research question of how background and the field experience context influenced the preservice teachers’ use of mathematical knowledge during lesson planning and instruction.
CHAPTER FOUR

RESULTS

The results presented in this chapter describe how four preservice teachers’ used mathematical knowledge during lesson planning and instruction. While instances of influence by their backgrounds and the contextual factors in the field experience are evident in these descriptions, these factors are discussed further in the cross-case comparison and in the findings of Chapter Five. The order of the case studies was organized by the preservice teacher’s field experience grade level: Elsa in the fourth grade, Viola in the fifth grade, and Drake and Rose in the sixth grade.

The remainder of this chapter presents each case study and the cross-case comparison in the following format. Each case study begins with three sections that describe the preservice teacher’s background, prior mathematical knowledge, and the context of their field experience placement that includes information about the school, students, and mentor teacher. Then, a description of how each preservice teacher used their subject matter knowledge and pedagogical content knowledge during lesson planning. Next, how each preservice teacher used his or her mathematical knowledge during instruction is presented in three instructional categories identified for this study: engaging students’ preconceptions, connecting facts and concepts, and developing metacognitive self-monitoring. Following the description of the cross-case comparison a summary concludes this chapter.
Case Study: Elsa

Background

Elsa was interviewed five times for this study, and was observed teaching three lessons reviewing the use of number lines for adding, subtracting, and equivalent fractions. At 33-years old, Elsa decided to enter the teacher education program after working as a school librarian in a public elementary school. She was responsible for selecting books to read to individual classes that followed a seasonal theme or a specific topic, and she carefully planned her selections in advance. At one point, she had volunteered as a mentor and tutor for socio-economically disadvantaged children in various grade levels. She planned and implemented lessons for individual students mostly in the area of writing. With the exception of one baccalaureate degree in music history, Elsa’s academic baccalaureate and masters’ degrees are in the topic of literature.

Prior Mathematical Knowledge

Elsa’s prior mathematical knowledge was in a high range relative to this study. Her scores on the CSET were reported as passing the multiple-choice section on mathematical tools and procedures, passing one written response on mathematical reasoning and strategies, and passing the other writing response with improvement needed on subject matter knowledge. On both written responses, Elsa demonstrated knowledge about the purpose of the concept and strategy and demonstrated the ability to support her use of the strategy with relevant evidence in each case. On the mathematical knowledge questionnaire, Elsa responded accurately to 10 of the 13 questions. She selected the best representations for the both mathematics procedures and demonstrated knowledge of appropriate mathematical reasoning on 8 out of 11 problems.
Field Experience Context: School, Students, Mentor Teacher

Elsa was placed in a fourth-grade class with 14 boys and 14 girls at a kindergarten to sixth-grade public charter school with a total student population of 385. The class reflected the school population’s percentage of socio-economically disadvantaged students (42%). The class percentages of English-language learners (7%) and students with disabilities (3%) were lower than the school population percentages of English-language learners (19%) and students with disabilities (15%).

Elsa’s mentor teacher, Kelly, has 6 years of teaching experience with the last two at the fourth-grade level, and she is working on her master’s degree. Elsa was Kelly’s first preservice teacher, and she expressed eagerness to support Elsa. Kelly explained that collaboration with other teachers is important to her teaching philosophy. She thinks teachers need to collaborate to brainstorm how to meet all students’ needs through a variety of instructional strategies. Kelly stopped writing lesson plans her first year of teaching, but makes notes in the teacher’s guides. She frequently uses activities and materials created by other teachers at her school site and from websites in order to support student achievement of the learning objectives. In addition to formal assessments, Kelly used daily informal assessments through questioning and/or written assignments to inform her planning, and Elsa adopted the assessment strategies. Most of the assessments are included in the new curriculum and other assessments are from Kelly’s resources.

The school was piloting mathematics curriculum from EngageNY that is based on the Common Core Standards. Kelly thought the materials are well prepared and well organized, but still supplements the lessons with tasks and activities from other sources to
engage her students and to meet the students’ learning needs. Mathematics instruction is scheduled in the morning for 90 minutes to allow for direct instruction and mathematics investigations. Kelly encouraged Elsa to consider students’ learning needs, prior class assessments, and the learning objective when selecting supplemental activities to support students’ review of the material for the observed lesson sequence. Elsa admitted that she preferred not to vary from the curriculum lesson plans. Elsa did begin to vary from the published curriculum around the tenth week of the fifteen-week semester at Kelly’s urging.

Subject Matter Knowledge and Pedagogical Content Knowledge in Planning

After reviewing the results of an end-of-unit assessment on adding and subtracting fractions using number lines, Elsa voiced a concern to her mentor teacher about the low student achievement of the learning goals. They decided to stop the scheduled curriculum for three days to review the topic. The curriculum did not contain a review for the topic, so Elsa created her lesson plans. Elsa indicated that the university’s lesson plan template learned in the methodology course was helpful with the structure of the review lessons, but added she had not used the template since the last visit from a university supervisor. Elsa’s collaboration with her mentor teacher regarding the assessment demonstrated her use of subject matter knowledge and pedagogical content knowledge. She was able to explain to her mentor teacher where the student errors most likely occurred and how to address the learning gap.

When asked during the pre-observation interview how much time she spent refreshing her knowledge on the topic and preparing the lessons, Elsa was uncertain and responded, “I’m thinking with the discussion and [website] searches and thinking about
the students...maybe two to three hours. It could’ve been more...or less.” Elsa’s resources for preparing to teach the topic were described by her as “only a few since we’d already covered this [in previous lessons].” Preparing which topics to cover in the review lesson sequence, Elsa reviewed the summative assessment, collaborated with her mentor teacher, reviewed lesson activities and worksheets on websites, reflected about previous lessons, and reflected about the students. Reflecting on the previous lessons, anticipating common preconceptions and errors, and evaluating various curriculum materials demonstrated Elsa’s use of pedagogical content knowledge during the preparation of the three lessons. Elsa’s mathematical knowledge was further observed instruction of her planned lessons.

**Mathematical Knowledge Use during Instruction**

Elsa was observed using eight instructional strategies taught in the methodology course that demonstrated her use of mathematical knowledge that supports the principles of instruction: discussions, reasoning through errors, used real-world examples, prepared relevant representations, encouraged and used student representations, often checked for understanding, encouraged problem solving, and provided multiple opportunities for students to communicate their mathematical reasoning. In addition, Elsa aligned the lesson plans with the learning objectives from the earlier formative and summative assessments.

Elsa engaged the students’ preconceptions through discussions that used questioning and encouraging conversations about mathematical explanations and reasoning. In addition, Elsa worked through mathematical errors through questioning strategies. Elsa supported connecting mathematical facts and concepts by using relevant
mathematical representations that were real-world examples. Elsa selected most of the representations, and she solicited and incorporated student examples. She used questioning and tasks as formative assessments to check for understanding of the facts and concepts during the lessons. Elsa developed students’ metacognitive self-monitoring through problem solving discussions that incorporated teacher-student conversations as well as student-student conversations.

Elsa used subject matter knowledge and pedagogical content knowledge during instruction. While some of the pedagogical skills were selected during lesson planning, many instances of Elsa’s choice of pedagogical skills were observed and described during her instruction. Those instances of in-the-moment pedagogical skill use described in the remainder of this section infer Elsa’s use of mathematical knowledge from both the subject matter knowledge domain and the pedagogical content knowledge domain.

**Engaging Students’ Preconceptions**

Discussions prompted by Elsa’s questioning and questions from the students were used throughout the three lessons. Elsa wrote questions into her plans to remind herself of key aspects of the concept and the topic. During the observation of each lesson, Elsa asked questions as prompts for whole-group discussions with students raising their hands to respond, and at other times, she called on individuals using random-name selection to keep students engaged. After asking a question, she would pause and allow students time to think about a question. Discussions focused on the procedures for creating a number line, how to use a number line for addition and subtraction, and the representation of fractions on a number line.
When asked during the pre-observation interview about writing the questions into lesson plans, Elsa explained, “I learned that it helps to think about what to say ahead of time. So much is happening when you teach. I try to think about how to get them to start thinking about the math.” During the post-observation interviews, Elsa viewed eight video segments in total depicting her questioning of students, “Why do you think that is?” After viewing her student questioning during the first post-observation interview, Elsa commented, “Sometimes I’m trying to find out if they know what they’re doing; if they understand. Sometimes I’m trying to figure out how I can re-state what they’re saying.”

Elsa often prompted students to explain their responses during the lessons. She was observed repeating the explanations or probing others to add to an explanation. If an erroneous response was given, Elsa would question the student about their process. She accepted other students’ input about the process. She prompted the class toward clarity of the concept and an accurate response by posing mathematical reasoning questions such as “How do we do that?” or “Why didn’t that work for us?” repeatedly during the discussions. Elsa was trying to work with student errors as a strategy to promote mathematical reasoning. She observed her mentor teacher and another site colleague using student errors “in a very positive way.” During the second post-observation interview, Elsa commented that she felt she was “getting better at knowing when to use the error and not feeling embarrassed” for the student.

In addition, Elsa prompted students to explain their process when an accurate response was given. If a student used an unfamiliar process, Elsa would pause and say, “I see what you did.” She was observed using this statement during the first observation.
After making the statement, Elsa prompted the student through further explanation of the procedure. She often summarized as the discussion progressed. Questioning and using students’ incorrect responses to further their thinking and learning on a topic were taught during the methodology course. Elsa recalled some of the course material, but she felt that her mentor teacher showed her how to implement the strategy.

Another strategy that Elsa often used was think-pair-share during the three lessons. She would pose a question about the concept or a step in the procedure and then tell the students to think about the response and write it down. Next, she would ask the students to talk about their response with the person near them. Finally, she would ask students to share what was discussed with the partner. During the first post-observation interview, Elsa explained, “They get to tell what they did with someone else. When I listened, I heard pairs agreeing or just repeating, but some pairs in the back were talking about the math and one pair asked a challenge question.”

Elsa often asked for volunteers to share their work on the white board. If an error was made, Elsa would prompt the student by questioning each step of the process or ask the student to explain their process. In addition, she used table-group activities to build and use number lines. After each table group completed an activity, she would ask the table groups to share their work with the class. Again, she prompted the students’ thinking and procedures through questioning during the whole-class discussion.

Most of Elsa’s lessons were designed around mathematical discussions. She had questions embedded in her lesson plans, but she was observed varying from the planned questions based on student responses during the discussions. Below is a conversation
from the first lesson observation as the class began using the number line to add fractions.

The topic raised by a student was not part of Elsa’s lesson plan.

Fran:  Can you skip count on a number line?  Like two-fifths, four-fifths, six-fifths?  That would make everything fit.
Elsa:  Well, that’s a really good question.  We should see if it works.  If I’m adding one-fifth to two-fifths, how would I show this?
Fran:  Your dot’s between two tick marks.
Elsa:  So, we can show it.  Can anyone think when this might not work?  Alice?
Alice:  I mess up counting tick marks.  I’d forget to count between the two.
Elsa:  That would mess someone up.  Barry?
Barry:  You should just put the mark to remember to count it, ‘cause you’re counting it.  You just have to draw the tick marks smaller, closer together to fit it.
Elsa:  Yes, you would need to remember that you skipped writing the numbers but you can’t skip counting the numbers.  It may not work for everyone.

The discussion reasoned through the student’s question without Elsa imposing one correct answer.  This method of posing questions to the class and not just the student posing the question was observed often when Elsa was confronted by students’ erroneous response during a whole-group discussion.

Elsa reviewed a video segment during the first post-observation interview of a student error written on the white board number line.  She recalled that she had seen the student make similar errors on her worksheets.  Elsa remembered thinking, “‘Now I see what you’re doing.’ I hoped she would see her error as she tried to explain it.  I think she did.”  Elsa further explained that when she paused on the video she was trying to think of questions that would “help her [the student] and not embarrass her.”  She added that she was still “getting comfortable working with errors” during the lessons.  She becomes concerned about students getting embarrassed and she is “very cautious” with her questioning when she reasons through a student error during the lesson.  The following is an excerpt of Elsa working through a student error during the first observation.
Elsa: Who would like to come up here and show eight plus five on our number line? Kath. She's doing a very nice job making sure the marks are evenly spaced. So, she’s starting the problem at the five.

Andy: What? She stopped.

Elsa: Okay. I want to take a look at this. What are we showing with this number line? We have our eight and we have our five, but what we just learned...what problem is that showing on this number line? Meg.

Meg: Now it’s showing instead of eight plus five it’s showing five plus three.

Elsa: So, we started at five and we added how many?

Andy: Three.

Elsa: So, this is showing five plus three. And what is five plus three?

Class: Eight.

Elsa: Eight, which is where we ended up. Does that make sense? Do you want to revise your answer?

Kath: Yes.

Elsa: How would we show five plus eight or eight plus five? Which number are you going to start at?

Kath: Eight.

Elsa: Eight. Okay. Why are you starting with eight?

Kath: Because it comes first there.

Elsa: Okay. How many are you going to count up?

Kath: Five.

Elsa: Okay. Why are you counting up five?

Kath: ‘Cause that’s the next number.

Elsa: Okay. Let’s count from eight with her.

Class: One, two, three, four, five.

Elsa: Where did we end up?

Kath: Thirteen.

Elsa: Thirteen. Okay. Does that make sense?

Kath: Yes.

Elsa: Who can tell me why that makes sense now? Susie.

Susie: The answer, eight from before, needed to be bigger than eight.

Elsa: Okay. Why do you say that?

Susie: Because you’re adding to eight so the answer is bigger, is going to be bigger than eight.

Elsa: Perfect. Does everyone see that? If you’re adding two numbers, the answer is going to be greater than any one of those numbers. Okay.

Elsa assisted the mathematical reasoning through the error with prompting questions. When the question was solved correctly, she led the discussion toward the concept. Finally, Elsa re-stated the concept. This type of questioning requires both subject matter knowledge and pedagogical content knowledge elements. Elsa used
common content knowledge to recognize the error was made, specialized content
knowledge to identify where the error was made, and knowledge of content and teaching
to select the questions that led the students to clarify the concept.

Connecting Facts and Concepts

Elsa planned and used strategies taught in the methodology course such as slowly
modeling the steps of an activity and checking for understanding during the modeling and
guided practice portions of the lesson. Elsa explained during the pre-observation
interview that in previous lessons she “looked over the Engage curriculum and practiced
the procedures they used. But I had to find my own problems for the review. I had to
look if the problem was relevant.” She selected hands-on activities to engage the
students and give them opportunities to perform multiple representations of the
mathematics.

She planned examples and word problems, but was observed asking students for
ideas to create mathematical problems during all three lessons. Elsa was shown two
video segments when she was incorporating students’ suggestions into fraction problems
during the second post-observation interview. She explained, “The examples were good
and they were just a little different; not just switching the numbers, but the way to think
about the solution.” This demonstrated Elsa’s ability to evaluate student suggestions and
responses during instruction. She made her evaluation based on the students’
mathematical reasoning as well as evaluating the procedural accuracy of the students’
suggested representations.

In addition, Elsa selected several representations and examples from the
curriculum materials and website worksheets for all three lessons. When using the
representations and activities, Elsa varied her pacing throughout the three lessons depending on student reactions, responses, and discussions. She actively listened to the students’ reasoning and questioning by summarizing what she heard or by asking clarifying questions during discussions. As the students seemed to demonstrate an understanding of the concept and the procedures through the formative assessments, Elsa would summarize the concept or procedure and introduce the next portion of the activity.

When Elsa viewed a video segment during the second post-observation interview and was asked about the summarizing and the pacing in the lesson, Elsa explained that the questions she asked prompted the responses that let her “know they were ready to continue to the next part.” Her perception was that this ability to question had developed over the semester of field experience while she watched her mentor teacher use the same strategy. She added, “Sometimes their examples tell me if they’re understanding.”

Below is an example of Elsa working through a student’s representation of the fraction three-fourths.

Elsa: How would you explain the fraction three-fourths? Mike.
Mike: You can draw a pizza and everyone would get one slice.
Elsa: Can you say that again using this fraction to explain it?
Mike: You can draw a pizza with four pieces and leave one slice.
Elsa: How many pieces are there?
Mike: Four.
Elsa: Why four?
Mike: ‘Cause they’re four people at the table.
Elsa: Okay. You and three friends are eating pizza. Out of this particular pizza, using this fraction, how many slices would we be eating?
Mike: One.
Elsa: One slice? Okay, so we would have the three left over. Okay. So, we switched it.
Mike: Yes. I want to know how much I get to eat.
Elsa: Okay. So, the other pieces would be...?
Mike: Would be for my friends. There would be three-fourths left for my friends.
Elsa: Okay. Right. I see that.
Elsa explained that she could tell by the student’s use of the fraction that he understood “the unit for the fraction and the portions of the fraction.”

These instances demonstrated Elsa’s use of subject matter knowledge and pedagogical content knowledge. Using the student’s real-world representation required Elsa to use her common content knowledge to recognize the fraction and her specialized content knowledge to identify and explain the student’s representation. Elsa was unable to use the published curriculum for this review, but she did use other curriculum materials that required evaluation and adaption using her knowledge of content and curriculum in that process.

Developing Metacognitive Self-Monitoring

Elsa reviewed a video segment during the second post-observation interview of the students communicating during a think-pair-share, and recalled that, when she saw the students’ “engaged and talking about the activities and the problems,” she was reassured that she made the appropriate activity selections that provoked problem solving and mathematical reasoning. Elsa planned to use one central activity that asked the table groups to organize fraction cards on a large number line on the white board. She saw the students working with each other and heard the students discussing where to place the fraction cards. Elsa anticipated the activity would have the students physically experience the number line, but added she had “not expected the level of communication between the students.”

When questioned further about the amount of think-pair-share and small-group activities she used in her lessons during the third post-observation interview, Elsa explained, “They need to talk about it and not just listen to me. I can hear their thinking.
Sometimes I don’t even need to walk around the room. I can hear it. Some discuss more, but that’s to be expected.”

The knowledge Elsa used to provide students the opportunity to reason through a mathematical problem or concept with others was her knowledge of content and students and her knowledge of content and teaching from the pedagogical content knowledge domain. Elsa used the knowledge that students need to discuss their learning and she provided appropriate and guided opportunities for communication. Elsa used teacher-student communication and student-student communication to promote problem solving, mathematical reasoning, and monitoring for accuracy during all three lessons.

The final part of the lessons involved problem solving using worksheet practice problems that Elsa copied from websites. While she used the discussions and questions as formative assessments that informed her if she needed to re-phrase or review the information at that moment of instruction, the worksheets gave Elsa data that would inform the subsequent lesson. She described her procedure during the first post-observation interview, “If I see a lot of errors, like this one, I think back to what this student has done before. I’m looking at how he got that answer. I may need to think of another way to show this.”

During the third post-observation interview, Elsa displayed a student’s worksheet that had the correct answer but the procedure on the number line was inaccurate. She explained, “He’s made a lot of improvement, but he could use more practice adding fractions on a number line.” After comparing previous worksheets and assessments on this topic for the entire class, Elsa discussed at the final study interview that she saw
improvement on the use of number lines and viewed the three review lessons as useful. Elsa added that she was “happy and surprised the review actually helped.”

**Summary**

Elsa’s background included a master’s degree, prior lesson planning and instruction, and higher-level mathematical knowledge, but she described her mentor teacher as her greatest resource during lesson planning and instruction. She used all five applicable elements of mathematical knowledge and all eight of the foundational instruction practices taught in the methodology course. The fourth-grade class contained low percentages of English-language learners and students with disabilities, and contained a moderate percentage of students who are socio-economically disadvantaged. Elsa and her mentor teacher considered the field experience as a collaboration and the mentor teacher provided multiple opportunities for Elsa to practice planning and instruction.

Her mentor teacher encouraged Elsa to use a variety of instructional strategies. Elsa included discussions, reasoning through errors, used real-world examples, prepared relevant representations, encouraged and used student representations, often checked for understanding, encouraged problem solving, and provided multiple opportunities for students to communicate their mathematical reasoning during instruction. Because the lesson sequence was a review and the curriculum did not contain any review materials, Elsa needed to create the lessons. Inconsistent with previous research, Elsa’s primary focus during lesson planning was not on time management and engaging activities but on state standards and lesson alignment that addressed student achievement (Lloyd & Behm, 2005; Grossman & Thompson, 2008; Nicol & Crespo, 2006; Rozelle & Wilson, 2012).
Case Study: Viola

Background

Viola was interviewed four times and observed teaching two lessons that covered an introduction to finding volume of a rectangular prism. Viola’s desire to learn prompted her pursuit of a teaching credential at 25-years old. She received her baccalaureate degree in English, worked in retail for a couple years, and then applied for the teacher education program. Viola entered the teacher education program without previous lesson planning or instructional experience.

Prior Mathematical Knowledge

Viola’s mathematical knowledge was in a low range relative to this study. Her scores on the CSET were reported as passing the multiple-choice section on mathematical tools and procedures, passing one written response on mathematical reasoning and strategies, and passing the other writing response with improvement needed on subject matter knowledge, on knowledge of the purpose of concepts and strategy, and on providing relevant evidence supporting her use of the strategy. On the mathematical knowledge questionnaire, Viola responded accurately to 7 of the 13 questions. She was unable to select the best representations for the both mathematics procedures. Viola demonstrated knowledge of appropriate mathematical reasoning on 7 out of 11 problems.

Field Experience Context: School, Students, Mentor Teacher

Viola was placed in a fifth-grade class of 12 boys and 14 girls at a kindergarten to sixth-grade public school. The total school population was 296. The class percentages for socio-economically disadvantaged students (57%) and English-language learners (21%) were lower than the school population percentages for socio-economically
disadvantaged students (79%) and English-language learners (59%). The class percentage for students with disabilities (25%) was higher than the school population’s percentage (17%). There was a full-time instructional aide assigned to the class to serve two students with special behavior and academic needs.

The mentor teacher, Cheryl, has 29 years of teaching experience with the last 10 in the fifth grade. She was retiring at the end of the school year. During the school year, Cheryl gave her personal classroom activity resources and materials away to colleagues, friends, and Viola. Cheryl has mentored many preservice teachers during her career and enjoyed supporting their learning. Cheryl thinks behavior management is an important skill and carries across all grade levels and subject matter. In addition, Cheryl focuses on language development and thinks teachers need to be culturally sensitive to the students’ primary language. She is concerned this year with the large amount of identified and unidentified students with disabilities in her class. In order to manage the behaviors and keep the students engaged, she often integrates children’s literature into mathematics lessons and encourages preservice teachers to adopt her practice. Because engaging the students and maintaining their focus on the topic was important to Cheryl, she tried to teach Viola to use activities in her lesson plans that are hands-on in nature.

The school district adopted the Harcourt Math series in 2008 for all grade levels. The mathematics series aligned with the previous California state content standards instead of the Common Core State Standards for Mathematics. The fifth-grade teachers also use the Mathematics Assessment Resource Service (MARS) activity packet purchased and provided by the school district. The packet contains multi-step activities designed to assess student’s application of a mathematics procedure through multiple
representations. Cheryl uses the MARS activities to engage the students with a mathematical challenge. She integrates children’s literature and other activities from resources she gathered over the years. Some activities were acquired from previously district-adopted textbooks, Cheryl purchased supplemental mathematics books that contained activities, some activities were passed along from colleagues, and Cheryl created some activities over the years.

Cheryl made her activities and materials available to Viola. Due to the large amount of available resources, Cheryl often selected a few activities for Viola to choose from during her planning. Cheryl was comfortable with the fifth-grade topics and said she frequently adds learning activities just prior to the start of a lesson or during a lesson. The mathematics lessons were scheduled for 2-hours. Cheryl said that the large time block allowed her to vary activities and give students 5-minute breaks to keep them engaged with the material. Cheryl added that most of the flexibility in her lesson planning is to manage off-task student behaviors.

Viola also noted, and it was observed, that managing off-task behaviors used a lot of instructional time. Viola and her mentor teacher identified many of the students that exhibited the off-task behaviors as the low-performing English language learners and the students with identified learning and behavioral disabilities. They estimated those student groups accounted for about 25% to 30% of the class. Viola watched the students and adjusted her pace when she noticed an increase in the off-task behaviors. The most common adjustment Viola made was reducing the examples and her questions. She then added a practice problem and allowed the students to talk at their table groups about the
problem. The practice problems were available to Viola at the teacher’s desk, but were not included in the lesson planning.

**Subject Matter Knowledge and Pedagogical Content Knowledge in Planning**

An introduction to volume was the last unit in the mathematics textbook that her mentor teacher, Cheryl, would cover with this class. After Viola finished her field experience, Cheryl would review mathematical concepts and procedures that she selected during the last month of the school year. Viola stopped writing lessons early in the field experience. She only wrote out the lesson plans when required by the university supervisors. Viola created the lessons based on activities she found on websites, the Mathematics Assessment Resource Services (MARS) tasks, and Cheryl’s suggestions. She did not use a textbook to plan the lessons, and stressed vocabulary skills throughout both lessons.

The students were not assessed prior to the start of the lesson sequence, but Viola and Cheryl both commented that the students performed below their expectations on the previous topic of surface area. When asked during the pre-observation interview how she refreshed her knowledge to teach the lesson and how she prepared the lesson, Viola said she reviewed the topic for about an hour, thought about the topic and lesson for two hours, and then spent 20 to 30 minutes looking at websites. She explained, “I just thought for two hours about how to teach this, what would keep them interested.” Viola’s preparation resources included her mentor teacher, the curriculum materials, a previous assessment on area and perimeter, websites about the topic of volume, and websites about introductory lessons for volume. Reviewing curricular materials demonstrated Viola’s use of pedagogical content knowledge.
Knowing that mathematics is her “weakest subject,” Viola reviewed the topic of volume in the teacher’s edition of the textbook, the MARS supplemental task book, the grade-level student packet about shapes created by the fifth-grade teachers at the school site, and by watching an instructional video on the BrainPOP website. Viola explained, “I needed to review the material. Everything I looked at helped me to remember volume and the vocabulary.”

Viola’s mathematical knowledge use during lesson planning used both subject matter knowledge and pedagogical content knowledge. Her subject matter knowledge was limited and she sought resources to strengthen her own understanding of volume. She determined the difficulty of the vocabulary and common errors that could be made due to the mathematical vocabulary. Her pedagogical content knowledge was demonstrated as she selected activities and tasks that supported vocabulary development and mathematical explanations in the activities. Viola’s instruction allowed for further observation of her developing subject matter knowledge and pedagogical content knowledge.

Mathematical Knowledge Use during Instruction

Viola was observed using six instructional strategies taught in the methodology course that demonstrated her use of mathematical knowledge that supports the principles of instruction: discussions, used real-world examples, prepared relevant representations, often checked for understanding, encouraged problem solving, and provided opportunities for students to communicate about the activities. In addition, Viola aligned the lesson plans with the learning objectives from the textbook, but did not use the textbook lesson plans.
Viola engaged the students’ preconceptions through discussions that used questioning and encouraging conversations about mathematical procedures, but few questions promoting conceptual or mathematical reasoning discussions. In addition, Viola did not work through mathematical errors with students during the two lessons. Viola supported connecting mathematical facts and concepts by using relevant mathematical representations that were real-world examples. Viola selected all of the representations, but did not solicit or incorporate student examples. She used questioning and tasks as formative assessments to check for understanding of the facts and concepts during the lessons. Viola developed students’ metacognitive self-monitoring through problem-solving discussions that incorporated teacher-student conversations as well as student-student conversations. However, Viola’s rationale for using the student-student conversations was to keep the students engaged with the lesson and not to encourage a depth of mathematical understanding; the student-student conversations were unplanned.

Viola used her subject matter knowledge and pedagogical content knowledge during instruction, but at a lower level. She selected activities and tasks that were engaging, supported learning and clearly represented the mathematical procedures. She did not expand on mathematical reasoning during the activities and tasks that would have further developed student understanding of the concept of volume. The depth of her whole-class discussions was at a lower level focused on vocabulary development and did not demonstrate well-developed pedagogical content knowledge.
Engaging Students’ Preconceptions

Viola asked many prompting questions during the two lessons. While reading a children’s book about mathematics to the students, she often paused to ask questions. An example from the first lesson observation follows.

Viola: [Reading] Look again at the screen. It is a rectangle. It has four straight sides. Opposite sides are the same size and all angles are right angles. To find the area of a rectangle you multiply....
Viola: What? You multiply...?
Class: Base times height.
Viola: Yes, base times height. What about a triangle?
Class: Base times height divided by two.
Viola: Yes, base times height divided by two.

Viola explained during the first post-observation interview that the students “need a lot of review, especially with terms.” She learned the method of questioning from watching her mentor. Viola added, “It works. They seem to get it.”

During her questioning and discussions with the students, Viola did not incorporate student examples into her discussions. She did listen to and summarize what the students said when they responded to her questions. After watching a segment of video from the first lesson during the post-observation interview, Viola voluntarily said, “I repeat a lot for language development.” Fifty-nine percent of the students are English language learners and this influenced many of Viola’s instructional decisions during planning and teaching. One strategy Viola used was to call on a student to repeat another student’s response, and then she summarized the response. Viola explained during the second post-observation interview that this strategy kept them “alert” during the lesson.

Viola used another technique to keep the students focused. She would often randomly call on students throughout the lesson. The questions prompted responses about definitions or procedures. Working on a new vocabulary word, Viola used
questioning to develop the meaning while the students looked at a picture of a tall rectangular prism in the following example from the first lesson observation.

Viola: Okay. Congruent. We haven’t talked about congruent. But what can you infer based on looking at the picture that congruent means? Deb, look at the picture. What can you infer congruent means based on that picture what congruent means? What do you think congruent means?
Deb: I think congruent means double.
Viola: Okay, so she says she sees two squares on the top and the bottom that are double. Two. Okay. Sure. Two congruent square bases. Two squares. What do you think congruent means? I think congruent means... Chase.
Chase: I think congruent means...I think congruent means...the same.
Viola: The same. I think congruent means the same. Raise your hand if you agree. Okay, everyone.

Viola wrote questions into her lesson plans that anticipated student struggles with vocabulary and procedural development. There were fewer questions prompting discussions about the concept of volume, and there were no examples of Viola anticipating or working with student errors. When questioned about these observations during the first post-observation interview, Viola explained, “We’re more concerned that they learn the vocabulary and the equation, width times depth times height. This is the introduction for what they’ll need later in sixth grade. We don’t use their errors. It’s already confusing enough.”

Viola was not observed anticipating students’ mathematical misconceptions and errors during the lesson planning or instruction. During the second post-observation interview, Viola viewed a video segment of her pausing when a student wrote an incorrect answer on the white board. When questioned about her pause, Viola said that she realized the students were trying to compute the “surface area by using the equation for perimeter” instead of the equation for area. When probed to expand on her surprise
about the error, Viola replied, “I really didn’t expect that. I thought they knew the
difference.”

When students gave erroneous responses, Viola did not use the error as a starting
point to clarify and discuss the mathematical process or concept. Instead, Viola would
ask for another student to volunteer the answer or to help the student who gave the
incorrect response. In addition, Viola did not use student examples for guided practice or
elaboration of the process or the concept. Not using the strategy of incorporating student
examples was different from the suggestions taught in the methodology course. When
Viola expanded on her reasoning for not using the strategy in class during the first post-
observation interview, she explained, “This is the strategy Cheryl uses to keep the
students focused. They can check their answers with us; as we do the problem step-by-
step.” Again, she explained that behavior management was important and that Cheryl
tried to minimize instructional strategies that might distract many students.

The mathematical knowledge Viola used for the instructional strategy of
questioning the students were from the subject matter knowledge domain: common
content knowledge and specialized content knowledge. She refreshed her common
content knowledge of the procedure to find the volume of a rectangular prism through
multiple sources. While refreshing her knowledge about finding volume, Viola used her
specialized content knowledge to recognize that the vocabulary could be challenging for
students.

**Connecting Facts and Concepts**

Viola was observed during both lessons using real-world representations to find
the volume of a rectangular prism. Referring to filling different types of pictured boxes
for different purposes were used throughout the lessons. In addition, she used examples of boxes that she drew on the document camera and on the white board. All of the representations were written in the lesson plans. Again, when probed about not using examples suggested by students during the first post-observation interview, Viola explained, “This is so new to them. It would get too confusing.”

Viola selected representations to “make the vocabulary real” for the students. During the pre-observation interview, Viola explained that she chose the piece of children’s literature for the first lesson to engage the students with humor and to “review how to pick out the important details of the word problems in the story.” She used the instructional video to “review the flat shapes and how to find the area and perimeter so they could use that in the lesson.” The mathematics from the MARS task activities were the mathematical representations most used during the two lessons. When asked why she used this resource during the second post-observation interview, Viola explained, “The grade level uses these and I think they’re good problems. The students get plenty of practice.” After viewing a segment during the first post-observation interview where a student suggested an extension to one of the problems from the worksheet, Viola explained, “Sometimes they can get distracted with the story. Using the printed problem let’s them see it and stay focused.”

The hands-on activity for the first lesson had students checking their answers from a worksheet with 1-centimeter cubes. Viola walked around the room using formative assessment by asking students to explain, “How did you use the cubes?” and “Did your answer from the cubes match your work on the page?” The hands-on lesson planned for the second lesson was for students to calculate the surface area of one side of
a flattened-box pattern. Then, the students were to cut out and fold the paper box and calculate the volume to extend their work with the cubes from the first lesson.

However, the second lesson was much different than Viola had planned. Six minutes before class began, the mentor teacher was observed telling Viola not to do the planned activity of measuring and creating paper boxes. The mentor teacher gave Viola several household-type boxes of varying sizes and told her to have the students find the volume of real objects. Viola had not prepared for the activity and had not previously observed this activity. She was flexible in changing her plans, but noticeably struggled with questioning, guiding, and summarizing during the activity.

After viewing a video segment during the second post-observation interview when Viola changed the instructions that guided the students into the activity, she explained, “It was obvious they needed more time with the math before doing this activity.” She added that she would have liked to save the activity for a third lesson, but her mentor teacher did not want to spend more time on the topic. Viola explained that she tried to rely on her knowledge of the students and other activities she had viewed on the websites and the textbook to understand the structure of the mentor teacher’s activity. She commented, “I didn’t know how to make the connection for the students; to summarize what they just finished.”

During the first lesson, Viola selected activities based on her pedagogical content knowledge. She realized how the students learn the mathematical vocabulary and procedures. Viola evaluated and selected relevant representations and activities using that knowledge. During the second lesson, Viola was unable to find ways to connect the activity to the concept. She did use her pedagogical content knowledge to recognize that
the students’ procedural mathematics were not developed enough for the activity. She did not use her pedagogical content knowledge to review and/or rephrase the mathematical concept to encourage student understanding during the confusion created from the mentor teacher’s activity.

**Developing Metacognitive Self-Monitoring**

Viola described during the pre-observation interview her plan to use a miniature marshmallow multi-layered tower to challenge the students to use the newly learned equation for finding volume of a rectangular prism. She gave short breaks, two 5-minute breaks during the first lesson and one 3-minute break during the second lesson that allowed students to view the tower and discuss how to solve the problem. After the first break during the first lesson observation, Viola asked the students what they observed about the tower. Most students observed that every layer was two marshmallows high. Viola did not probe further, but did prompt them to keep thinking about how to figure out the number of marshmallows in the tower.

During the final interview, Viola explained that the marshmallow tower task was her assessment. In addition, the worksheet problem-solving tasks were used as formative assessments since no summative assessments were planned for this topic at the request of the mentor teacher. While Viola used student-student communication, she used the strategy as a formative assessment to check for understanding and not to further mathematical communications and reasoning.

Viola did not write student-student communication or think-pair-share into her lesson plans so students would discuss topics and communicate their reasoning. Viola inserted the strategy during both lesson observations. During both post-observation
interviews, Viola explained that when she perceived the students were losing focus and needed to talk, she used a student-student communication strategy. The students were observed talking about the mathematical procedures when prompted to participate in a think-pair-share during both lessons. The conversations were often about checking answers and correcting errors in their work. The students did not vary in their conversations from the procedural, and did not discuss the concept of volume. Viola walked around the room during this time and checked for correct mathematical procedures as well as managing off-task behaviors during both observations. While planning for and instructing problem solving, Viola used her subject matter knowledge and her pedagogical content knowledge as she selected ways to represent and explain the vocabulary and the procedures for finding volume.

A summative assessment was not planned for or used during the two lessons. Formative assessments were used over the two-lesson topic. The assessments were in-class worksheets, homework worksheets, ‘exit tickets’ that involved each student answering the same question Viola asked as they left the classroom for recess, and Viola’s observations and questioning during the activities. This is contrary to the suggestions from the methodology course since data from the assessments were not being used to inform about student progress or inform future lessons. Viola explained during the second post-observation interview that her mentor teacher had mentioned that she should do more assessment of the students during each topic, but this was not observed.

The challenge activity of calculating the volume of a marshmallow tower covered both days of the topic. At the end of each lesson and at short breaks, the students were observed looking at the tower in small groups trying to calculate the volume. Viola
reported during the final interview that by the end of the second day she received a calculation from each student. She commented that, “about six students were unable to use the equation to figure out the volume; instead, they tried to count and make a guess.” The other 22 students used the equation with some guidance from her and the mentor teacher, and 10 of those answered correctly. She shared marshmallows with the class at the end of the day.

**Summary**

Viola used all five applicable elements of mathematical knowledge from the subject matter knowledge and pedagogical content knowledge domains during lesson planning and instruction. While her mathematical knowledge was at a lower level, Viola used many resources to prepare herself for the topic and for instruction. Viola used six of the eight foundational instruction practices taught in the methodology course: discussions, used real-world examples, prepared relevant representations, often checked for understanding, encouraged problem solving, and provided opportunities for students to communicate about the activities. The fifth-grade class contained high percentages of English-language learners, students with disabilities, and students who are socio-economically disadvantaged. Viola’s mentor teacher considered the field experience as a time for her to teach Viola how to perform in an elementary classroom with a diverse student population. Her mentor teacher taught Viola numerous behavior-management techniques while allowing Viola to practice instruction.

Her mentor teacher supported Viola with resources and materials, but discouraged using two foundational instruction practices due to the demographics of the class. The mentor teacher encouraged Viola to focus on students’ language development and on
controlling off-task behaviors. Viola was not observed using the foundational instruction practices of reasoning through student errors and using student representations. In addition, Viola used student-student communication as an engagement strategy and not as a communication strategy. Preservice teachers focusing on behavior management and engaging activities is consistent with previous research (Kagan & Tippins, 1992). The mentor teacher focused heavily on engaging activities, and changed one of Viola’s activities six minutes prior to the start of class. Viola attempted to adapt to the last minute change and modified her lesson plan before class started. Viola’s adaptation to her mentor teacher’s pedagogy and classroom management strategies is consistent with previous research (Rozelle & Wilson, 2012). However, Viola’s adaptation revealed her pedagogical content knowledge was still in early development since she was unable to select review and rephrasing of the mathematical concept as a strategy.

**Case Study: Drake**

**Background**

Drake was interviewed five times and observed teaching three lessons on finding the volume of solid figures during this study. Drake at 40-years old changed his career from landscape architect to elementary education based on his long-time desire to teach children in the upper-elementary grades. His baccalaureate degree is in Russian literature and his master’s degree is in landscape architecture. During his career as a landscape architect, he worked with school personnel and the surrounding communities. Drake thinks some of the school contacts influenced his decision to apply to the teacher education program.
Prior Mathematical Knowledge

Drake’s mathematical knowledge was in a high range relative to this study. His scores on the CSET were reported as passing the multiple-choice section on mathematical tools and procedures, passing one written response on mathematical reasoning and strategies, and passing the other writing response with improvement needed on subject matter knowledge. On both written responses, Drake demonstrated knowledge about the purpose of the concept and strategy and demonstrated the ability to support his use of the strategy with relevant evidence in each case. On the mathematical knowledge questionnaire, Drake responded accurately to 10 of the 13 questions. He selected the best representations for the both mathematics procedures and demonstrated knowledge of appropriate mathematical reasoning on 8 out of 11 problems.

Field Experience Context: School, Students, Mentor Teacher

Drake was placed in a sixth-grade public-school class of 15 boys and 14 girls. The kindergarten through sixth-grade school has a total student population of 334. The class percentages for socio-economically disadvantaged students (86%), English-language learners (68%), and students with disabilities (13%) were lower than the school population’s percentages for socio-economically disadvantaged students (99%), English learners (68%). The class percentage for students with disabilities (13%) was lower than the school population’s percentage (15%). Out of the four participants, Drake’s school and class contained higher percentages of socio-economically disadvantaged students and English-language learners than the other three schools participating in this study. There was a full-time instructional aide assigned to the class to assist several students with special behavioral and academic needs.
The mentor teacher, Michaela, had 6 years of experience teaching in the sixth grade, and is currently working on her master’s degree. Drake is the first preservice teacher that Michaela mentored. Michaela views teaching and learning as a community effort and explained that teacher collaboration is necessary to support all students. She focuses on vocabulary building across all content areas and on building relationships with and between the students. Michaela does not write out lesson plans, but uses the mathematics textbook for structure. She enhances the lessons with materials and activities created with other grade-level colleagues and teacher websites to support students’ language development. She encourages students to communicate their understanding as a support for language development and to support their achievement of the learning objectives. Michaela frequently uses various forms of formative and summative assessments to guide her planning and to check for student understanding.

The school district adopted the Harcourt Math series in 2008 for all grade levels. The mathematics series aligned with the previous California state content standards instead of the CCSS-Mathematics. For the topic observed for this study, the district-adopted textbook was supplemented with pages from a purchased mathematics activity workbook that were used for both formative and summative assessments. Michaela often changes the order of the lesson tasks and activities depending on the difficulty of the vocabulary and the mathematical concepts and procedures. After the direct instruction period of 30 minutes, Michaela groups the students by ability levels during the activity period for 30 to 45 minutes. Michaela generally uses this daily lesson schedule for mathematics instruction.
**Subject Matter Knowledge and Pedagogical Content Knowledge in Planning**

Drake described his preparation during the pre-observation interview. He collaborated with his mentor teacher and the grade-level teachers while developing the three lessons based on the textbook. The grade-level teachers had not taught this topic for the last three years due to the need to review fundamental concepts covered during the school year. A review of the assessment on area and perimeter revealed the class was challenged when applying the equation to a novel situation. Based on a suggestion by Drake, the teachers chose to change the order of the lesson activities in the volume topic to better support vocabulary development and to allow for more practice of the equations. The ability to explain the assessment and the student needs during collaboration demonstrated Drake’s use of subject matter knowledge and pedagogical content knowledge.

Supplemental materials from the curriculum were selected as homework and assessments. Drake had adopted his mentor teacher’s lesson planning method of making notes aligned with the textbook lessons regarding specific real-life examples, additional representations, practice problems, and integrating information from the previous assessment on area and perimeter. When asked how much time he spent planning the lessons, Drake replied, “a couple of hours at least, but we generally follow the text.” Drake’s evaluation, adaptation, and modification of the curriculum demonstrated his use of pedagogical content knowledge. He selected the appropriate activities and tasks in a sequence that would support the students’ learning of the concept and procedures. In addition, he recognized the high demand the academic language would place on the students and selected strategies to support language development while learning the
concept. Drake’s use of his subject matter knowledge and pedagogical content knowledge was observed as he used his instructional strategies during the three lessons.

**Mathematical Knowledge Use during Instruction**

Drake used eight instructional strategies taught in the methodology course that demonstrated his use of mathematical knowledge that supports the principles of instruction: discussions, reasoning through errors, used real-world examples, prepared relevant representations, encouraged and used student representations, often checked for understanding, encouraged problem solving, and provided multiple opportunities for students to communicate their mathematical reasoning. In addition, Drake aligned the lesson plans with the learning objectives from an earlier summative assessment.

Drake engaged the students’ preconceptions through discussions that used questioning and encouraging conversations about mathematical explanations and reasoning. In addition, Drake worked through mathematical errors through questioning strategies. Drake supported connecting mathematical facts and concepts by using relevant mathematical representations that were real-world examples. Drake selected most of the representations, and he solicited and incorporated student examples. He used questioning and tasks as formative assessments to check for understanding of the facts and concepts during the lessons. Drake developed students’ metacognitive self-monitoring through problem solving discussions that incorporated teacher-student conversations as well as student-student conversations.

**Engaging Students’ Preconceptions**

Drake’s discussions encouraged students to think about the concept and the procedure. Drake’s introductory discussion during the first lesson observation about
finding volume started with a review of finding the area of a square and extended to
volume as he expanded the representation from a square to a box. The following is an
excerpt from the discussion.

Drake: We’re still talking about two dimensions. How many factors do we have?
How many things are we multiplying together?
Ben: Two. Oh, that’s squared.
Drake: It will be squared. Now what is our next step, Juan?
Juan: Multiply by four.
Drake: Multiply it by four. So we take our twenty-five square centimeters and
multiply by?
Juan: Times four.
Drake: Times four. That should be an easy one.
Julia: One hundred.
AJ: Cubic centimeters.
Drake: I write what?
AJ: Three. It’s cubic. It’s three dimensions.
Julia: One hundred cubic centimeters.
Drake: Right, one hundred cubic centimeters. Ready to do one on your own?

When he is teaching, Drake has a few examples or representative problems
planned, but he often added more if he thought more were needed based on his formative
assessments. Drake viewed a segment of himself looking at and responding to students’
answers to a problem regarding the volume of a cylinder on their white boards during the
third post-observation interview. He explained that most of the students had the same
wrong answer. He was thinking about “what error did they make” in the equation. Since
it did not seem apparent, Drake asked the students for measurements for another cylinder.
He had not planned to do another example, but he was looking for the error. As he
worked through the example with the whole group, he explained in the interview that he
“realized they were using the circumference instead of area” for the circle. He referred to
a bicycle tire problem from a previous lesson while explaining the problem. Drake
described that the students “seemed to get that and used it.” The bicycle tire problem was
a representation Drake created since he thought that the students would not relate to the textbook figure illustrations.

Drake described during the pre-observation interview that he adapted the textbook lessons by adding activities that anticipated challenges with the vocabulary and the procedures for the students. He acknowledged that the textbook offered some suggestions and supports for teachers regarding language development within the lesson, but “they don’t go far enough to reach the kids. It’s a good start.” He chose to use other resources for language development that he received in the teacher education courses. In addition, Drake included strategies that supported students based on anticipated misconceptions and common errors when learning volume. When he introduced the topic during the first observation, he connected to prior learning on finding area of various shapes including circles. He asked the class to “give me some real-world examples that uses this stuff [finding area].” The examples volunteered by the students were buying flooring, buying a rug, buying soil for garden plots, and buying a pool cover. Drake created a story around each example.

With each story during the first observed lesson, Drake used questioning to prompt the students’ reasoning when using the equation and visualizing the examples. For example, he would ask, “Why do we need to find that number? What does that have to do with this problem?” He used erroneous student responses as a way to model mathematical reasoning. As students would hold up their answers to problems on their small white boards, Drake would call on students to “Explain how you got that?” As the student explained, Drake would write it on the document camera. When the student
would reach the point of error, Drake would probe the student’s thinking. This was a fast-paced method and the students seemed eager to respond.

Drake was observed during the three lessons questioning correct responses by probing the students’ thinking. After asking students to do a problem or a portion of a problem on their white boards, he would affirm each student. When he was finished checking all of the boards from the front of the room, he would call on students to explain how they got the answer or he would ask students to “Show that around to everyone.” After watching a video segment of this process during the first post-observation interview, Drake volunteered, “I summarize a lot. Good, they hear it several times. They can hear all of us thinking.”

Drake used his common content knowledge, specialized content knowledge, and knowledge of content and students as he reasoned through the discussions with the students. He identified errors, recognized where the error occurred, and used examples and questions to support the students correct the error. He encouraged students to talk about the concept and the procedure with the whole group and with each other.

**Connecting Facts and Concepts**

Drake varied his question prompts and examples based on student responses and student examples. After viewing a video segment during the second post-observation interview where he paused on a student’s example, Drake explained that he was trying “to figure out how to incorporate it” and that the example had caught him “off balance.” Drake was able to connect the student’s example to a prior lesson and continued using the student’s example. The following is an excerpt from the discussion.

Drake: What’s another example of needing to know volume?
Cruz: Painting a room.
Drake: Okay. Tell me how that works.
Cruz: You need to get the area of each wall. When you get the paint, it is small or large.
Drake: Oh, quarts or gallons?
Cruz: Yeah. You need to know how much it holds so you get enough.
Drake: So that you don’t run out of paint part way through painting the wall.
    Okay. You need to know how much is in the can or the volume. Right.

Drake used summarization and rephrasing throughout the three lessons. He explained during the first post-observation interview, “We’re trying to support their language learning through real conversations, authentic conversations.” Drake explained during the second post-observation interview that the summarizations served another purpose, re-stating the concept using “different ways to explain it strengthened language development and the concept.” During the lessons Drake describe measuring volume as “looking at and measuring each piece of the object all the way back.” He repeated throughout the lessons, “We’re looking inside; cubes made of inches, centimeters, yards, meters, or whatever you’re using to measure.”

Drake used the student examples suggested on the first day throughout all three lessons. He extended the example of the pool cover to figuring out how much water was needed to fill the pool. He used a box-shaped pool drawing as an example for the students. Drake explained during the first post-observation interview, “I was trying to keep the shape the same for as many examples as I can so the students focused on the numbers plugged in for the equation.” He chose to keep the same shape and change the story to keep the “meanings constant” of the words depth, width, and height. These instances demonstrate Drake’s use of his pedagogical content knowledge as he made the concept and procedures more accessible to the students through multiple representations.
During the second lesson observation, Drake used his pedagogical content knowledge as he drew a shorter rectangular prism and used different numbers. When the students finished the problem on their white boards, they noticed that the volume was the same even though the boxes looked different. Drake used this as his central activity to “get them into the math.” He added, “They’re using the language, cubed, cubic, squared. They’re talking about measuring three sides or two sides.” Drake expressed, “I was surprised how many got that so fast. I saw their learning.”

Throughout the lessons, Drake used his subject matter knowledge and pedagogical content knowledge to support student learning of the concepts and procedures. Drake used various real-world examples to demonstrate how and why volume was used. He summarized each example and connected it to the concept. In addition, Drake used his knowledge of content and curriculum to review, evaluate, and adapt the textbook activities and instructional strategies.

**Developing Metacognitive Self-Monitoring**

Drake used the instructional strategy of active listening during discussions by repeating and summarizing student questions and responses. When he observed students struggling with a one of his questions, he encouraged the students to use the resource posters in the room. After viewing a video segment during the third post-observation interview of a long pause during questioning, Drake commented, “I don’t want them to become dependent on posters, but I want them to know how to use things around them to solve a problem. They’re getting quicker, and I know we’re on the verge of getting it.” He added that Michaela covered the posters during quizzes.
Drake often used two forms of student-student communication during the lesson. One form Drake used was to direct students to work a problem independently on their white board. After Drake reviewed the white boards, he would give one student group time to explain their answer to their partner; then the partner had time to explain their answer. Drake explained during the second post-observation interview, “There’s no time to be off task.” The second form was a think-pair-share discussion between partners. Each communication strategy took about one minute.

Managing the communication strategies used elements of mathematical knowledge for teaching. Drake used his pedagogical content knowledge as he prompted and encouraged students to talk about the problems and the solutions. He offered a variety of problems for the students to solve prior to the 30 minutes of small group problem-solving worksheets.

Drake used problem sets and worksheets from the curriculum materials to inform his instruction for each lesson. In addition, the most frequent formative assessment he used was the white board displays of student work during each lesson. During the first post-observation interview, Drake explained that in the past, he has “added a review problem or two or three into the next lesson if the worksheet scores are low. I can see them struggling with it.”

Drake used the summative assessment from the textbook at the end of a topic. He discussed how he used the summative assessments during the final interview. If the summative assessment scores are high with students demonstrating an understanding of a concept and a procedure, Drake thinks about what strategies he used that may help students during the next topic. If the scores are low and the students are struggling,
Drake thinks about the possibility of revisiting the topic in a review lesson. He commented, “It’s so hard to see them get hit by a hardball on a quiz. I like to throw them softballs and work up to the hard stuff.” Drake’s mentor teacher told him that time constraints in the curriculum and with other activities preparing for the students’ transition to middle school make it difficult to revisit topics the last half of the school year.

The class average for the summative assessment for this topic was 77%. Drake said that seven students scored below 70% and would participate in a remediation lesson in a small group the following week. Overall, Drake and his mentor teacher thought the students did well on the topic and this performance is typical for the students in the topic of mathematics. Drake expressed confidence in using his lesson planning and instructional skills, and gratitude toward his mentor teacher and the grade-level colleagues.

**Summary**

Drake described his mentor teacher as his greatest resource even though he possesses a master’s degree and a higher level of mathematical knowledge. Drake used all five applicable elements of mathematical knowledge for teaching and all eight of the foundational instruction practices taught in the methodology course. The sixth-grade class contained high percentages of English-language learners, students with disabilities, and students who are socio-economically disadvantaged. Drake’s mentor teacher focused on English language development while using a variety of instructional strategies. In addition, his mentor teacher considered the field experience a time to teach Drake how to collaborate with her and in a grade level. The mentor teacher allowed Drake
opportunities to practice presenting his ideas about learning during collaborations as well as practicing instructional strategies.

With his mentor teacher’s encouragement, Drake’s instructional strategies included discussions, reasoning through errors, used real-world examples, prepared relevant representations, encouraged and used student representations, often checked for understanding, encouraged problem solving, and provided multiple opportunities for students to communicate their mathematical reasoning during instruction. Drake felt comfortable adapting the curriculum to meet student needs and support achievement of the learning objectives. Inconsistent with previous research, Drake’s primary lesson planning focus was not on time management and engaging activities but on state standards and lesson alignment that addressed student achievement and language development (Lloyd & Behm, 2005; Grossman & Thompson, 2008; Nicol & Crespo, 2006; Rozelle & Wilson, 2012).

Case Study: Rose

Background

Rose was interviewed four times and observed teaching two lessons on solving percent problems. Rose at 50-years old decided to enter the teacher education program after working as an instructional aide at a private religion-based kindergarten to eighth-grade school. Rose originally left a career in the chemical engineering field to stay home with her children, and took the instructional aide position when her children entered the school. Her baccalaureate degree is in chemical engineering emphasizing biology. As an instructional aide, she assisted the teacher with planning small-group reading and
mathematics lessons based on assessments administered by the teacher. Rose’s work in the classroom influenced her decision to enroll in the teacher education program.

**Prior Mathematical Knowledge**

Rose’s mathematical knowledge was in the middle range relative to this study. Her scores on the CSET were reported as passing the multiple-choice section on mathematical tools and procedures, passing one written response on mathematical reasoning and strategies, and passing the other writing response with improvement needed on subject matter knowledge and on knowledge of the purpose of concepts and strategy. On both written responses, Rose demonstrated the ability to support her use of the strategy with relevant evidence in each case. On the mathematical knowledge questionnaire, Rose responded accurately to 9 of the 13 questions. She selected the best representation for one of the two mathematics procedures and demonstrated knowledge of appropriate mathematical reasoning on 8 out of 11 problems.

**Field Experience Context: School, Students, Mentor Teacher**

Rose was placed in a sixth-grade class with 14 boys and 9 girls with the teacher she previously worked with as an instructional aide. The school is a private religion-based school that serves grades kindergarten through eighth grade. There are no socio-economically disadvantaged children or English-language learners in the class or in the school population. There are no children with disabilities in the class, and 1% of the school’s student population has disabilities. Out of the four participating schools, Rose’s placement school has the smallest student population with the largest grade span. In addition, the school has the smallest disadvantaged student population. According to the
school’s administrator, the student population is common in private elementary schools due to the cost of tuition and the lack of services for students with special needs.

The mentor teacher, Laura, has taught for 8 years. Rose was Laura’s instructional aide prior to entering the teacher education program. Laura is the only sixth-grade teacher at the school. Laura is aware of the students’ performance and behaviors by collaborating with previous grade-level teacher, and she is aware of academic and behavior expectations on the students for the following grade-level. She mainly uses the textbook and some websites for lesson planning. The textbook selected by the school is the 2001 version of California Middle School Mathematics: Concepts and Skills published by McDougal and Littell. The textbook is aligned with the previous California state content standards instead of the CCSS-Mathematics. Laura adapted the textbook publisher’s prepared slides as her primary instructional tool. The slides are projected on a Smart Board during the lessons. She supplements the lesson activities with student journals and other activities she has created or acquired from other teachers.

Laura frequently assesses the students’ learning through homework, in-class assignments, and quizzes. The assessments inform Laura when she is selecting supplemental activities and/or problem sets for the lessons. After the 30-minute direct instruction for each lesson, the students work silently on problem sets from the textbook for 30 minutes. Laura does not like to vary from this structure and views time management important to organizing the material and providing structure that supports student learning. Time management and lesson pacing are two topics that Laura explained she wanted to teach Rose during her field experience. Laura trusts the structure of the curriculum materials and keeps each mathematics lesson sequence the
same: two days of direct instruction and practice, one day of silent problem-set practice, and a final day of a brief review and a quiz. Laura expected Rose to adhere to her lesson planning and instructional structure.

Subject Matter Knowledge and Pedagogical Content Knowledge in Planning

The resources Rose used to prepare the lessons were her mentor teacher, the textbook, the textbook slides, an instructional video lesson website, and a story from a supplemental book on mathematics instruction. Rose and Laura selected the practice problems for the lessons based on the students’ prior performance on a quiz and homework problem sets about fractions. When asked during the pre-observation interview how long it took to prepare for the lesson sequence, Rose replied, “Well, the structure is the same for each lesson. I find the topic straightforward. I possibly spent one, maybe two hours.” Rose respects Laura’s request not to vary too much from the textbook format, and remarked that she appreciated the opportunity to use the instructional videos to engage students. However, she does feel restrained by the adherence to the textbook’s lesson structure. Rose explained, “I would like to spend a little more time on some topics. At times, it feels rushed.” Rose used her subject matter knowledge to collaborate with her mentor teacher regarding the students’ previous assessment and her pedagogical content knowledge when selecting the appropriate practice problems.

Rose planned to use questioning during the lesson discussion. This is not typical in Laura’s lesson planning. Rose explained in the pre-observation interview that Laura has trained the students with “don’t ask and don’t interrupt.” Laura preferred to get through the lesson slides and then answer questions individually during the 30 minutes of
independent work time. Rose wanted to include questions that would “get the kids involved and thinking about why they’re learning this stuff.” While Rose attempted to anticipate student misconceptions and errors, she admitted to stressing more on “accuracy in setting up the problem” than on other common student errors. Planning for discussions that contain questions focused on mathematical procedures demonstrated Rose’s use of pedagogical content knowledge.

**Mathematical Knowledge Use during Instruction**

Rose used four instructional strategies taught in the methodology course that demonstrated her use of mathematical knowledge that supported two of the three principles of instruction: real-world examples, prepared relevant representations, checked for understanding, and encouraged problem solving. Rose did not engage the students’ preconceptions through discussions, use questioning to work through errors or misconceptions, or encourage conversations about mathematical procedures. She used her subject matter knowledge while reviewing the mathematical procedures during the two lessons. Rose used a lower level of her developing pedagogical content knowledge during the lessons since she did not believe she could change the instructional strategies from the mentor teacher’s lesson structure.

The lesson strategies focused on mathematical procedures and did not address mathematical concepts. In addition, Rose attempted to work through mathematical errors with students during the lesson, but was unsuccessful completing the procedure. Rose used the textbook representations, and did not solicit or incorporate student examples. The instructional videos Rose selected for the lessons used real-world representations that supported using the procedures. Rose checked for understanding by calling on students
to respond to the questions on the slides and by looking in the students’ mathematics journals. Rose developed students’ metacognitive self-monitoring through independent problem solving, but the discussions centered on procedures and not on communications that would support mathematical reasoning.

**Engaging Students’ Preconceptions**

Rose’s discussions were brief as she followed her mentor teacher’s preferences and example. She used the questions from the textbook slides prepared by her mentor teacher. The questions focused on discerning the important pieces of information to solve the problem. Rose attempted to start a discussion with the students when she stopped the Math Antics instructional video to ask questions that reviewed procedures during the first lesson observation. An example of Rose’s questions and comments during the video follows.

Rose: So, you see how he’s taking the paragraph of words and just pulling out and highlighting the key information? When you are doing your math homework, you can do that same thing. So, you’re not going to actually highlight in your book, but you can write down and figure out that information. Okay?

[Video: 2 minutes]
Rose: Okay, so remember this process we did when we were finding the proportions and solving for percent? Right, this is looking familiar to you guys? Okay.

[Video: 2 minutes]
Rose: Okay, so that was the fraction method. Remember we said we could use the fraction method or the proportion, all those ways. That was an example of the fraction method.

[Video: 2 minutes]
Rose: Based off that, what method do you think he’s going to explain next?
Will: Decimal.
Rose: Right, he’s just going to follow a decimal method.

Rose’s questions did not delve into the concept of solving percent problems; instead, the focus was on following the procedures. Rose controlled the information that
would appear on the slide. As the students answered portions of the problem based on Rose’s prompting, she would expose the information. The following is another excerpt from the first lesson observation.

Rose: [Reading from slide] Your softball team won nineteen of its twenty-five softball games. What percent of the games did it win?
Rose: So the part.... What is the question asking, Ron? What are we looking for?
Ron: What percent of the games did the softball team win?
Rose: The green percent is going to be our variable, and they tell us how many games they’ve won. How many games did they win, Max?
Max: Nineteen.
Rose: And then, Max, how many total games did they play?
Max: Twenty-five.
Rose: Twenty-five. So it’s going to go on the bottom, the denominator. Everybody got that? So when you solve that, what do you get? Go ahead and write it in your notebook. Once you have your answer, close your notebook.

After checking students’ notebooks for responses, Rose called a student to the white board to show his work to the class. As the student started to show his work, he could not explain it. Rose tried to use the student’s error to question the student through the mathematical reasoning in front of the class, but was stopped by the mentor teacher partially through the problem. She explained during the first post-observation interview, “I was trying to understand the shortcut he used because he had the right answer in his book. I thought, ‘What did you do there?’” As Rose was going through each step with the student at the white board, neither one could get the multiplication to work. The mentor teacher, Kelly interrupted Rose by saying, “This is throwing them off. You can go over it later with him.” Rose explained during the interview that she was in the process of figuring out “How do I get out of this?” when Kelly stopped the explanation. Rose expanded on her thinking about stopping by volunteering that she thought, “This is going to derail the class.” She explained that she looked in his journal before calling on
the student and did not see the error in the procedure. After that event, Rose did not work through other errors on the white board in either lesson.

Another example of attempting to use a student error was during a formative assessment as Rose checked responses in journals. After viewing a video segment of a student holding up the wrong answer in her journal during the first post-observation interview, Rose explained, “I saw what she did and I’d seen it on her homework, too. I thought, ‘Alright, let’s get you to where you need to get.’” She decided to ask a question that would make the student look at her process and find that the error was “a simple poor-problem-set-up error.” When the student did not seem to understand the question, Rose did not use a re-phrased follow-up question. Instead, Rose told the student to check her decimal position.

A third example of Rose attempting to work with a student’s error occurred during the second lesson. She viewed a video segment during the second post-observation interview of a student proclaiming that he was lost. Rose recalled, “I thought, ‘Yes, I can tell you are, but where did I lose you?’ So, I asked him to walk me through his steps.” She started prompting him through each step, but did not go to the end of the problem. After viewing the video segment of the discontinuation of the step-by-step questioning, Rose explained, “I could see that he got it; that he found his error because he started working faster in his journal. So, I moved on.” Rose added that she checked the student’s journal during the independent work time and he did have the correct process and answer.

In her lesson planning, Rose anticipated the common error that students would make was not paying attention to details or not selecting the correct details in the word
problems. During both lesson observations, she questioned the students about the process and the relevant details in the example problems on the slides in anticipation of the errors. The questions she used were reasoning through the procedure and not questions that would promote mathematical explanations or reasoning of the concept of percents, proportions, or ratios. The instruction contained questions often beginning with *what* and not *why*.

Rose continued to prompt the students to check for their own errors by asking questions about their procedures during both lesson observations. The students would work a problem in their journals copied from a slide. She would ask for volunteers or randomly call on a student to give the response. Next, Rose would reveal the correct answer. Then, she revealed the procedures on the slide and called on different students to explain each step shown. Rose finished each problem by telling the students to “Get the problem into your journal notes.” She explained during the first post-observation interview that the students were allowed to use their journals as they worked on the in-class and homework problem sets.

The mathematical knowledge for teaching Rose used was her subject matter knowledge when identifying accurate responses and procedures. In addition, she used subject matter knowledge and a lower level of pedagogical content knowledge when questioning the students through each portion of the word problems.

**Connecting Facts and Concepts**

For the first lesson, Rose added a story and a Math Antics instructional video to help raise awareness of the anticipated errors of missing details in the problem and procedures. The story was about people not reading a sign accurately and missing a
detail. Rose explained during the first post-observation interview that the story from *Math Doesn’t Suck* by Danica McKellar was intended to prompt a discussion about reviewing every detail in the word problem and “your procedure when you get an incorrect answer.” It was observed during the lesson that the students engaged in the story, but did not engage in the written-response portion the way Rose anticipated. She summarized the story, but did not prompt the students further through the activity.

The Math Antics instructional video used engaging word problems to do worked examples of the procedure of solving percent problems. Rose stopped the video about halfway through to begin the textbook lesson. After viewing the video segment during the first post-observation interview, Rose explained, “I thought, ‘They’re no longer listening. They’re looking at the problems in their book.’ They wanted to get to the problems so they wouldn’t have as much homework.” The remainder of the lesson was from the mentor teacher’s slides adapted from the textbook publisher. Those textbook examples were real-world problems such as sale prices, percentages reported in surveys, and materials usage.

As she went through the worked examples, Rose checked for understanding by looking in student journals. When reviewing the problem sets from the first lesson, Rose shared during the first post-observation interview that “on the first problem, right off the get-go, I saw, they were not setting up the problem with X over a hundred. I thought, ‘That’s the basic part.’” When asked if she would change the next lesson, Rose responded, “I will just go in and start off by saying, ‘This is where some of you were trying to go yesterday, but let me explain this portion. And for tonight’s homework you’ll just be finding the other parts.’”
However, Rose’s introduction to the second lesson did not fully explain the homework error to the students and she did not model the correct procedure. The introduction observed for the second lesson follows:

I’m going to show you the video clip that I showed you last time. It’s a shorter video clip so hopefully you’ll have more time to get started on your homework. I know that was hard for a lot of you yesterday. I got a lot of homework passes in. So, at any rate, we’re going to continue on, this time just finding the other pieces. Last night you just had to find the percent. Always the proportion over a hundred. That’s what you needed to do for all those problems last night. So today, he’s going to explain how to find the other spaces. Remember, there were three spaces that could change in that proportion. You could find the total or the base or you could find how many, the part they were looking for or the percent. So now, we are looking for the other. So let’s go ahead and get started.

Rose’s response to the students’ errors focused on the procedure and ignored the concept. When questioned during the second post-observation interview about her perception of students’ grasp of the topic, Rose responded, “I felt that we caught some of the holes from yesterday. The eyes of the students showed the lights were on today. I could see that they were getting it.” Rose volunteered that their work “was much improved” as she checked the students’ work after the second lesson.

Rose used her subject matter knowledge when she identified the errors and recognized the portions of the problems needed for review. Rose used her pedagogical content knowledge to understand and use the curriculum materials.

**Developing Metacognitive Self-Monitoring**

When Rose and her mentor teacher planned instruction, they collaborated on the student assessments, student behaviors, and some of the lesson plans, but few changes were made to the lessons during the meetings. Rose commented during the pre-observation interview that usually reviewing the plans involved looking at the prepared slides and selecting the problem sets from the textbook. The order of the problem sets in
the textbook did not match the order of the procedures in the lessons. This is where Rose felt she had the most flexibility; selecting the practice problem sets. She mentioned that Laura had an infant child at home and was not getting much sleep, so Rose did not want to aggravate the situation further by pushing for more flexibility or creativity in the lesson planning. When asked what she would prefer to do in the lessons, Rose described using more hands-on activities and connecting the mathematics lessons to real-life use and careers so “they can answer the question ‘why are we learning this?’”

Student communication of their reasoning through a problem was not observed during the two lessons. The problem-solving aspect was observed when students individually and quietly completed guided-practice portions of problems during the each lesson and independent practice toward the end of each lesson. Students were asked to tell their answer or to describe a problem or describe a procedure from the slide.

Planning the practice sets for problem solving used elements of mathematical knowledge for teaching. Rose used her pedagogical content knowledge when she evaluated and selected the practice problems connected to the lessons and recognized the support the students needed when practicing the procedure.

The scores from the homework problems determined the problem sets that were selected. Each lesson sequence ended with a summative assessment that was administered the day after the independent practice day. During the final interview, Rose discussed that 5 out of the 23 students scored below 70% on the summative assessment. Ten students scored above 90% with eight of those students scoring 100%. Rose was concerned that the five students did not receive a passing score on the summative assessment, but no further work will be done with those students.
Summary

Rose’s background contained prior instructional experience as an instructional aide and she possessed a middle-range level of mathematical knowledge. Her use of subject matter knowledge and pedagogical content knowledge was hindered by a lack of opportunities to use her knowledge to its full potential. She applied all five elements of mathematical knowledge during lesson planning and instruction to a lesser capacity due to the adherence to the mentor teacher’s instructional strategies. She used four of the foundational instruction practices taught in the methodology course: real-world examples, prepared relevant representations, checked for understanding, and encouraged problem solving. The private religion-based sixth-grade class did not contain any English-language learners, students with disabilities, or students who are socio-economically disadvantaged. Rose’s mentor teacher considered the field experience as an opportunity for Rose to learn how to teach at a religion-based school. Following the school’s structure was important to the mentor teacher since she thought it met the church community’s needs.

The school structure and student demographics influenced Rose’s mentor teacher, who did not think she needed to vary her instructional strategies with the class. Rose’s mentor teacher discouraged Rose from trying different instructional strategies, and Rose did not engage the students’ preconceptions through discussions, use questioning to work through errors or misconceptions, or encourage conversations about mathematical procedures. Much of the discussions and many of the questions during the lessons focused on procedures and not on the concept. When Rose attempted to use the instructional strategy of reasoning through student errors, her mentor teacher interrupted
the lesson and stopped Rose from continuing. Consistent with previous research, Rose adapted to her mentor teacher’s pedagogy and classroom management strategies (Rozelle & Wilson, 2012).

**Cross-Case Comparisons**

This study attempted to describe how background and contextual factors in the field experience influenced four preservice teachers’ use of mathematical knowledge during lesson planning and instruction. The knowledge of selecting the instructional resources and strategies developed in the context of the mathematics methodology course in the teacher education program during low-level, inauthentic practice. The knowledge of using mathematical knowledge and instructional strategies developed further in the context of the field placement during high-level, authentic practice. This section compares and describes the similarities and differences between the factors influencing the preservice teachers’ use of their mathematical knowledge and instruction practices. A comparison of the preservice teachers’ backgrounds, prior mathematical knowledge, and field experience contexts are described in this section.

All four preservice teachers selected instructional strategies supported by their use of mathematical knowledge for teaching: subject matter knowledge and pedagogical content knowledge. The amount and depth of instructional strategies used by the preservice teachers varied. Elsa and Drake used all eight practices, Viola used six practices, and Rose used five practices. Elsa and Drake encouraged mathematical reasoning of conceptions and misconceptions through whole-class and student-student communications. The similarities between Elsa and Drake were their level of education, their prior mathematical knowledge, and their mentor teachers.
**Backgrounds**

Academic background seemed to contribute to the preservice teachers’ use of mathematical knowledge during lesson planning and instruction. Elsa and Drake were similar in the level of academic experience possessing master’s degrees, but the degrees were from different disciplines. Elsa’s degree was in English literature concentrating on Irish literature and culture, and Drake’s degree was in landscape architecture that requires mathematical knowledge. Both used their subject matter knowledge and pedagogical content knowledge extensively and with depth during lesson planning and instruction.

Viola and Rose used their subject matter knowledge and pedagogical content knowledge in limited capacities and at a lower level of development during lesson planning and instruction. Both Viola and Rose possessed bachelor’s degrees from different disciplines. Viola’s degree was in English literature, similar to Elsa, and Rose’s degree was in chemical engineering with an emphasis in biology. Rose’s degree required mathematical knowledge, similar to Drake’s degree. However, opportunities to observe all four preservice teachers in equal planning and instructional contexts did not occur. Viola and Rose’s mentor teachers did not give the same allowances in lesson planning and instruction as Elsa and Drake’s mentor teachers did.

In addition, prior lesson planning and instructional experience in their backgrounds did not seem to influence the use of subject matter knowledge and pedagogical knowledge in the selection of instruction practices. Elsa and Drake both used all eight instructional practices consistently during this study. Elsa had prior lesson planning and instructional experience while Drake had no prior planning or instructional experience. Both demonstrated a well-developed pedagogical skill in selecting
appropriate instructional strategies. Rose, who used only five of the instructional practices, had prior lesson planning and instructional experience. Viola used six of the instructional practices had possessed no prior lesson planning or instructional experience. However, Elsa and Drake’s mentor teachers encouraged them to seek out multiple resources and challenged them to try new skills. Viola and Rose were not given the same freedom to demonstrate their abilities by their mentor teachers.

**Prior Mathematical Knowledge**

Even with varied prior mathematical knowledge, all four preservice teachers used subject matter knowledge and pedagogical content knowledge during planning and instruction. However, the extent to which the knowledge was used seemed to delineate between higher and lower levels of mathematical knowledge based on the abilities to reason through the mathematics and to select appropriate mathematical representations. Elsa and Drake’s mathematical knowledge questionnaire and CSET scores suggested a higher level of mathematical knowledge than Rose and Viola. Rose’s mathematical knowledge was in the middle range with responses that suggested knowledge of mathematical representations was a weak point in her knowledge base. Viola’s mathematical knowledge was in the lower range with responses that suggested knowledge of mathematical reasoning and mathematical representations were weak points in her knowledge base.

Two preservice teachers used mathematical reasoning during whole-class discussions and reasoning through student errors and student representations. Elsa and Drake both used mathematical reasoning through concepts, procedures, and errors during their lessons using their subject matter knowledge and pedagogical content knowledge to
make instructional decisions in the moment of the discussion. They both used student-
student communication to encourage mathematical discussions about concepts and
procedures. Elsa and Drake made connections between the conceptual knowledge and
the factual knowledge contained in their lessons by summarizing during their whole-class
discussions. Elsa and Drake demonstrated higher reasoning ability and a higher ability to
discern appropriate mathematical representations on the mathematical knowledge
questionnaire than Viola and Rose.

However, Viola and Rose were not given the same amount of opportunities to use
these skills. Rose, with prior mathematical knowledge in the middle range, attempted to
implement the strategy, but struggled with representation of the mathematics and was
stopped by her mentor teacher. Viola’s mentor teacher perceived that this strategy
confused the students and did not want Viola to use the practice.

Field Experience Contexts

School and Students

The school and student demographics for Drake and Viola’s field placements
were similar. Both schools had high percentages of students who were socio-
economically disadvantaged, English-language learners, and/or had disabilities. Both
Drake and Viola focused on language development during lesson planning. Both classes
had instructional aides assigned full-time to assist students with disabilities during
instruction. Viola cited English language development and behavior management as
reasons her mentor teacher did not want her to use student errors or student examples and
representations during instruction. However, Drake used both of those strategies
throughout all three of his lessons citing the need to encourage authentic communication for English language development.

The amount of time spent on behavior management was an observed difference between the four preservice teachers. Drake re-directed student behavior once during each lesson. Viola re-directed student behavior once every 10 to 15 minutes during each lesson. Student behavior was not a focus of this study, but it seemed to influence the selection of the instructional strategies. Viola thought of managing student behaviors through engaging activities at the start of her lesson planning consistent with research by Kagan and Tippins (1992). She used think-pair-share as a student work break during the lesson. Viola’s mentor teacher perceived teaching behavior management was important during the field experience. In contrast, Drake did not consider managing student behaviors during the initial lesson planning. He used the same think-pair-share strategy to give students the opportunity to communicate their mathematical reasoning. Drake maintained a rapid pace during the discussions and tasks that seemed to manage student behavior and engagement. Drake’s mentor teacher perceived teaching developing relationships between the students and providing authentic language opportunities were important during the field experience.

Elsa re-directed student behavior twice during the first lesson, once during the second lesson, and not at all during the third lesson. Elsa used think-pair-share for the same reason as Drake, as a strategy for students to communicate their reasoning although she was not focused on developing English-language learning. Research supports the use of the strategy encouraging student communication as a core practice (Stein et al., 2008).
Rose needed to re-direct one student’s behavior during the first lesson. Even though Rose had the least amount of behavior management issues and school demographics with little to no students who were disadvantaged socio-economically, English-language learners, or disabled, she did not use think-pair-share as a work break or as a strategy for students to communicate their mathematical reasoning. In addition, Rose did not use student representations during the class discussions. All mathematical representations were from the curriculum and viewed on projected slides. Therefore, the discussions focused on the mathematical procedures and not on the mathematical concepts. During the interviews, Rose expressed that she would like to use different strategies, but respected her mentor teacher’s wishes that she adhere to the textbook.

Viola also did not use student representations during instruction. Viola referenced that the English-language learners and the students with disabilities would become confused if the students were allowed to suggest examples. In contrast, Drake often used student examples and representations with his class even though there were more English-language learners in his class than in Viola’s class. He prompted students to contribute examples as well as preparing his own representations during lesson planning.

All of the preservice teachers considered student needs during lesson planning. Elsa evaluated other curricular materials in her lesson planning for a review since the adopted curriculum did not contain review materials. Her review started with the learning goals and knowledge she gained about the students through assessments. Her focus was on supporting the students’ understanding of the concepts with engagement a secondary concern. Drake evaluated the adopted curriculum materials with a primary
focus on the language needs of his students to support attainment of the learning goals. He next focused on student engagement.

Elsa and Drake’s curricular evaluation focused first on the learning needs of the students and then on the engagement of the students using mathematical knowledge for teaching in their lesson planning (Hiebert & Morris, 2009; Hiebert et al., 2007). This differs from the previous research that described engaging activities and time management were preservice teachers’ planning focus (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006; Stein et al., 2008).

Viola began her focus on the curriculum materials as a means to increase or refresh her knowledge of the topic. Next, she focused on engagement strategies based on her knowledge of the students’ behavioral and language needs. Finally, Viola focused on the learning goals of the topic. Viola’s lesson planning and instructional strategy selections based on student behaviors and engagement are similar to practices discussed in previous research (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006; Stein et al., 2008).

Rose evaluated the adopted curriculum materials first for learning goals and assessment alignment, and then for student learning of the concepts. Rose was limited in the use of her engagement strategies by her mentor teacher’s lesson structure. When asked during the post-observations interviews and the final interview what instructional strategies she would prefer to use, Rose described strategies that focused on students’ deeper understanding of the concepts and making the mathematics relevant to the real world. Rose’s strategy selection through curricular evaluation was not fully observed during this study since she adopted her mentor teacher’s strategies consistent with
Rozelle and Wilson’s (2012) research into relationships between preservice teachers and mentor teachers. Rose’s mentor teacher held the curriculum as authoritative in regards to pedagogical strategies that support student learning, which is consistent with prior research on novice teachers (Grossman & Thompson, 2008; Valencia et al., 2006). Rose was not observed using instructional strategies that encouraged student communication of mathematical reasoning that supported conceptual learning per her mentor teacher’s request.

As expected, all of the preservice teachers reviewed their choice of instructional strategies with their mentor teachers prior to the final selection of strategies. Many of the differences described in lesson planning and instruction that arose in the data analyses related to the planning and instructional desires of the mentor teachers.

**Mentor Teachers**

Elsa and Drake used all elements of mathematical knowledge for teaching while using foundational instruction practices taught in the mathematics methodology course. The support and encouragement they received from their mentor teachers gave them opportunities to practice and gain comfort with applying their subject matter knowledge and pedagogical content knowledge when selecting instructional strategies.

Viola and Rose used all elements of mathematical knowledge for teaching, but did not use all of the foundational instruction practices. Viola’s mentor teacher supported Viola using an instructional technique that focused on behavior management. The mentor teacher was not opposed to Viola using different instructional strategies, but behavior management was foremost in planning instructional activities. Viola’s pedagogical content knowledge development seemed to be less than Elsa and Drake’s.
Viola used the think-pair-share instructional strategy to manage behavior and not to support conceptual learning.

Rose’s ability to use instructional strategies was hindered by the adherence to the textbook format reflected in the mentor teacher’s slides for the mathematics lessons. Rose’s attempt at discussions with the students was strained due to the lesson structure and classroom management imposed by the mentor teacher. Rose was unable to practice many of the instructional strategies taught in the methodology course. The development of Rose’s pedagogical content knowledge seemed to be performed at a lower level than the other three preservice teachers as observed during her instruction.

All four preservice teachers collaborated with their mentor teachers, but this occurred at differing levels of support regarding the selection and use of instructional strategies. Elsa and Drake expressed feeling supported and valued. Both were encouraged by their mentor teachers to try new strategies in their teaching. In addition, they were encouraged to observe other on-site teachers and collaborate with other teachers. While Viola and Rose expressed feelings of support, the observations exposed that their mentor teachers sometimes hindered their instructional decisions.

Viola’s mentor teacher encouraged her to observe other teachers at the school site. They collaborated about lesson planning, instructional skills, language development, and behavior management. However, the mentor teacher directed what and how Viola would teach the lessons for consistency in the classroom management. The mentor teacher did not encourage Viola to try new or challenging instructional techniques and often narrowed Viola’s choice of activities.
Rose’s mentor teacher also did not encourage her to try new or challenging instructional techniques. The school site had only one sixth-grade class, so Rose was unable to observe other sixth-grade teachers. Rose and her mentor teacher collaborated on lesson planning, assessments, and student behaviors. Their mathematics lesson planning was limited to selecting the problem sets from the mathematics textbook. Rose’s mentor teacher viewed the curriculum as authoritative when it came to instructional strategies. This view was discussed in Grossman and Thompson (2008) and in Valencia et al. (2006) as novice teachers’ curriculum belief and use.

Elsa had to create the three review lessons since the curriculum did not contain review materials. She was often observed varying from her lesson plans to engage students in mathematical reasoning discussions. During the three lessons taught by Elsa, she was observed challenging herself to mathematically reason through student errors with the whole class. She described and explained her discomfort and apprehension using the practice during all three post-observation interviews. Elsa explained that she had observed her mentor teacher and another teacher at the school using the practice effectively with students. With support and guidance from her mentor teacher, Elsa was observed using the technique with caution during the three lessons. Elsa practiced the strategy of reasoning through student errors in an authentic setting with feedback from her mentor teacher (Grossman, Compton et al., 2009).

Similarly, Drake was observed mathematically reasoning through student errors with the whole class. He was encouraged early in the semester by his mentor teacher to use this instructional practice. In addition, Drake was encouraged to try out various behavior-management techniques and lesson formats by his mentor teacher. Drake was
observed using mathematical reasoning in a rapid-paced discussion format. The rapid pace of the discussion, that seemed comfortable for Drake, was practiced early in the semester. This supported practice in the authentic classroom environment of the field placement allowed Drake to develop the instructional strategy beyond the beginning stage (Grossman, Compton et al., 2009).

Viola and Rose did not use the instructional strategy of using student errors to encourage mathematical reasoning. Rose attempted to use student errors three times during the two lessons. She was stopped by her mentor teacher during the first error discussion, and did not complete two other error corrections based on her perceptions of the students’ grasp of the information. Viola’s mentor teacher did not use the practice of reasoning through student errors, and Viola did not attempt to use the strategy. Viola’s practice in the field placement was based on the mentor teacher’s practice that focused on behavior management and language development and consistent with research by Rozelle and Wilson (2012).

Elsa’s mentor teacher practiced using a variety of instructional strategies. She promoted Elsa’s creativity in lesson planning for the review lessons. Drake felt his mentor teacher valued his suggestions to change the order of the activities and lessons. Viola’s mentor teacher supported her lesson planning but often guided Viola’s decisions. In addition, Viola’s mentor teacher was observed changing a central activity 6 minutes before the second lesson observation began. The change caused confusion for Viola and the students. Rose’s mentor teacher discouraged any variation from the textbook lesson format. Again, this supports the research done by Rozelle and Wilson (2012) regarding
the influence of the mentor teacher on the preservice teachers’ knowledge and skill development.

Summary

Information about how background and contextual factors influenced the preservice teachers’ use of mathematical knowledge during lesson planning and instruction were collected from the background questionnaire, mathematical knowledge questionnaire, lesson plan analyses, interviews, observations, field notes, and student assessments. All of the preservice teachers used their subject matter knowledge and pedagogical content knowledge during this study. The application of their knowledge varied in the number of instructional strategies and the depth of implementation of those strategies leading to conceptual learning.

The variation of the application of their knowledge indicated similarities in academic background and prior mathematical knowledge. Elsa and Drake both used their subject matter knowledge and pedagogical content knowledge to plan and implement instructional strategies that often used mathematical reasoning of concepts and procedures. Both possessed graduate-level degrees and scored high relative to this study on the sections of the CSET and the mathematical knowledge questionnaire addressing selection of appropriate mathematical representations to support learning and mathematical reasoning. However, Viola and Rose were not given the same opportunities to plan and instruct as Elsa and Drake were in their field experiences.

The field experience contexts seemed to be the most influential factor on the preservice teachers use of subject matter knowledge and pedagogical content knowledge during lesson planning and instruction. The student demographics placed the
instructional focus on English-language learning in Drake and Viola’s field placements. The high percentage of students with disabilities in Viola’s field placement changed the focus to behavior management and altered and/or eliminated the use of some instructional practices during planning and during the lessons.

The students’ responses and reactions during the lesson prompted all of the preservice teachers to alter or adapt their instruction. In the cases of Elsa and Drake, the adaptations observed often used a student’s representation as an example and reasoned through a student’s error. In the cases of Viola and Rose, the adaptations observed often were to change the pace or the questions to keep students engaged.

The way the preservice teachers used resources and strategies during instruction varied. Elsa, Viola, and Drake experimented with strategies and adapted them based on student responses and reactions observed through formative assessments. However, Viola’s experimentations and adaptations focused on behavior management and mathematical procedure with little emphasis on conceptual learning. The strategies during lesson discussions varied the most among the preservice teachers. Elsa and Drake used student errors to support mathematical reasoning, while Viola and Rose did not use student errors. Rose attempted to use student errors, but was uncomfortable with the skill and did not complete three attempts to reason through the errors. Elsa and Drake used questions to prompt mathematical reasoning through the concepts and the procedure. Viola and Rose used questions to prompt reasoning through procedural problem solving.

Elsa and Drake’s mentor teachers encouraged them to try a variety of instructional practices. They modeled the practices, allowed them to see other teachers use the practices, and gave feedback when they used the practices. The gradual learning in the
authentic setting supported Elsa and Drake’s development of pedagogical content knowledge and their use of the instructional practices. Viola’s mentor teacher encouraged her to try instructional practices, but was more restrictive due to the students’ need for behavior management. Rose’s mentor teacher restricted Rose from trying a variety of instructional practices. The mentor teacher viewed the textbook as the authority that met all student learning needs and did not like to alter the lesson plan structure. Viola and Rose developed some instructional strategies, but still need encouragement when they begin their careers to experiment with and learn other instructional practices.

The analyses of the information collected for this study on the influence of background and contextual factors on preservice teachers’ use of mathematical knowledge during instructional practices revealed three findings. The three findings were: (a) the level of opportunities to practice during the field experience encouraged the continued use of mathematical knowledge and instructional practices learned in the methodology course; (b) student demographics influenced lesson planning and instructional strategies used by the preservice teachers; and (c) the mentor teachers’ attitudes toward learning, instruction, and the field experience determined the type and use of instructional strategies the preservice teachers practiced. The next chapter describes the summaries, limitations, a discussion of findings, and the implications for research and practice.
CHAPTER FIVE

SUMMARY, LIMITATIONS, DISCUSSION, AND IMPLICATIONS

This chapter provides summaries, limitations, a discussion of the findings, and the implications for research and practice. The summary of the case studies presents an overview that includes the rationale, the purpose, the theoretical framework, the research question, and the methodology for this study. Then, the findings are described in a summary. The summary of the findings is followed by a description of the limitations of the study. Next, three sections discuss the findings, the implication for research, and the implication for practice. Finally, a summary concludes the chapter.

Summary of the Study

The culminating field experience in a teacher education program challenges preservice teachers to apply their developing knowledge and skills in an authentic practice setting (Grossman, Hammerness, et al., 2009). While preservice teachers’ attitudes and beliefs about teacher education programs, learning to teach, and teaching are well documented in the research, fewer studies focus on the specific learning or transfer of skills that occur during teacher preparation (Anderson & Stillman, 2013; Ball & Forzani, 2009; Clift & Brady, 2005; Wilson et al., 2001). One particular concern regarding the transfer of knowledge and skills is the research suggesting preservice teachers focus on student activities and time management without evaluating curriculum for the appropriate pedagogy that supports conceptual learning (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006). The paucity in the research examining preservice teachers’ application of knowledge and skills transferred from the mathematics methodology course to the field experience leaves mathematics teacher
educators uninformed about the preservice teachers’ knowledge and skill needs as they prepare to transition into their teaching careers (Ball et al., 2009; Clift & Brady, 2005; Cochran-Smith & Zeichner, 2005).

Preservice teachers use their developing mathematical knowledge for teaching and instructional practices learned in the mathematics methodology course during lesson planning and instruction in their field experience (Ball et al., 2008). The culminating field experience supports preservice teachers in the authentic practice of the knowledge and skills first developed in the mathematics methodology course (Grossman, Compton et al., 2009). The authentic classroom context that includes students and state-adopted curriculum materials, as well as the mentor teachers’ guidance, influences the preservice teachers’ development of knowledge and practice (Grossman, Compton et al., 2009; Rozelle & Wilson, 2012). Examining the factors of preservice teachers’ use of their mathematical knowledge for teaching and instructional strategy selections during lesson planning and instruction contributes to the information teacher educators could use when developing supportive assignments and experiences in methodology courses in preparation for a teacher career (Grossman et al., 2000; Grossman & Thompson, 2008).

The purpose of this study was to examine and describe the factors influencing preservice teachers’ use of their developing mathematical knowledge and practices during lesson planning and instruction in the field experience. This study attempted to describe how the background, prior mathematical knowledge, and the field experience context influenced preservice teachers’ use of subject matter knowledge and pedagogical content knowledge in instructional decisions. Examining influential factors of the use of mathematical knowledge and instructional strategies identified tensions in the field
experience that hindered the preparation of the preservice teachers’ practice of their developing knowledge and skills (Ball et al., 2009; Boerst et al., 2011; Rozelle & Wilson, 2012; Russell & Russell, 2011). The examination of the development of knowledge and instructional practices informs teacher educators how to prepare preservice teachers for the field experience. Preparation for the field experience enhances the learning and development of knowledge and skills preservice teachers will take into their teaching career (Ball et al., 2009; Boerst et al., 2011; Grossman, Compton et al., 2009; Shulman, 1998).

This examination of how preservice teachers were influenced in the field experience when using their mathematical knowledge and pedagogical practices applied the conceptual framework of mathematical knowledge for teaching (Ball et al., 2008). Ball et al. identified two domains of mathematical knowledge for teaching: subject matter knowledge and pedagogical content knowledge. Each domain contains three aspects. Subject matter knowledge uses common content knowledge, specialized content knowledge, and horizon content knowledge. Pedagogical content knowledge uses knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. Horizon content knowledge is not relevant to this study since it involves long-range planning and the preservice teachers’ full-time field experience lasted for one semester or the equivalent of half a school year in kindergarten through twelfth grade; mentor teachers did the long-range planning. The other five aspects of mathematical knowledge for teaching applied to the preservice teachers’ lesson planning and instruction.
In recent research, Ball and her colleagues (2005, 2008, 2009) have defined aspects of mathematical knowledge for teaching. Common content knowledge refers to the mathematical knowledge that most adults possess after completing secondary-level schooling. Specialized content knowledge refers to the mathematical knowledge that teachers use when selecting representations, when explaining procedures, and when reviewing unusual student methods for problem solutions. Both of these knowledge types are used within the subject matter knowledge domain.

Knowledge of content and students refers to teachers understanding how students think and learn about mathematical concepts and procedures. Knowledge of content and teaching is the integration of mathematical concepts and procedures with the knowledge of the methods to teach mathematical concepts and reasoning. Knowledge of content and curriculum has not been fully conceptualized in the research. The current definition refers to the knowledge of the mathematical pedagogy contained within the curriculum material is based on previous research by Grossman (1991). The three knowledge types are used within the pedagogical content knowledge domain. The two domains of mathematical knowledge for teaching were foundational when responding to the research question.

This study sought to examine the following research question: How do background and contextual factors influence preservice teachers’ use of mathematical knowledge in lesson planning and instruction during the field experience? The examination of the research question was completed through a mini-case study design. Four preservice teachers enrolled in the same teacher education program at a private Northern California university participated in this four-week study. The field placements
were at four separate locations in three Northern California school districts. Three
preservice teachers were placed in public schools and one was placed in a private
religion-based school. The first preservice teacher taught in the fourth grade at a
kindergarten-to-sixth-grade public charter school. The second preservice teacher taught
in the fifth grade at a kindergarten-to-sixth-grade public school, while the third preservice
teacher in the same district taught in the sixth grade at a kindergarten-to-sixth-grade
public school. The fourth preservice teacher taught in the sixth grade at a kindergartento-eighth-grade private school.

Seven instruments were used to collect the data for this study: (a) background
questionnaire, (b) mathematical knowledge questionnaire, (c) lesson plan analyses, (d)
interviews, (e) observations, (f) field notes, and (g) student assessment. The
questionnaires provided demographic and prior mathematical knowledge information
about the preservice teachers. The lesson plans were reviewed twice for aspects of
mathematical knowledge for teaching and identification of instructional strategies. The
interviews were semi-structured, conducted prior to and after the observations, and
provided information about the preservice teachers’ selection of resources and instruction
strategies as well as what influenced any changes they made during instruction. Field
notes were written during the observations and reflective notes written immediately after
observations and post-observation interviews.

During the post-observation interviews, an adaptation of video-stimulated recall
was used to refresh the memories of the preservice teachers. All interviews were audio
recorded and transcribed. Each lesson was observed and video recorded; the video
recordings were transcribed after the preservice teachers viewed segments during the
post-observation interviews. Two preservice teachers completed a three-lesson sequence, and two completed a two-lesson sequence. Three of the four preservice teachers provided student assessment data from the topic taught. The fourth teacher provided anecdotal information about student performance after the lesson sequence.

As the data were collected, analyses were conducted. The study design included a feedback loop to identify and review emerging concepts and categories (Yin, 2014). Originally, this study proposed three research questions, but the inability to separate the concepts emerging in the data pointed to a refinement of the research questions into one research question. The data analyses and categorization are described in an audit trail, which strengthens the consistency and dependability of the findings, located in Chapter Four. After the data categories were identified, a check for disconfirming information was performed to strengthen the credibility of the findings. During the data collection and analyses, the four preservice teachers reviewed the transcripts from the interview and observation recordings as a check for accuracy. Summaries of the final descriptions of the data were sent to each preservice teacher for member checking for accuracy and consistency in the researcher’s interpretation; this enhanced the credibility of the findings.

**Summary of Findings**

The data analyses revealed three findings. First, the level of opportunity to use subject matter knowledge and pedagogical content knowledge encouraged the use of instructional strategies that supported students’ conceptual and procedural development. Second, student needs and behaviors influenced the preservice teachers’ lesson planning and instruction. Third, the mentor teachers’ attitudes toward learning, instruction, and the
field experience influenced the type and use of instructional strategies practiced by the preservice teachers.

First, all of the preservice teachers used their subject matter knowledge and pedagogical content knowledge. Only two mentor teachers encouraged and supported the preservice teachers, Elsa and Drake, to take chances and refine their practice of instructional strategies. The other two preservice teachers, Viola and Rose, were restricted in the selection of instructional strategies they could use in their field placements. Elsa and Drake were given opportunities to practice, receive feedback, and refine the practice that promoted the development of knowledge and skill while promoting a comfort level with using the practices. This is consistent with the research on education in professional practice (Grossman, Compton et al., 2009; Grossman, Smagorinsky & Valencia, 1999).

Second, student needs and behaviors influenced lesson planning and instructional strategies used by the preservice teachers. Only one preservice teacher, Viola, started her planning by thinking about keeping the students engaged to manage behaviors. In addition, she used a student-student communication technique as a work break to control behaviors and not as a mathematical communication support. Viola explained the students in her class display off-task and disruptive behaviors if they lose interest in the lesson. Viola’s focus on student activities is consistent with previous research (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006). Inconsistent with the research, Elsa, Drake, and Rose focused on the learning objectives to begin their lesson planning. They adapted their strategies based on student learning and language needs in their classes.
Third, the mentor teachers’ attitudes towards learning, instruction, and the field experience influenced the preservice teachers’ instructional practices. All four preservice teachers described a feeling of support during lesson planning and instruction. Elsa, Viola, and Drake were encouraged by their mentor teachers to be creative during the lesson planning. However, Rose was discouraged from varying from the textbook lesson plan format. Elsa and Drake’s mentor teachers viewed the field experience as an opportunity to model collaboration with the preservice teachers, while Viola and Rose’s mentor teachers focused on teaching specific behavior-controlling and time-management techniques. Viola’s mentor teacher focused on teaching Viola behavior-management techniques. Rose’s mentor teacher focused on teaching Rose time-management techniques. Elsa and Drake were given many opportunities to practice their knowledge and skill development that focused on supporting students’ conceptual learning and procedural proficiency. Viola and Rose were not given many opportunities to expand their knowledge and skills. Their mentor teacher practices were consistent with research regarding the relationship between the mentor teachers and the preservice teachers (Kennedy, 2010; Rozelle & Wilson, 2012; Stigler & Hiebert, 1999).

Limitations

As with all research, there were limitations for this study. A common limitation among case studies is the lack of generalizability to a larger population. This study used only four preservice teacher participants, and the findings do not generalize beyond their personal experiences in this teacher preparation program. While the four preservice teachers studied participated in the same teacher preparation program, it would be difficult to claim that their personal experiences reflect all preservice teachers’
experiences in this teacher education program. In addition, the small geographic location limits the generalizability of this study. The preservice teachers lived and worked within the same county in Northern California and this reduced the generalizability beyond the geographical area.

A second limitation of this case study was the possibility of researcher bias and subjectivity. As a former elementary teacher and a current teacher educator, past and current experiences shape the researcher’s perspective of teacher-student, teacher-curriculum, and preservice teacher-mentor teacher relationships. Two semesters prior to this study, the preservice teachers were enrolled in two methodology courses taught by the researcher. Earlier in the same semester as the study, the researcher acted as one of two university supervisors for the preservice teachers.

One advantage that developed from the previous relationships between the researcher, the preservice teachers, and the mentor teachers was the depth of the conversations. The preservice teachers were comfortable reflecting about their planning and their practices. Little prompting was needed by the researcher to get in-depth discussions and reflections during the interviews. In addition, the mentor teachers were comfortable having the researcher in the room, and spoke freely with the researcher. This is consistent with the research conducted by Everhart (1977).

The development of protocols for the semi-structured interviews, the observations, and the lesson plan analyses were used to reduce the researcher’s bias during this study. A members’ check was completed with no changes to the researcher’s interpretation requested by the preservice teachers.
Discussion of Findings

Three finding were revealed during the data analyses. First, the opportunity to use subject matter knowledge and pedagogical content knowledge encouraged the planning for and use of instructional strategies that contributed to students’ conceptual and procedural development. Second, student needs and behaviors influenced the preservice teachers’ lesson planning and instruction. Third, the mentor teachers’ attitudes toward learning, instruction, and the field experience influenced the type and use of instructional strategies practiced by the preservice teachers.

Opportunity to Practice Mathematical Knowledge for Planning and Instruction

The preservice teachers participated in the same mathematics methodology course in the teacher education program approximately 6 months prior to the culminating, full-time field experience. During the methodology course, the preservice teachers learned about subject matter knowledge and pedagogical content knowledge. The preservice teachers learned how to use this knowledge for lesson planning and instruction. The intention was that the preservice teachers would have many opportunities to continue the development of their new knowledge and skills during the field experience.

Each preservice teacher continued to use their mathematical knowledge and instructional strategies in their field experience, but at varying levels of opportunity. All four preservice teachers were observed using subject matter knowledge and pedagogical content knowledge in their lesson planning and instructional practices. While none of the participants used the terminology associated with mathematical knowledge for teaching, they described the use in the interviews and were observed using their knowledge during
lesson planning and instruction supporting research by Ball and her colleagues (2008, 2009).

However, all four of the preservice teachers did not use their knowledge to plan for instructional strategies that enhanced students’ conceptual learning. Two of the four mentor teachers, Elsa’s and Drake’s, challenged and guided the preservice teachers to extend their level of practice. Elsa and Drake were observed using instructional strategies that dealt with mathematical reasoning more often than Viola and Rose. Drake appeared comfortable with all of the observed strategies and implemented the lessons at a rapid pace. Early in the semester, Drake’s mentor teacher gave him opportunities to try different instructional strategies that required Drake to draw upon his subject matter knowledge and his pedagogical content knowledge during the lessons. He was observed making many in-the-moment pedagogical decisions while using different types of strategies. In contrast, Rose’s mentor teacher restricted the types of strategies Rose practiced throughout her field experience. While Rose used her subject matter knowledge and her pedagogical content knowledge, her instructional skills were less developed when observed during whole-class discussions. Rose did not incorporate student representations and did not successfully reason through student errors.

Incorporating student representations requires the ability to decide in the moment of teaching the relevancy or the adaptability of a student representation to the concept or procedure. Reasoning through student errors during discussion requires the ability to recognize the mathematical error and create appropriate questions to support student reasoning without embarrassing the student. Both of these strategies require the use of subject matter knowledge and pedagogical content knowledge.
Viola and Rose were reluctant to use these strategies. Viola and Rose’s mentor teachers did not use the strategies and did not encourage using the strategies during the field experience. Viola and Rose’s reluctance to use the complex instructional strategies is consistent in the research of preservice and novice teachers’ struggle with mathematically reasoning through student errors and student representations (Crespo et al., 2011; Rowland, 2008; Van Zoest & Stockero, 2009).

Elsa and Drake were given the encouragement and guidance to mathematically reason through student errors and student representations. By practicing and developing the skills, they were also furthering the development of their subject matter knowledge and pedagogical content knowledge through practice. Elsa and Drake seem better equipped to start teaching in their own classrooms with higher levels of knowledge and skill development at the beginning of their careers.

The varying levels of skill development are consistent with the concept of higher levels of and opportunities for approximations of practice (Ghousseini, 2009; Grossman, Compton et al., 2009). Consistent with the findings from Ball et al. (2009) and Boerst et al. (2011) Elsa and Drake’s development of their knowledge and pedagogical skills led to more use and variety of instructional strategies and deeper exploration of the mathematical concepts with students.

**Student Influences on Planning and Instruction**

The students influenced the preservice teachers’ decisions during lesson planning and instruction. All four preservice teachers used subject matter knowledge and pedagogical content knowledge as they evaluated and adapted curriculum materials. In addition, Elsa, Viola, and Rose located, evaluated, and adapted supplement materials
from websites and other available resources. The order of the evaluation of items and the purpose behind the order in the process differed among the preservice teachers based on the students. These practices are consistent with research on preservice teachers’ curriculum materials use by Grossman and Thompson (2008).

After Viola initially refreshed her content knowledge, she reviewed supplemental materials for activities with the purpose of student engagement to manage behaviors, next for English-language learning, and then for learning goal alignment. This is consistent with prior research on preservice and novice teachers’ evaluation of curriculum materials based on engaging activities (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006).

Unlike the findings in previous research by Grossman and Thompson (2008), Elsa, Drake, and Rose started their evaluation of the curriculum materials with aligning student learning needs and the learning goals; they did not start with student engagement. Similar to Grossman and Thompson’s research, Drake and Rose depended upon the curriculum materials when creating their lessons. A possible explanation may be the sixth-grade level of mathematics and the pace of the instruction in that grade level, but that was not explored in this study. However, the high percentage of English-language learners in Drake’s class led him to adapt the lesson plans for vocabulary development; using his pedagogical content knowledge for the adaptations. Rose added material to the introduction for student engagement, but was restricted by her mentor teacher from modifying the lesson plan too much.

The high percentage of English-language learners in Viola and Drake’s classes influenced their selection of vocabulary and their mathematical representations. While
all four preservice teachers used real-world representations, Viola and Drake focused on using culturally relevant real-world representations. Drake solicited students for representations knowing their selections would be familiar in their home lives. Viola did not solicit student representations, but she often used real-world objects such as shipping boxes for the mathematical representations. Both Viola and Drake repeated the mathematical vocabulary during their instruction more frequently than Elsa and Rose.

Viola’s use of the instructional practice of think-pair-share for mathematical communication was altered due to the high percentage of behavior management issues with the students. The English-language learners and the students with disabilities would display off-task behaviors during the 2-hour lesson block. The behaviors influenced Viola to use the think-pair-share as a work break or she gave students a 5-minute break from all learning activities.

Drake used think-pair-share to allow students the opportunity to communicate the mathematical vocabulary, concepts, and procedures. He explained that the high percentage of English-language learners needed to use the vocabulary and articulate their reasoning. He timed the think-pair-share communication to push the students to articulate the mathematics without pausing on the vocabulary.

Elsa used think-pair-share to hear students’ thinking and to give them a chance to communicate their thinking. As she listened to the conversations, Elsa checked for understanding. If she did not hear clarity about the concept or the procedure, Elsa revisited the topic. She often had students she overheard using accurate mathematics communications share their discussion with the whole class after think-pair-share. Elsa
explained this was a mathematical communication strategy that reinforced the topic for the students she heard were unclear on the topic.

Rose did not use student-student mathematical communication strategies due to her mentor teacher’s preference to stay on a schedule. In addition, Rose explained that none of the students in the class were English-language learners so she did not repeat or check for understanding of the vocabulary. Rose did check the students’ mathematics journal for understanding of the procedures.

Consistent with the research, the varying use of students’ mathematical communications depended on how the preservice teacher interpreted the learning situation and how familiar they were with the strategy (Kazemi et al., 2011). All four of the preservice teachers planned and used instructional strategies while thinking about the needs of the students. All of the preservice teachers shared their lesson plan choices with the mentor teachers before instruction began. Once instruction began, the preservice teachers made in-the-moment modifications to their strategies based on the responses and reactions of the students; using both subject matter knowledge and pedagogical content knowledge. Elsa and Drake did not receive assistance from their mentor teachers during instruction, but reflected on the lessons with the mentor teachers during breaks throughout the day. Viola’s mentor teacher changed her second lesson before class started and helped with behavior management during both lessons. Rose’s mentor teacher interrupted Rose during instruction to keep her on the time schedule during both lessons. The reliance on the mentor teacher is consistent with research (Rozelle & Wilson, 2012).
Mentor Teacher Influence on Instructional Practice

All of the mentor teachers influenced the preservice teachers’ use or attempted use of instructional strategies. This dissertation examined individual attributes and practices, but as posited by Kennedy (2010), it is difficult to ignore the situational influence on individual practice. While all four preservice teachers described feeling supported by their mentor teachers, it was observed that the mentor teachers’ beliefs and attitudes about learning, instruction, and the field experience influenced the opportunities for practice.

The lack of opportunity to practice a variety of instructional strategies was concerning; Grossman et al. (2000) argued that the strategies learned in the teacher education program are transferred into a teacher’s career. The influence of the mentor teacher on preservice teachers’ planning and instruction was consistent with previous research on the role that mentor teachers’ beliefs and attitudes toward education and preservice teachers play in preparing preservice teachers (Russell & Russell, 2011; Stanulis et al., 2014). In addition, this finding is consistent with previous research on the preservice teachers’ adoption of the mentor teachers’ beliefs and practices (Hiebert & Morris, 2012; Rozelle & Wilson, 2012; Smagorinsky, Cook, Moore, Jackson, & Fry, 2004; Valencia et al., 2009).

Elsa, Viola, and Drake were encouraged by their mentor teachers to adapt the curriculum when lesson planning. Mentor teachers for Elsa, Viola, and Drake modeled many of the instructional strategies they encouraged them to try during the field experience. One difference was that Elsa and Drake’s mentor teachers modeled all of the aspects of the instructional practices that encouraged students’ concept development, and
Viola’s mentor teacher was focused on developing Viola’s behavior management strategies. Elsa, Viola, and Drake were given the encouragement and opportunity to try foundational instruction practices, receive feedback from their mentor teachers, and try the strategy again. However, Viola’s mentor teacher did change an activity 6 minutes before the second lesson began and left Viola unprepared. The opportunity to strengthen her practice was hindered by the mentor teacher’s decision (Valencia et al., 2009).

Elsa and Drake’s mentor teachers both described their attitudes toward the field experience as an opportunity to focus on collaboration with the preservice teachers. Both mentor teachers provided Elsa and Drake opportunities to communicate with other teachers at their schools and to observe other teachers. Both encouraged the preservice teachers to take chances with their instructional strategies and provided frequent feedback. Both mentor teachers shared their pedagogical content knowledge during the lesson planning and after instruction.

Viola’s mentor teacher described her attitude toward the field experience as an opportunity to teach Viola how to manage classroom behaviors. She valued English language development and students’ primary language and cultures, but thought that off-task behavior distracted from language development and overall learning. While she was willing to allow Viola to explore different instructional strategies, she kept Viola focused on behavior management and suggested strategies she perceived as managing behavior while supporting student learning.

Rose’s mentor teacher appeared to hold beliefs and attitudes for a traditional instructional structure that viewed the curriculum materials as the instructional authority (Drake & Sherin, 2006). This particular attitude was addressed in the methodology.
course since it can hinder the use of instructional practices that promote mathematical proficiency. The mentor teacher viewed time management important to supporting student learning and for behavior management. Rose’s mentor teacher focused on teaching Rose how to manage instructional time during a lesson and throughout the school day. Rose entered into what Feiman-Nemser and Buchmann (1985) termed the two-worlds pitfall. She learned about implementing instructional strategies that used mathematical knowledge for teaching in the teacher education program, but she was unable to practice those strategies in her field experience. Previous research has described Rose’s situation of being caught between wanting to use new instructional strategies and wanting to appease the mentor teacher (Feiman-Nemser & Buchmann, 1985; Rozelle & Wilson, 2012; Smagorinsky et al., 2004; Valencia et al., 2009). This can be a difficult situation for a preservice teacher to navigate, and often causes stress between the field experience relationships.

The contrast between the mentor teachers and the opportunities for practice by the preservice teachers to use their developing knowledge and skills was viewed through the situative learning perspective for this study (Brown et al., 1989; Putnam & Borko, 2000). While the preservice teachers are practicing in an authentic setting, they must navigate the culture of the classroom that included the beliefs and attitudes of the mentor teacher (Grossman, Compton et al., 2009; Kennedy, 2010; Valencia et al., 2009). The dissemination of beliefs and attitudes often goes unchecked since mentor teachers generally receive little to no support or guidance from university teacher education programs (Hamilton, 2010). The context of the field placement seemed to influence whether the preservice teacher benefitted from the experience or was at risk with
underdeveloped instructional knowledge and skills (Dewey, 1904/1965; Kennedy, 2010). Unfortunately, this dilemma is not new to teacher education.

**Conclusions**

This case study described how background, prior mathematical knowledge, and contextual factors influenced four preservice teachers’ use of mathematical knowledge and practices during lesson planning and instruction. Identifying what influenced preservice teachers’ planning and instruction practices transferred from the mathematics methodology course into the field experience would inform teacher educators about the knowledge and skills used in an authentic setting. This information led to three conclusions.

First, three preservice teachers started lesson planning by looking at the learning goals and prior assessments. This is inconsistent with previous research that argued preservice teachers start lesson planning selecting engaging activities and did not focus on the learning objective for the lesson (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006). In 2008, California legislated the use of Teaching Performance Assessments (TPAs) based on Teacher Performance Expectations (TPEs) (http://www.ctc.ca.gov/educator-prep/standards/adopted-TPEs-2013.pdf). The TPEs were assessed through state-structured TPAs at various times during the teacher education program. The TPAs were submitted to the state credentialing office for evaluation of the preservice teacher’s performance. Preservice teachers were expected to use evidence from classroom assessments to plan lessons that meet learning objectives stated in curricula. Elsa, Drake, and Rose’s lesson planning behavior may be the result of TPEs that were taught and applied throughout the teacher education program. The three
preservice teachers’ focus was placed on the learning objective and the needs of the students.

Second, all preservice teachers used their subject matter knowledge and their pedagogical content knowledge during the selection and use of instructional strategies. Of the instructional practices, mathematical discussions were prevalent during the observations. Modeling and decomposing mathematical discussions during the methodology course would support development of this practice by preservice teachers consistent with the research by Boerst et al. (2011), Grossman, Compton et al. (2009), and Stein et al. (2008). The practices of working with student representations and student errors varied among the four preservice teachers in this study. These two practices call for in-the-moment evaluations of mathematical concepts and procedures. Posing a variety of representations and errors to preservice teachers would develop their evaluative skill. Developing the skill prior to entering the field experience would support the transition into the multifaceted, authentic practice setting of the field experience placement.

Third, navigating the context of the field placement seemed challenging for some preservice teachers. The opportunity to practice their developing mathematical knowledge and instructional strategies may not arise in a restrictive field placement. The mentor teacher’s focus in his or her classroom reflects the teacher’s educational philosophy. It is difficult for the teacher education program to force a change of practice on a mentor teacher. However, the teacher education program could support the preservice teachers by providing additional support to the mentor teachers. Many of the mentor teachers acquired their credentials under different credentialing standards; the
mentor teachers may be unfamiliar with the current requirements for practice of
knowledge and skill. As suggested in the research (Hamilton; 2010; Hammerness, 2005),
teacher education programs provide some information to the mentor teachers about
required observations and credentialing performance assessment requirements, but do not
provide specific program information. Providing specific information to the mentor
teachers about the teacher education program, its philosophy, and its instructional focus
would potentially create a supportive environment that may decrease the gap between the
university and the field experience placement and reduce the tension of navigating the
field experience for preservice teachers.

Implications for Research

Findings in this study support prior research regarding the importance of
developing mathematical knowledge for teaching to enhance lesson planning and
instruction (Ball et al., 2008). The findings added to the discussion about preservice
teachers’ development and use of mathematical knowledge for teaching. In addition, the
findings added to the discussion about the development of foundational instruction
practices used by preservice teachers. However, questions arose about the strength of the
connection between theory and practice in the field experience regarding mathematical
knowledge for teaching. Most notably, several questions arose regarding the mentor
teachers’ practices, philosophies, and influence imparted to the preservice teachers.

Further research should focus on preservice teachers’ perspectives about the
relationship between mathematical knowledge for teaching and the foundational
instructional practices. The preservice teachers did not use the terminology connected to
mathematical knowledge for teaching, and often seemed to pause when asked for their
rationale in selecting instructional strategies. The researcher used an instrument that specifically identified the mathematical knowledge for teaching aspects, but did not identify if the preservice teachers knew those aspects. Research in the area of preservice teachers’ connection between the theory of mathematical knowledge of teaching and the application of that knowledge would support the focused development of activities and tasks in the teacher education program. Activities and tasks that support preservice teachers’ understanding and practice of their developing mathematical knowledge would better prepare them for the field experience and, eventually, their teaching career.

Moreover, future research should focus on how preservice teachers navigate the field experience context in conjunction with the context of the teacher education program. Specifically, what skills would support preservice teachers to develop a relationship with the mentor teacher that allowed them more opportunities to practice developing instructional practices learned in the teacher education courses? How does the relationship differ in another model of teacher education, such as a residency program? Two mentor teachers restricted use of certain instructional practices during the observations. A longer study may have revealed other instructional strategies preferred by the mentor teachers that supported student learning and further development of the preservice teachers’ instructional skills. Still, the National Research Council (2001, 2005) argued the importance of using the foundational practices mentioned in this study across all content areas to support student learning to a proficient knowledge and skill level. The foundational practices were not fully encouraged by two mentor teachers.

Furthermore, research into how mentor teachers are selected by school districts would inform teacher education programs on how to create a productive and supportive
learning environment for preservice teachers in the field experience. Lortie (1975) argued that teachers often resorted to teaching how they were taught in elementary and secondary school. The teaching and learning philosophies of the mentor teachers in this study seemed to influence the opportunities for practice and the philosophies of the preservice teachers. Several questions arose from this study regarding the mentor teachers. What influence does mentor teacher selection processes have on preservice teachers’ performance and learning in the field experience? How do teacher education programs and school districts determine if a mentor teacher would practice a constructive educational philosophy? How do mentor teachers approach professional development and their personal learning of new curricula and instructional techniques? Does the mentor teacher’s approach to professional learning influence how teaching and learning philosophies are applied with students and preservice teachers? The above questions have research implications for mentor teacher selection processes as well as for professional development or training for the mentor teacher.

Research into professional development for mentor teachers would inform school districts and teacher education programs about how to support currency of information and practice in our schools. How does a mentor teacher’s participation in professional development influence the preservice teacher? How do different types of training and interactions between the teacher education program and the mentor teacher influence the experience for the preservice teacher? What types of interactions between the teacher education program and the mentor teacher positively influence the preservice teacher? These questions imply a stronger relationship between the university and the school district with the goal of producing well-prepared novice teachers.
Implications for Practice

The focus in the mathematics methodology course at the university in this study was on developing preservice teachers’ mathematical knowledge for teaching so they can select and use foundational instructional practices that would develop all students’ mathematical proficiency. Continued reflection on the methodology course curriculum would keep the information and practices current supporting the development of relevant mathematical instruction for students.

The structure of the methodology courses could include more opportunities for the preservice teacher to observe the practices of preparing for and guiding discussions. The addition of more video representations of practice, more opportunities to observe teachers, and more role-playing of instructional strategies would further prepare preservice teachers for the demands of the field experience. It was observed in this study that not all preservice teachers have the same opportunities to practice using their knowledge and skills during the field experience. The teacher education program could provide the activities and opportunities for practice.

Extending the amount of field experience would also enhance preservice teacher practice and learning. The opportunity to observe more teachers using a variety of instructional strategies in an authentic setting at a variety of school sites would expose the preservice teachers to multiple instructional strategies or multiple ways to use a particular strategy. The exposure to more teachers would offset the heavy reliance on a couple of mentor teachers’ philosophies. The preservice teachers would be better prepared to draw on previous observations to participate in the part-time and full-time field experiences.
The preservice teachers were observed in their field experience using the knowledge and skills acquired in the methodology course at varying levels. While the preservice teachers expressed satisfaction with their instructional knowledge and skill development, the struggles and tensions they experienced navigating the field experience were observed during this study. Providing information on how to navigate the tensions in the field experience could lead to the creation of more collaborative relationships between the preservice teacher and the mentor teacher. Learning the culture of teaching is a part of the field experience. However, learning is hindered if the culture of the field experience is unsupportive. Mentor teacher selection practices need clarification and consistency.

A strong partnership between the teacher education programs and the school districts would develop mentor teacher selection practices that enhance the learning environment for the preservice teachers and, ultimately, the students. The development of a professional development program would inform mentor teachers about the university program and state credentialing requirements. The teacher educators would learn about the context of the field placements and the methods the mentor teacher uses with the students. A dialog about educational philosophies between the teacher educators and the mentor teachers would improve the consistency of information and expectations for the preservice teacher.

The preservice teacher often acts as the go-between and informs the mentor teacher of the teacher education program’s expectations. Frequently, the lesson planned for observation by the university supervisor presents an ideal interaction between the preservice teacher and the students. The intention is to observe as many TPEs practiced
by the preservice teacher as possible during the field experience. While acting as the university supervisor for the four preservice teachers, I observed different behaviors from the mentor teachers for Viola and Rose than I did as a researcher for this study. Viola and Rose were able to use instructional strategies during the university supervision visits with little interruption from the mentor teachers. The restrictions on the instructional strategies by Viola and Rose’s mentor teachers were not observed during university supervision visits. Viola had not realized that her choices and material organization were different between the university supervision and research observations. She perceived that her mentor had not disrupted her lesson planning during this study.

Rose’s mentor teacher was straightforward that Rose’s lesson planning should meet the university requirements. For the supervision visits, Rose’s the mentor teacher did not allow discussions, but did allow small group tasks. Small groups were used during the university supervision visit, but were not used any other time with the students. Therefore, university supervision would be improved if at least one visit was unannounced to authentically observe the interactions of the preservice teacher with the students, the curricula, and the mentor teacher. The preservice teachers hold their mentor teacher in high regard, and are often not forthcoming with feedback about their learning situation in the field experience. The field experience is multifaceted and the level of complexity calls for a support system to be put in place to allow for a positive learning environment for the preservice teacher.

Summary

Learning to teach mathematics is multifaceted. The field experience of the teacher education program provides an authentic opportunity for preservice teachers to
practice their developing knowledge and skills with support from a mentor teacher. This study examined how four preservice teachers’ backgrounds, prior mathematical knowledge and the context of the field experience influenced their lesson planning and instruction.

The preservice teachers were observed implementing instructional strategies that demonstrated their use of subject matter knowledge and pedagogical content knowledge. Two preservice teachers, Elsa and Drake, were given encouragement and multiple opportunities to try different strategies, and they appeared comfortable navigating the multifaceted classroom interactions. One preservice teacher, Viola, was given encouragement and opportunities to try strategies that she appeared comfortable using, but the choice of strategies was limited by the mentor’s philosophy on learning and behavior management. The fourth preservice teacher, Rose, was given little encouragement or opportunity to practice instructional strategies due to her mentor teacher’s perception of the importance of time management, the curriculum, and learning. The observed outcomes of the amount and opportunities to practice were consistent with previous research into professional practice (Grossman, Compton et al., 2009; Grossman, Smagorinsky & Valencia, 1999). The influence of the mentor teacher relationship with the preservice teacher determined the amount of practice and, thus, the amount of skill development the preservice teacher accomplished during the field experience.

The influence of student needs and behaviors were observed during lesson planning and instruction. Contrary to previous research, Elsa, Drake, and Rose started lesson planning by reviewing the learning objectives and prior student assessments (Grossman & Thompson, 2008; Lloyd & Behm, 2005; Nicol & Crespo, 2006). This may
be the influence of the California Teacher Performance Expectations used and assessed throughout the teacher education program. Viola started her lesson planning consistent with previous research by focusing on engaging activities to control student behaviors. All four preservice teachers adapted strategies and responded to students in the moment of instruction. The preservice teachers evaluated the relevance and accuracy of student responses using their subject matter knowledge and pedagogical content knowledge. Viola was limited in the types of questions and discussions she led because her mentor teacher wanted student behaviors controlled and viewed discussions as too open and uncontrollable. Rose had fewer opportunities to demonstrate her ability to respond to students because her mentor teacher restricted student questioning during direct instruction due to perceived time limitations.

The most prominent influence on the amount and type of practice afforded the preservice teachers were the mentor teachers. The educational philosophies held by the mentor teachers influenced their decision to allow the preservice teachers to practice certain instructional strategies. The mentor teachers’ influence on the preservice teachers’ performance and the observed deference is consistent in previous research (Kennedy, 2010; Rozelle & Wilson, 2012; Stigler & Hiebert, 1999). Two preservice teachers appeared comfortable and flexible when collaborating, lesson planning, and teaching. Elsa and Drake were observed using their knowledge to implement a variety of instructional strategies with adaptability to the student responses. Two preservice teachers missed opportunities to develop their knowledge and skills. Viola’s mentor teacher focused on behavior management and Rose’s mentor teacher focused on time management. Hence, the students in those classes did not experience instructional
strategies that encourage mathematical reasoning; a skill that the National Research Council (2005) argued contributes to mathematical proficiency.

The preparation of teachers who use instructional strategies leading to mathematical proficiency continues to be a focus in local and national policy (California Commission on Teacher Credentialing, 2014; U.S. Department of Education, 2014). This study spotlighted the inconsistency of professional learning opportunities in the field experience. The knowledge and skills learned in the teacher education program were used, or attempted to be used, in the field experience by the four preservice teachers. The needs of the students influenced the preservice teachers to adapt to the situation and select appropriate instructional strategies learned in the teacher education program in their lesson planning and, when possible, in their instruction.

However, the measures taken in the teacher education program to prepare the preservice teachers to select and use a variety of effective instructional strategies that would lead to mathematical proficiency were not advocated or used by all of the mentor teachers in this study. Ralph Waldo Emerson posited, “The secret to education is in respecting the pupil.” The current inconsistencies and obstacles in teacher education are not respectful of the professional preparation needed for preservice teachers and their future students. If teacher education aims to prepare effective teachers to meet the educational needs of students, system-wide changes in teacher education are called for in order to prepare and support preservice teachers that are knowledgeable, skillful, and adaptable in a changing society.
REFERENCES


Durkin, K., & Rittle-Johnson, B. (2012). The effectiveness of using incorrect examples to support learning about decimal magnitude. Learning and Instruction, 22, 206-214.


APPENDICES
Appendix A

Approval Letters
Exemption Notification - IRB ID: 254

To: Margaret Swearingen
From: IRB Chair
Subject: Protocol #254
Date: 03/04/2014

The Institutional Review Board for the Protection of Human Subjects (IRBPHS) at the [redacted] has reviewed your request for human subjects approval regarding your study.

Your project (IRB Protocol #254) with the title Pre-service Teachers' Use of Mathematical Knowledge for Teaching During Lesson Planning for the Field Experience has been approved by the [redacted] IRBPHS as Exempt according to 45CFR46.101(b). Your application for exemption has been verified because your project involves minimal risk to subjects as reviewed by the IRB on 03/04/2014.

Please note that changes to your protocol may affect its exempt status. Please submit a modification application within ten working days, indicating any changes to your research. Please include the Protocol number assigned to your application in your correspondence.

On behalf of the IRBPHS committee, I wish you much success in your endeavors.

Sincerely,

Chair, Institutional Review Board for the Protection of Human Subjects

IRBPHS [redacted]
February 24, 2014

Institutional Review Board for the Protection of Human Subjects

Dear Members of the Committee:

This letter confirms that we give our permission to doctoral student Margaret Swearingen to conduct her proposed dissertation research on pre-service teachers' use of mathematical knowledge during lesson planning. Margaret has provided information about her research design. Her proposed methodology is a multi-case study using questionnaires, observations, and interviews. The proposed voluntary research participants will be pre-service teachers enrolled in the final field experience portion of the Teacher Education program located at the branch campus during the spring semester of 2014.

Margaret has stipulated that she will recruit participants solely on a volunteer basis. They will not receive extra credit for their participation. Also, Margaret promises to maintain confidentiality and anonymity, both for the research participants and for the Teacher Education program. She will not discuss specific information she learns from participants with others at the site, and the sources of her findings (students and program) will not be identifiable in her dissertation or anything she publishes from it. She will use pseudonyms in her field notes and interview transcriptions as well as in conversations with her dissertation committee and others.

Our signatures confirm our consent for Margaret Swearingen to conduct the research study, pending IRBPTIS approval, in the Teacher Education program at the branch campus.

Sincerely,

[Signatures]

Chair and Associate Professor
Teacher Education Department

Assistant Director, Branch Campuses
Teacher Education Department
Appendix B

Informed Consent Forms
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Below is a description of the research procedures and an explanation of your rights as a research participant. You should read this information carefully. If you agree to participate, you will sign in the space provided to indicate that you have read and understand the information on this consent form. You are entitled to and will receive a copy of this form.

You have been asked to participate in a research study conducted by Margaret Swearingen, a graduate student in the Department of Learning and Instruction, School of Education at xxxxxxxxxxxx. The faculty supervisor for this study is Dr. xxxxxxxxxxxx, a professor in the Department of Learning and Instruction, School of Education at xxxxxxxxxxxx.

WHAT THE STUDY IS ABOUT:
The purpose of this research study is to investigate preservice teachers’ knowledge use when lesson planning during the culminating field experience.

WHAT WE WILL ASK YOU TO DO:
During this study, you will be asked to complete a questionnaire about your education background, any instructional experience, your elementary mathematics knowledge, and your knowledge of lesson planning. You will be interviewed about three mathematics lesson plans you prepared for your field experience prior to and after your enactment of each lesson. Your enactment of each lesson will be observed for elements of your knowledge use or adaptations during the lesson.

DURATION AND LOCATION OF THE STUDY:
Your participation in this study will involve a one-hour questionnaire and interview session, three lesson observations at the length to be determined by your lesson, and three one-hour interview sessions. The study will take place at the xxxxxxxxxxxx branch campus or your school site over a three- to four-week period.

POTENTIAL RISKS AND DISCOMFORTS:
I do not anticipate any risks or discomforts to you from participating in this research. If you wish, you may choose to withdraw your consent and discontinue your participation at any time during the study without penalty.

BENEFITS:
You will receive no direct benefit from your participation in this study; however, the possible benefits to others include information that will support the development of curricula and assignments for teacher education programs in the future.

PRIVACY/CONFIDENTIALITY:
Any data you provide in this study will be kept confidential unless disclosure is required by law. In any report I publish, I will not include information that will make it possible to identify you or any individual participant. Specifically, I will use pseudonyms throughout the documents. All forms with your signature of consent will be kept separate and in a locked location. The audio recordings of the interviews will be destroyed after the recordings are transcribed with all identifying information concealed.
VIDEO/AUDIO RECORDINGS:
Audio recordings will be made of the interviews to accurately capture the conversation. The recordings will be transcribed and the recordings destroyed after you review the transcripts for accuracy of your statements. All identifying information will be removed during transcription. Video recordings will be made of the lesson implementations. Segments of the recording will be replayed to stimulate recall and give the questions context during interviews. Similar procedures for Teacher Performance Assessments (TPAs) will be used during this study. The video will focus on the preservice teacher and not the students or the mentor teacher. After the video-stimulated recall interview, the recordings will be transcribed. After you review the transcription for accuracy of your statements, the recordings will be destroyed.

COMPENSATION/PAYMENT FOR PARTICIPATION:
You will receive a $100.00 Amazon gift card for your participation in this study. If you choose to withdraw before completing the study, you will receive a $25.00 Starbuck’s gift card.

VOLUNTARY NATURE OF THE STUDY:
Your participation is voluntary and you may refuse to participate without penalty and receive the Starbuck’s gift card. Furthermore, you may skip any questions or tasks that make you uncomfortable and may discontinue your participation at any time without penalty and receive the Starbuck’s gift card. In addition, the researcher has the right to withdraw you from participation in the study at any time. Participation or withdrawal from participation is not connected to your grade or performance evaluation in your field experience.

OFFER TO ANSWER QUESTIONS:
Please ask any questions you have now. If you have questions later, you should contact the principal investigator: Margaret Swearingen at [Phone Number] or mmswearingen@[Email Address]. If you have questions or concerns about your rights as a participant in this study, you may contact the Institutional Review Board by calling [Phone Number] or email at IRBPHS@[Email Address].

I HAVE READ THE ABOVE INFORMATION AND RECEIVED A COPY OF THE RESEARCH SUBJECTS’ BILL OF RIGHTS. ANY QUESTIONS I HAVE ASKED HAVE BEEN ANSWERED. I AGREE TO PARTICIPATE IN THIS RESEARCH PROJECT AND I WILL RECEIVE A COPY OF THIS CONSENT FORM.

__________________________________________  __________________________
Signature (Printed Participant Name)                          Date
Research Subjects’ Bill of Rights

The rights below are the rights of every person who is asked to be in a research study. As a research subject, I have the following rights:

Research subjects can expect:

- To be told the extent to which confidentiality of records identifying the subject will be maintained and of the possibility that specified individuals, internal and external regulatory agencies, or study sponsors may inspect information in the medical record specifically related to participation in the clinical trial.

- To be told of any benefits that may reasonably be expected from the research.

- To be told of any reasonably foreseeable discomforts or risks.

- To be told of appropriate alternative procedures or courses of treatment that might be of benefit to the subject.

- To be told of the procedures to be followed during the course of participation, especially those that are experimental in nature.

- To be told that they may refuse to participate (participation is voluntary), and that declining to participate will not compromise access to services and will not result in penalty or loss of benefits to which the subject is otherwise entitled.

- To be told about compensation and medical treatment if research related injury occurs and where further information may be obtained when participating in research involving more than minimal risk.

- To be told whom to contact for answers to pertinent questions about the research, about the research subjects' rights and whom to contact in the event of a research-related injury to the subject.

- To be told of anticipated circumstances under which the investigator without regard to the subject's consent may terminate the subject's participation.

- To be told of any additional costs to the subject that may result from participation in the research.

- To be told of the consequences of a subjects’ decision to withdraw from the research and procedures for orderly termination of participation by the subject.
• To be told that significant new findings developed during the course of the research that may relate to the subject's willingness to continue participation will be provided to the subject.

• To be told the approximate number of subjects involved in the study.

• To be told what the study is trying to find out.

• To be told what will happen to me and whether any of the procedures, drugs, or devices are different from what would be used in standard practice.

• To be told about the frequent and/or important risks, side effects, or discomforts of the things that will happen to me for research purposes.

• To be told if I can expect any benefit from participating, and, if so, what the benefit might be.

• To be told of the other choices I have and how they may be better or worse than being in the study.

• To be allowed to ask any questions concerning the study both before agreeing to be involved and during the course of the study.

• To be told what sort of medical or psychological treatment is available if any complications arise.

• To refuse to participate at all or to change my mind about participation after the study is started. If I were to make such a decision, it will not affect my right to receive the care or privileges I would receive if I were not in the study.

• To receive a copy of the signed and dated consent form.

• To be free of pressure when considering whether I wish to agree to be in the study.

If I have other questions, I should ask the researcher or the research assistant. In addition, I may contact the Institutional Review Board for the Protection of Human Subjects (IRBPHS), which is concerned with protection of volunteers in research projects. I may reach the IRBPHS by calling or by email at .
Consent to Collect Data at School Site

[Date]

[School Address]

Dear [School Administrator or Mentor Teacher Name]:

My name is Margaret Swearingen; I am contacting you with a request to collect observation data at your school site. I am a doctoral student and a teacher educator with the XXXXXXXXXXX, and a former California elementary teacher. For my doctoral research, I am studying student teachers’ practices of using mathematical knowledge during lesson planning and instruction. One week of observations are proposed for the study. [Name of preservice teacher] has consented to volunteer for this study, and I am requesting your approval to observe and video record her at your school using the procedures similar to the Teacher Performance Assessment protocol. This protocol is currently being used by the student teacher in the classroom.

I am not observing the students or mentor teachers. I am not evaluating the school environment, the classroom program, or the curriculum. My goal is not to disrupt the classroom environment. There are no physical, psychological, or sociological risks to anyone at the school site, nor to any of the participants. All identifying information of the student teachers, teachers, students, school site, and district will be kept confidential and secure. Pseudonyms will be used for anonymity of all persons and places. I received approval from the XXXXXXXXXXX’s Institutional Review Board for the Protection of Human Subjects (IRBPHS) and the Teacher Education Program to proceed with this project with your consent.

Your signature at the bottom of this letter confirms your consent for me to conduct research at your school site. My supervising professor is Dr. XXXXX XXXXXX in the School of Education, Learning and Instruction Department at the XXXXXXXXXX.

Respectfully,

Margaret Swearingen
mmswearingen@XXXXX

Signature         Date
[date]

Dear Families:

My name is Margaret Swearingen and I am a graduate student in the School of Education at the XXXXXXXXXXX. I am sending this letter to explain why I would like to video record in your child’s classroom. I am studying lesson planning resources for mathematics and would like to see how student teachers use these resources during teaching.

The video recording will be focused on the student teacher, [name]. I will not video record any students during my observation. The audio portion will be transcribed and all names used during the recording will be changed. After the transcriptions are completed, the recordings will be destroyed. Additionally, the names of the student teacher, the mentor teacher, and the school will be changed in the written study.

The study will be conducted for approximately four days depending upon the length of the mathematics topic; it may be shorter. There are no known psychological, physical, or sociological risks involved in this study. If you have any questions, please contact me by email at mmswearingen@XXXXX or contact my faculty supervisor, Dr. XXXXXXXX, by email at XXXXXXXX.

Respectfully,

Margaret Swearingen
Appendix C

Questionnaires
Background Questionnaire

Please respond to the following questions and statements regarding your personal, professional, and academic background. All personal information provided is confidential and any identifying information will be concealed and kept in a secure place. Feel free to extend your responses on the back of this page.

Your name: _________________________________________  Your age: ________

Your part-time grade-level placement: ______

How many students are in your current field-placement class? ______

What was your CSET Math score? ________

What was your undergraduate major(s)? _______________________________________

If applicable, what was your undergraduate minor? ______________________________

If applicable, what graduate degree(s) or professional certificate(s) do you hold and in what discipline(s)?

_______________________________________________________________________

_______________________________________________________________________

Have you held service-related jobs?  YES  NO
(If applicable, write the service-related jobs on the back of this page.)

Do you have any prior experience using lesson plans or lesson planning?  YES  NO

Do you have any prior experience conducting mathematics instruction or tutoring?  YES  NO

Indicate your mathematics learning experience between kindergarten to sixth grade:

EASY  LITTLE DIFFICULTY  SOME DIFFICULTY  A LOT OF DIFFICULTY

Indicate your mathematics learning experience between seventh grade to twelfth grade:

EASY  LITTLE DIFFICULTY  SOME DIFFICULTY  A LOT OF DIFFICULTY

Indicate your mathematics learning experience in college-level courses:

EASY  LITTLE DIFFICULTY  SOME DIFFICULTY  A LOT OF DIFFICULTY
Mathematical Knowledge Questionnaire

Circle the best response for each item.

You will be given an opportunity to explain the following responses during an interview.

1. Ms. Dominguez was working with a new textbook and she noticed that it gave more attention to the number 0 than her old book. She came across a page that asked students to determine if a few statements about 0 were true or false. Intrigued, she showed them to her sister who is also a teacher, and asked her what she thought.

Which statement(s) should the sisters select as being true? (Mark YES, NO, or I’M NOT SURE for each item below.)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>I’m not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 0 is an even number.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b) 0 is not really a number. It is a placeholder in writing big numbers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c) The number 8 can be written as 008.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

2. Ms. Chambreaux’s students are working on the following problem:

Is 371 a prime number?

As she walks around the room looking at their papers, she sees many different ways to solve this problem. Which solution method is correct? (Mark ONE answer.)

a) Check to see whether 371 is divisible by 2, 3, 4, 5, 6, 7, 8, or 9.

b) Break 371 into 3 and 71; they are both prime, so 371 must also be prime.

c) Check to see whether 371 is divisible by any prime number less than 20.

d) Break 371 into 37 and 1; they are both prime, so 371 must also be prime.
3. Imagine that you are working with your class on multiplying large numbers. Among your students’ papers, you notice that some have displayed their work in the following ways:

Which of these students would you judge to be using a method that could be used to multiply any two whole numbers?

<table>
<thead>
<tr>
<th>Student A</th>
<th>Student B</th>
<th>Student C</th>
</tr>
</thead>
</table>
| \[ \begin{array}{c}
35 \\
\times 25 \\
\hline
125 \\
+75 \\
\hline
875
\end{array} \] | \[ \begin{array}{c}
35 \\
\times 25 \\
\hline
175 \\
+700 \\
\hline
875
\end{array} \] | \[ \begin{array}{c}
35 \\
\times 25 \\
\hline
25 \\
+600 \\
\hline
875
\end{array} \] |

Which of these students would you judge to be using a method that could be used to multiply any two whole numbers?

<table>
<thead>
<tr>
<th>Method would work for all whole numbers</th>
<th>Method would NOT work for all whole numbers</th>
<th>I’m not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Method A</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b) Method B</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c) Method C</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

4. Mrs. Johnson thinks it is important to vary the whole when she teaches fractions. For example, she might use five dollars to be the whole, or ten students, or a single rectangle. On one particular day, she uses as the whole a picture of two pizzas. What fraction of the two pizzas is she illustrating below? (Mark ONE answer.)

a) \(\frac{5}{4}\)  

b) \(\frac{5}{3}\)  

c) \(\frac{5}{8}\)  

d) \(\frac{1}{4}\)
5. Mr. Garrett’s students were working on strategies for finding the answers to multiplication problems. Which of the following strategies would you expect to see some elementary school students using to find the answer to $8 \times 8$? (Mark YES, NO, or I’M NOT SURE for each strategy.)

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>I’m not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) They might multiply $8 \times 4 = 32$ and then double that by doing $32 \times 2 = 64$.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b) They might multiply $10 \times 10 = 100$ and then subtract $36$ to get $64$.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c) They might multiply $8 \times 10 = 80$ and then subtract $8 \times 2$ from $80$: $80 - 16 = 64$.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d) They might multiply $8 \times 5 = 40$ and then count up by 8’s: 48, 56, 64.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

6. Mr. Foster’s class is learning to compare and order fractions. While his students know how to compare fractions using common denominators, Mr. Foster also wants them to develop a variety of other intuitive methods.

Which of the following lists of fractions would be best for helping students learn to develop several different strategies for comparing fractions? (Circle ONE answer.)

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>$\frac{1}{4}$</td>
<td>$\frac{1}{20}$</td>
<td>$\frac{1}{19}$</td>
<td>$\frac{1}{2}$</td>
</tr>
<tr>
<td>b)</td>
<td>$\frac{4}{13}$</td>
<td>$\frac{3}{11}$</td>
<td>$\frac{6}{20}$</td>
<td>$\frac{1}{3}$</td>
</tr>
<tr>
<td>c)</td>
<td>$\frac{5}{6}$</td>
<td>$\frac{3}{8}$</td>
<td>$\frac{2}{3}$</td>
<td>$\frac{3}{7}$</td>
</tr>
<tr>
<td>d) Any of these would work equally well for this purpose.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D

Lesson Plan Document Analysis
<table>
<thead>
<tr>
<th>Lesson Plan Component</th>
<th>Description of Mathematical Tasks in the Lesson Plan (Ball et al., 2008)</th>
<th>Mathematical Knowledge for Teaching (Hill et al., 2004)</th>
<th>*Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials and Resources:</td>
<td>Making judgments about the mathematical quality of instructional materials and modifying as necessary</td>
<td>Specialized Content Knowledge (SCK)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Appraising and adapting the mathematical topics of textbooks</td>
<td>SCK</td>
<td></td>
</tr>
<tr>
<td>Introduction:</td>
<td>Explaining mathematical goals and purpose</td>
<td>SCK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elaborating on accomplishing mathematical goals</td>
<td>Knowledge of Content &amp; Teaching (KCT)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grasping where the lesson is situated in the curriculum (what was the previous and will be the next lessons in the curriculum and where topics related to the lesson are in the curriculum)</td>
<td>Knowledge of Content and Curriculum (KCC)</td>
<td></td>
</tr>
<tr>
<td>Activity Sequence:</td>
<td>Anticipating, with given activities and problems in a lesson, what students are likely to do and get confused about</td>
<td>Knowledge of Content and Students (KCS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elaborating on how problems and tasks are posed</td>
<td>KCT</td>
<td></td>
</tr>
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<td></td>
<td>Deciding the sequence of activities, representations, examples, explanations, questions, etc.</td>
<td>KCT</td>
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<tr>
<td></td>
<td>Deciding when to pause and ask questions and offer explanations and when to use students’ ideas during a lesson</td>
<td>KCT</td>
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<tr>
<td>Activity Choices:</td>
<td>Anticipating how mathematical ideas change and grow in one lesson</td>
<td>SCK</td>
<td></td>
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<td></td>
<td>Posing mathematical questions that are productive for students’ learning</td>
<td>KCT</td>
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<td></td>
<td>Deciding what is most important for students to know and understand about the provided tasks and problems in a lesson</td>
<td>KCC</td>
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<tr>
<td>Assessing During Lesson:</td>
<td>Monitoring students understanding throughout a lesson</td>
<td>KCS</td>
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<tr>
<td></td>
<td>Making mathematical and pedagogical judgments about students learning throughout a lesson</td>
<td>KCS</td>
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<td>Adjusting teaching based on the monitoring students learning</td>
<td>KCT</td>
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<tr>
<td>Assessing After Lesson:</td>
<td>Choosing a task to assess students understanding</td>
<td>KCT</td>
<td></td>
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<tr>
<td></td>
<td>Taking next steps according to results of evaluations of a lesson</td>
<td>KCT</td>
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*RATING: 1 = Used to a minimal extent; 2 = Used to some extent; 3 = Used extensively*
Appendix E

Interview Protocols
Pre-Observation Semi-Structured Interview Protocol

1. Take a few minutes and give me an overview of the unit that you have put together.
   • What have you planned for the unit?
   • What was the previous unit?
   • What is the next unit?

2. How did you go about planning the unit?
   • What steps did you go through? (The intent of these questions is to get at the starting point of the planning process-e.g., problems, objectives, activities, or something else-and determine how this starting point gets transformed into an actual instructional plan.)

3. How much time did it take to plan this unit?
   • Did you plan the entire unit at once or did you plan it in more than one sitting?
   • What resources or knowledge did you draw upon?
   • What resources did you use from your methodology course?
   • What resources did you use from your cohort members?
   • What resources did you use from your mentor teacher?
   • What resources did you use from online sources?

4. What was the hardest part of planning this unit?
   • What was the easiest?
   • What would have made the planning easier?

5. Let’s look at the lessons from your unit. Give me an overview of each lesson.
   • How did you go about planning the lesson?
   • What steps did you go through?

6. What resources did you use to write this lesson?
   • How did you know about these resources?
   • What resource did you find most valuable and least valuable?
   • What resources did you use from your methodology course?
   • What resources did you use from your cohort members?
   • What resources did you use from your mentor teacher?
   • What resources did you use from online sources?

7. What is the learning objective for this lesson?
   • [If textbook used:] Did you change the objective for this plan?
   • How did you decide on this objective?
   • What other changes did you make to the lesson plan?
   • Why did you make those changes?
8. What task or activity is central in your lesson?
   • Why did you choose that task or activity?
   • [If applicable:] How will you group students for this task or activity?
   • What is your role during this task your activity?

9. What definitions, concepts, procedures, or ideas do students need to know to begin work on this task or activity?
   • How do you know this?

10. What problems or representations do you plan to use during instruction?
    • Why did you choose this type of model or representation?

11. What are all the ways this task could be solved?
    • What methods do you think students will use?
    • What misconceptions do you think students will have with this task or activity?
    • What errors do you think students will make?

12. I noticed you included student (responses, strategies, questions, misconceptions, etc.). [Probe the opposite if the anticipated responses are not included.]
    • Why did you include those?
    • What resources did you use to prepare those?

13. As students are working independently/in pairs/in groups, what will you being doing?
    • What questions will you ask?
    • What will you be looking for in their work?
    • How do you know to ask those questions?
    • How will you know the students are engaged with the task?

14. What will you see or hear that lets you know the students understand the mathematical ideas or strategies?
    • What ways will you assess student learning?
    • How did you choose these assessments?
    • How will you use the information from the assessments?

15. Why did you choose these extending activities? [Probe the opposite if they are not included.]

16. If there is homework with this lesson, how to you choose those problems?

17. Is there anything else you would like to tell me about your lesson plan or your lesson planning process?
Post-Observation Semi-Structured Interview Protocol

1. Take a few minutes and tell me how you think the lesson went?
   - What were the students’ reactions?
   - What proportion of the students do you estimate had difficulty learning the objective?
   - What proportion of the students do you estimate had little to no difficulty learning the objective?
   - Did anything surprise you during the lesson?
   - What did not go as planned?
   - What went better than you expected?

2. How do you think the activities went?
   - Talk about any changes you would make to the activities. Why or why not?
   - Change the introduction?
   - Change the modeling or representations?
   - Change the activity sequence?
   - Change the student work (independent/pairs/groups)?
   - Change the type or amount of work?
   - Change the extension?

3. How do you know if the students accomplished the learning objective?

4. Will you change anything for tomorrow’s mathematics lesson based on what happened in today’s lesson?
   - What changes will you make?
   - Why or why not?
   - What resources did you use in making the changes during the lesson?

5. Is there anything else you would like to tell me about your lesson planning or lesson enactment?
Appendix F

Observation Record
Observation Record

Preservice Teacher: _____________________________    Date: _________________

# of Students: ___   Lesson Start Time: ___________  Lesson End Time: _________

Lesson Topic: ___________________________________  #_____

Notation Protocols:
- Structure of lesson plan  - Instructional techniques  - Mentor teacher actions
- Pacing of lesson  - Student responses  - Instructional aide actions
- Hesitations or pauses  - Student actions  - Classroom management

<table>
<thead>
<tr>
<th>Time</th>
<th>-Note moments of hesitation or pause</th>
<th>-Reflections noted at the end</th>
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Appendix G

Mathematics Methodology Course Syllabus
School of Education
Teacher Education Department

TECXXXX: Multiple-Subject Curriculum and Instruction:
Mathematics, Science, and Physical Education

Course Schedule: Saturdays (9:00am - 4:30pm): XXXXXXXX
                  Wednesdays (4:00 - 10:00pm): XXXXXXXX

Instructor: Margaret Swearingen
            mmswearingen@XXXXXX (best method)

Office Hours: Before and after each class session or by appointment

Catalogue Description: Study of research and practice related to subject-matter content, instructional methods, materials, and media appropriate for teaching mathematics and science within the elementary school curriculum.

Course Overview: TECXXXX is designed to focus on a variety of pedagogical knowledge and skills applied to teaching in California’s diverse elementary classrooms. Emphasis is placed on what constitutes effective teaching and assessment practices. Candidates will focus on research-based instructional approaches, materials, and media appropriate for planning and delivering content specific instruction in mathematics, science, and physical education (PE) to students in kindergarten through eighth grade.

Course Objectives: At the end of the course, candidates will be able to demonstrate and apply knowledge of:
1. Curriculum trends and issues in K-8 education. (TPE 1, 12)
2. Current research on effective instruction as related to the teaching of elementary school science, mathematics, and physical education. (TPE 1, 12)
3. Impact of personal educational belief systems on curricular and instructional decision-making. (TPE 12, 13)
4. Strategies for teaching content, concepts, and thinking skills through a variety of curriculum materials and media to an academically, culturally, and linguistically diverse student population. (TPE 1, 4, 5, 6, 7, 8, 9)
5. Purpose and appropriate use of a range of instructional strategies including (but not limited to) direct instruction, cooperative learning, independent projects, peer teaching based on curriculum objectives, the nature and needs of students, personal philosophy/style of teaching, and available instructional resources. (TPE 1, 4, 5, 6, 7, 8, 9)
6. The teacher's role in an activity-centered classroom, the teaching of content and concepts in collaborative "hands-on" programs, the implementation of instructional goals outlined in the California Common Core State Standards and Frameworks. (TPE 1, 4, 5, 6, 7, 9, 10, 11)
7. How to access student information and use that data to plan and analyze instruction and assessment to meet the diverse needs of both the whole class and individual students. (TPE 2, 3, 8, 11, 12)
8. Assessment of instructional objectives, practical guidelines for use of performance-based assessments, portfolios as an alternative for assessment and improved instruction. (TPE 2, 3, 12)

9. Application of technology for effective planning, teaching, assessment, and communication as well as professional development. (TPE 1, 4, 6, 9, 12, 13)

**Required Readings:**
- Two textbooks should be available at the USF Bookstore and online:

**Additional Resources:**
- Assignments will be listed in the Class Meeting Schedule.
- Common Core State Standards
  - [California's Common Core State Standards for Mathematics](http://www.cde.ca.gov/ta/ac/ctsms/index.asp)
  - [California's Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science and Technical Subjects](http://www.cde.ca.gov/ta/ac/ctsms/index.asp)
- Curriculum Frameworks
  - [Mathematics Framework](http://www.cde.ca.gov/ta/ac/ctsms/index.asp)
  - [Science Framework](http://www.cde.ca.gov/ta/ac/ctsms/index.asp)
  - [Physical Education Framework](http://www.cde.ca.gov/ta/ac/ctsms/index.asp)
  - [Health Framework](http://www.cde.ca.gov/ta/ac/ctsms/index.asp)
- Annenberg Learner Workshops: [http://www.learner.org/workshops/workshop_list.html](http://www.learner.org/workshops/workshop_list.html). Assignments will be listed in the Class Meeting Schedule.

**Optional Instructional Materials:** Additional articles may be posted to our Blackboard site throughout the course to provide additional readings on specific issues.

**Keep Up-to-Date:** Websites, Organizations, Agencies, Museums, Blogs, and more to put on Your Favorites List: Click the Resources tab on our class Blackboard site. Class members are invited to add to the Resources file throughout the semester. When you post a resource, please add your name at the end of the posting.

**Requirements:**
- Attendance: Attendance and punctuality are essential. Since this course meets requirements for a California legislated credential attendance is mandatory. Absences should be for major illness or family emergencies. Three (3) tardies will be considered an absence. Attendance will be taken at the start of each meeting. In this 3-unit course, you
can miss 6.25 hours and still receive a passing grade. If you must be absent or late, notify
the instructor.
As a courtesy to the instructor and your fellow students, silence all cell phones and other
electronic devices during class. While computers may be useful during class, there will
also be times when they are a distraction. Thus, you may be asked to put your computers
away.

Unregistered “guests,” including children, relatives, friends, and non-service pets, may
not attend this course.

**Active Participation:** Active participation is defined as sharing questions, concerns,
constructive feedback, support, ideas, and resources. Active participation is being
attentive, self-motivated, respectful, independent, responsible, and flexible. This also
means that you will have completed assignments and readings listed in the syllabus for
the class date each is due. Attendance alone does not constitute active participation.

Pursuant to the Americans with Disabilities Act and Section 504 of the Rehabilitation
Act, students with disabilities who will need reasonable accommodations for this course
should contact Disability Related Services (v / tdd) as soon as possible. Students with Learning Disabilities may contact Learning Disability Services. Further information about the services that the Student Disability Services office provides

**Coursework:** All work must be typed in 12-point font and double-spaced, **unless
otherwise directed by instructor.** When citing sources, use APA format (6th edition)
and provide a reference list when appropriate. Please paginate any paper of more than
two pages and be sure your name is on the paper. Please proofread all work. Do not rely
on spell-check programs, similar words such as “chick” and “check” are read as correct
by most spell-check programs. Lesson Plans should use the Lesson Plan format on TaskStream.

**Expectations for Assignments:**
- All assignments will be submitted on time.
- Keep written assignments and backup copies of files until you receive a grade for
  this course.
- Submit lesson plan assignments electronically through TaskStream.

Some students may wish to obtain editorial assistance with grammar, syntax, and style,
which is acceptable. Editorial assistance for content is unacceptable. If you need help
with the former, the Writing Center is located on the campus. Phone to arrange an appointment. The Writing Center will arrange for a
writing coach to work with you at no cost.

**Academic Honesty:** Whenever you quote from, make reference to, or use ideas
attributable to others in your writing, you must identify these sources in citations or
references or both. If you do not identify the source, whether deliberately or accidentally,
then you have committed plagiarism. Plagiarism, defined as the act of stealing or using as one’s own the ideas of another, is not permitted in work submitted for courses at XXXXXX or in any published writing. Please read the complete text related to academic honesty in the XXXXXX Student Handbook under “Student Conduct, University Standards, Policies and Procedures: XXXXXX.” University faculty may use internet-based services to identify those portions of the person’s written assignments that might not meet the full standards of academic integrity.

**Course Assignments:**

**Reading:** All assigned reading must be completed by the due date indicated in the Class Meeting and Assignment Schedule. This course is an intensive format and I strongly recommend that you stay on schedule with the reading, which will support discussions and activities during our class meetings. The assignments are posted in the Reading Assignment area on Blackboard. (*Course Objectives #1, #2, and #4*)

**Reflection on Personal Learning Experience (20 points possible: 17% of grade):** Write a personal reflection (1-2 pages, double-spaced) on your experiences as a student in each of the subject content areas: mathematics, science, and physical education. Select a specific grade level, several grade levels, or an overall experience for each content area. Include in your reflections why your perception of the experiences were positive and/or negative. Conclude with a reflection on how your experiences will inform or influence your teaching practice. (*Course Objective #3*)

- **Reflection on mathematics, science, & physical education learning due:**

**Discussion Board Posts (posts #1-3: 18% of grade):** Original postings should be at least one to three paragraphs in length. You must respond to at least one classmate’s posting in a thoughtful and respectful manner; “ditto” or “I agree” does not indicate a thoughtful or respectful response. (*Course Objectives #1, #2, #3, #4, #5, and #9*)

1. **“What is number sense?”** Taking into account our class discussion, your assigned reading from the Burns text, and other information you locate, explain what you think number sense is and why it is important to develop this sense with children. After you have posted your response, then respond to one other classmate’s posting. Original post due by XXXXX and response post due by XXXXX. (*possible 5 points*)

2. **“Assessment Purpose”:** Based on the readings from the Burns and Bass texts, describe the purpose of diagnostic, formative, and summative assessments. You may use other resources to gather your information. What method(s) of assessment will you use in your lesson plans? What is your rationale for using the method(s)? Original post due by XXXXX and response due by XXXXX. (*possible 5 points*)

3. **Personal Field Trip:** Mathematics, science, or County Office of Education field trip post guidelines are listed below. Post due by XXXXX. (*possible 10 points*)

   *No response to classmate postings is necessary for this assignment.*
Textbook Review (10 points possible for each; 9% of grade each): Select and review a state-adopted textbook: one in mathematics (we will do this in class) and one (on your own) in science. Each review should follow the Textbook Review guidelines provided in this syllabus and posted on Black Board. The mathematics textbook review will be done in class as a collaborative project to model the process. There are several textbooks available in the library. Other resources can be found at your student teaching placement, any County Office of Education, or the Curriculum Resource Center in SOE-XXXXX on the main campus. Both reviews will be submitted in writing (limit of 2-3 pages per review).

- Review due by [date]. (Course Objectives #1, #4, #5, #6, and #8)

Personal Field Trip for Mathematics, Science, OR County Office of Education (10 points possible; 9% of grade--included in the Discussion Board percentage):

- Mathematics or Science: Links are on Blackboard under Personal Field Trips to suggested locations for this assignment. Write one to two paragraphs summarizing your experience, and one to two paragraphs evaluating the location as a potential field trip for students. Reflect on content standards, the surroundings, group management, and accessibility. Include how you would make use of this resource in your teaching.
  - Another location of your choice approved by the instructor

- County Office of Education: Another option is to take a personal field trip to the curriculum library at the County Office of Education. Explore the materials that are available for loan to teachers. There is a link in the Resources area on Blackboard. Post a one- to three-paragraph summary of your visit including items you were surprised to find available and items you may want to include in your own lessons in the Discussion area of Blackboard.

- Post your field trip information by [date]. We will discuss this in class. (It is not required to respond to a classmate's post.) (Course Objectives #1, #3, #4, and #5)

Written Lesson and Unit Planning (30 points possible; 26% of grade): Based on the Common Core State Standards and a state-adopted standards and frameworks, you will write for both mathematics and science:

- an outline of a unit of lessons that includes an outline of a single-concept lesson sequence from the unit;
- and a full lesson plan from the single-concept lesson sequence.

- For the physical education subject area, you will write a lesson plan based on state-adopted standards and framework.

- The units with the single-concept lesson sequences, and the lesson plans will be submitted using the Unit Plan and Standard Lesson Plan Formats in TaskStream. A separate handout providing detailed instructions for this assignment is provided. (Course Objectives #1, #2, #4, #5, #6, #7, #8, and #9)

- Lesson Plans and Unit Sequences due: [date]
**Learning Activities Implementation (25 points possible; 22% of grade):** Select a mathematics activity, a science activity, or the physical education activity from the written lesson plans to implement with our class. *(This is not a full lesson plan; it is only the supporting or central activity from the lesson.)* Each person will have about 25 minutes, which includes setting up, describing the context, and cleaning up. Breaks will be irregular at this class meeting. *(Course Objectives #1, #2, #4, #5, #6, #7, #8, and #9)*

- Activities presented at the last class meeting on [date]

**Course Evaluation:**
This is a graduate-level course therefore a passing grade is a B. All work will be returned to candidates. Any work that receives a mark below 80% should be revised and resubmitted for evaluation; resubmission is the choice of the student. It is not required. There are 115 possible points for this course, and the increments are indicated next to the assignments listed above.

**Late Assignments:** Late assignments will not be accepted without prior approval from the instructor. If a late submission is approved, one point will be deducted for each day the assignment is late. Repeated late assignments will result in a lowered grade for the course. **All Blackboard assignments are due by the indicated date at 11:59 pm. The Learning Activities will be implemented on the last day of class (DATE).**

**Incomplete (I) Grades:** I prefer **not** to post Incomplete (I) grades. Thus, an Incomplete (I) grade will only be issued after lengthy discussion. An Incomplete Grade/Course Completion Form must be filled out, signed by both of us, and submitted to the Dean's Office.

Remember: Incomplete (I) grades will automatically be changed to a Failing (F) grade after one full semester. In addition, an Incomplete grade can block your enrollment in full-time Student Teaching. Do not get behind; contact me at the first hint of a problem.

**Grading:** This course is designed to help you prepare to plan, teach, assess, and reflect on your practice in your own classroom. One of the most challenging issues for new teachers is developing an assessment/evaluation system that can be used for both formative assessment (helping students learn) and summative assessment (a grade for the report card). Thus, as a group, we will discuss and then develop grading criteria for some of the assignments in this course. The course grading scale is as follows: 100% - 94% = A; 93% - 90% = A-; 89% - 87% = B+; 86% - 83% = B; 82% - 80% = B-.
**Class Meeting and Assignment Schedule**

*This course outline serves as a general guideline. The instructor may delete or add topics and/or assignments. *Bring your textbooks to each class meeting.*

Pre-Seminar Reading Assignment due First Class Meeting:

**Reading:** Burns: pp. 3-44 (introduction to mathematics education)
Bass: pp. 86-108 (teaching science for understanding)

**Session I: (9:00am – 4:30pm)**

**Assignments Due:**
Reading: Burns: pp. 3-44 (introduction to mathematics education)
Bass: pp. 86-108 (teaching science for understanding)

**Topics:**
1) Introductions, Course and Syllabus Review
2) Teacher Content Knowledge, Pedagogical Knowledge, Pedagogical Content Knowledge, and Mathematical Knowledge for Teaching
3) Direct Instruction, Discovery, and Inquiry
4) Common Core State Standards
5) Integration and Themes
6) Curriculum Frameworks
7) Reviewing Lesson Plan Topics

**Session II: (4:00 – 10:00pm)**

**Assignments Due:**
1) Reading: Burns: pp. 51-66 (managing classroom instruction)
   Bass: pp. 110-134 (planning and managing inquiry instruction)
   Morgan and Hansen, 2008 (teacher perceptions of PE)
2) Personal reflection paper: Mathematics, Science, and Physical Education
3) Lesson Plans: Lesson subject, topic or unit of study, grade level, objective(s), and connected standard(s) (in-class discussion)
4) Common student misconceptions learning your selected topics

**Topics:**
1) Common Student Misconceptions
2) Using Student Errors for Mathematical Reasoning
3) Adaptation, Modification, and Differentiation
4) IRIS Center Module Preview
5) Managing Time and Behaviors
6) Assessment Introduction
7) Lesson Planning (Standard Lesson Plan Format)
8) Backwards Lesson Design (Aligning Standards, Objectives, Assessments)

**Session III: (9:00am – 4:30pm)**

**Assignments Due:**
1) Reading: Burns: pp. 47-50 (assessment)
   Burns: pp. 171-195 (teaching arithmetic)
   Bass: pp. 136-147 (assessment)
2) Lesson Plans: Assessment (in-class discussion)
3) Discussion Board: “What is number sense?” Post by 7/20; Respond by 7/22

**Topics:**
1) Assessment
2) Writing Assessment Rubrics
3) Differentiation Linked to Assessment
4) Building Assessment into Your Lesson Plan (Formative & Summative Assessments)
5) Checking for Understanding
6) Collaborative learning, KWL, Communications between Students
7) Leading Discussions
8) Implementation: Learning Context, Instructional Strategies, Engaging Learners, Time Allotment, and Assessment Plans
9) Reviewing Mathematics Textbooks and Other Resources

**Session IV: (4:00 – 10:00pm)**

**Assignments Due:**
1) Reading: Rink and Hall, 2008 (article: effective teaching in physical education)
   Pressé, Block, Horton, and Harvey, 2011, pp. 32-39 (article adapting physical education)
2) Textbook Evaluations (guidelines in the Written Assignments area on Blackboard)
3) Discussion Board post: Describe the purpose of diagnostic, formative, and summative assessments. What method(s) of assessment will you use in your lesson plans? What is your rationale for using the method(s)? Post by XXX; Respond by XXX
4) Lesson Plans: Procedure and Materials (in-class discussion)

**Topics:**
1) Technology: Purpose, Use, Planning, and Pitfalls
2) Using and Adapting State-Adopted Textbooks
3) Using and Adapting Other Published Lesson Plans
4) Procedures and Materials Management and Acquisition

**Session V: (9:00am – 4:30pm)**

**Assignments Due:**
1) Reading: Burns: pp. 365-402 (math questions from teachers)
   Bass: pp. 184-204 (effective questioning in science)
2) Lesson Unit Outlines (math, science, and physical education)
3) Lesson Plans from Unit Outlines (one from each content area)
4) Discussion Board Post: Personal field trip summary

**Topics:**
1) Classroom Environment for Activities during Collaborative Learning Strategies
2) Implementation and Purpose of Field Trips and Guests
3) Organizing Classroom Schedules

**Session VI: (4:00 – 10:00pm)**

**Assignments Due:**
1) Learning Activities project
2) Learning Activities demonstrations
Textbook Review Assignment

The purpose of this review is for you to become familiar with the state-adopted textbooks and curriculum in a specific subject area. **Familiarity with published lesson plans will assist you with evaluating, adapting, and modifying a lesson to fit the needs of your students when meeting learning objectives.** Review both the student portion and the teacher portion for each textbook. The teacher edition usually includes a copy of the student text as well as specially designed instructions for the teacher such as specific objectives, teaching strategies, learning activities, assessment instruments, and resources including many online resources to be used by both teacher and students. As you review a text, the following guidelines are intended to assist you prepare your paper, which should be about two to three pages in length. List the textbook title at the top of the paper in APA citation format.

**Guiding Questions and Prompts to Use Describing the Textbook Review:**

*How does the teacher's edition describe the following elements?*

- Learning goals (Consistent with state standards? Look up the standard.)
- Specific objectives for each lesson
- Units and lesson sequences described thoroughly (Are they developed with suggested time allotments?)
- Units, lessons, and materials are easily located and clear
- Suggested modifications and adaptations to meet individual student needs including:
  - Reading/Literacy levels
  - English Language Development
  - Special Needs (e.g. Learning Disabilities, Gifted, Talented, etc.)
- Specific techniques and strategies for instruction clearly described (Rationale for using the specified instructional techniques and strategies included?)
- Inclusion (or available from the publisher) of aids, materials, supplementary materials, CD Roms, web sites, and other resources
- Listings of suggested aids, materials, and resources that are not available through the textbook publisher
- Suggestions for extension activities as well as materials and resources to support these extensions
- Trade books or excerpts suggested to integrate the language arts
- Specific guidelines and/or tools for assessment of student learning

*Describe the student portion of the textbook for the following elements:*

- Describe the format. (Is it structured and easy to follow for the intended grade level?)
- Describe the illustrations and visuals. (Are they attractive, applicable to the text, useful, distracting, and/or visually overwhelming?)
- Describe the writing or wording. Is it clear and understandable for the intended grade level?
- Are the activities relevant to the learning goals?
Unit Outline with Single-Concept Sequence and Lesson Plan Assignment

Any lesson is typically part of a sequence of concepts in an overarching topic. Conceptual topics make up a unit of study. There may be 27 to 35 units in a curriculum. Each of the units contain about three to five chapters addressing subtopics in the “big idea” of the unit. Each of the chapters contain a single-concept sequence of two to four lessons. Each lesson is implemented over one to two class meetings. Generally, each single-concept lesson sequence introduces a concept, allows students time to work on the concept, and then assesses student attainment of the concept. A lesson is rarely a “stand-alone” activity with no connection to what came before or what will come after. Thus, when you write your lesson plans, you will need to think about the lesson as part of a conceptual-lesson sequence in that subject area, designed to teach a single concept or skill to your students.

In this assignment, you will identify the unit components and expand on the components of one single-concept sequence. Next, you will select one lesson from the single-concept lesson sequence. You will identify the components of the lesson for the Standard Lesson Plan template. You will describe the rationale for the instructional techniques used in the lesson or you may suggest modifications and provide your rationale for the changes.

This is not a creative writing exercise. You will become familiar with the textbooks and deciphering the units, single-concepts, and lesson components. In addition, you need to identify and use, somewhere in the single-concept lesson sequence, a piece of grade-level appropriate literature, fiction or non-fiction, that is related to the concept being taught.

You will use the Unit Plan template for the unit outline that includes the single-concept lesson sequence for mathematics and science. You will use the Standard Lesson Plan template for lesson plans for mathematics, science, and physical education. Two sections of the Standard Lesson Plan template do not need to be completed: Sample Student Products and Author’s Comments & Reflections. One section of the Unit Plan template does not need to be completed: Days and Topics Schedule.

Guidelines:
- You will complete an outline of a unit sequence for mathematics and science based on the topics and standards provided in a textbook of your choice. Use the Unit Plan template in TaskStream.
- List the title of your resources (textbook, trade book, and/or websites) in Resources and Unit Handouts section of the template, include the full reference information of your resources:
  - State-adopted textbook:
    - Title (year). Grade Level. Volume. City, State: Publisher.
  - Trade book (fiction or nonfiction):
    - Author. (year). Title. City, State: Publisher
  - Website:
    - Website name. (year, if available). Article or lesson title. Retrieved from [url]
  - Title of handout and/or worksheet
Write the objectives for the unit in the Objectives section. Learning goals/objectives (sometimes called outcomes) must be written in measurable terms (what will the students be able to do after the unit). The outcomes are created based on the adopted State standards and will inform your assessment plan.

- For a 3- to 4-chapter unit, you may have 2-5 learning outcomes that you will measure and assess at the end of the lesson sequence.
- For a single lesson, you may have 1-3 learning objectives that you will measure and assess during the lesson (formative) or at the end of the lesson (summative).

The title of each chapter in the unit sequence should be written in the Learning Activities section of the [Unit Plan template]

You will select one chapter or single-concept lesson sequence for mathematics and science and list the titles of each lesson in that chapter.

- A short overview of each lesson in the conceptual-lesson sequence should be written in the Learning Activities section of the [Unit Plan template]:
  - Lesson 1: Title: The purpose of this lesson is.... (completed for each lesson in the chapter)

In the Summary section, include a brief overview of the unit that includes your identification of the importance of the unit and the subtopics. If you modified the unit (changed the order, deleted a section, or added a section), describe why you made the change.

You will complete a single lesson plan for mathematics and science based on the lessons in your single-concept lesson sequence. You will complete a single lesson plan for physical education based on a standard that is an activity and not simply describing a rule. Use the [Standard Lesson Plan template] in TaskStream.

List your resources in the Materials and Resources section; include the full reference information of your resources.

- State-adopted textbook:
- Trade book (fiction or nonfiction):
  - Author. (date). Title. City, State: Publisher
- Website:
  - Website name. (year, if available). Article or lesson title. Retrieved from [url]

Learning outcomes must be written in measurable terms (what will the students be able to do after the lesson). The outcomes are created based on the State adopted standards and will inform your assessment plan.

In the Accommodations/Modifications section of each Standard Lesson Plan template, describe any changes you would make for universal access and indicate the rationale for the adaptations and/or modifications you made to the lesson.

In the Teaching Strategies section of each Standard Lesson Plan template, include brief rationales for the instructional strategies used in the lesson.

In the Assessment Plan section of each Standard Lesson Plan template, include a brief rationale for the described assessment(s).
Learning Activities Assignment

The purpose of this assignment is to give you the opportunity to manage time and materials while implementing a learning activity. Materials distribution, giving directions, managing learner behavior, and managing time are essential elements of teaching. The activity is a portion of a full lesson plan, but must be managed to effectively use instructional time. Remember, the learning objective is the goal of the full lesson and the activity should guide the learner toward the learning objective.

Guidelines:

Select a mathematics activity from the Burns text, a science activity from the Bass text, and a physical education activity from Teachers.net. Evaluate and modify each activity for the following:

- The mathematics activity is collaborative
- The science activity is a portion of an inquiry-based activity
- The physical education activity is in pairs, small groups, or teams.

Provide at least one extension or modification to each activity. It is important for you to know how to extend student learning or to modify an activity to meet the learning objective(s) or to differentiate to make the activity accessible to all learners. Provide the rationale for your extension or modification.

The written paper will be in an outline format. The outline will include the following elements:

- Activity title
- Subject or content area
- Grade level(s)
- Time allotment and identify what section of the Lesson Procedure the activity occurs (Anticipatory Set, Guided Practice, or Independent Practice)
- Learning objective(s) this activity supports
- Materials and resources: Include how you will manage or distribute the materials
- Description of activity sequence
- Extension, adaptation, or modification: Include your rationale

Select one activity to implement with our class. Each person will have about 30 minutes, which includes setting up, briefly describing the context, implementing the activity, and cleaning up. The schedule will be tight, and there will be an overlap of someone setting up while someone else is cleaning up. We will need to take breaks during this time and eat snacks and lunches in the classroom to accommodate the presentations.