For Jon and Olivia
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The purpose of this study was to discover how novice teachers’ formative assessment knowledge and practice developed in a practice-embedded course evolved as they transitioned from preservice to novice teacher. A secondary aim was to identify the impact of the course, school settings, and individual characteristics on the evolution of their knowledge and practice. A multi-case study was conducted with four novice teachers who previously participated in a practice-embedded formative assessment for mathematics instruction course. Observations and interviews were conducted to describe current formative assessment knowledge and practice and identify supports and constraints for the evolution of that knowledge and practice. Activity theory was a lens for describing participants’ appropriation of formative assessment knowledge and practice. A Formative Assessment Levels of Appropriation Framework was developed and used as a coding structure to describe the changes in participants’ formative assessment knowledge and practices. Inductive analysis was used to identify the ways in which the course, current setting, and individual characteristics supported and constrained their development.
Results of the study found all participants experienced growth in the formative assessment knowledge and practices during the course, but not all continued this growth as novice teachers. All participants attributed their development, in part, to the practice-embedded design of the course. Participants appropriated some aspects of formative assessment better than others, reflecting strengths and weaknesses in the course design. Supporting contextual factors in the participants’ current teaching settings included administrative support, curriculum, technology resources, professional freedom, and school accountability initiatives. Constraining factors included time, classroom management, student characteristics, and limited support structures. Individual characteristics included knowledge and beliefs for teaching mathematics and professional growth. These findings imply that similar online, practice-embedded course models may be able to support novice teacher use of formative assessment, but there is a continued need for support from schools in the form of professional development, planning time, and instructional resources when preservice teachers transition to comparable school environments.
CHAPTER 1
INTRODUCTION

Teachers entering the field today are facing increasingly diverse classrooms. Recent emphasis on mainstreaming exceptional students, reducing gifted programming, and detracking has resulted in a greater range of academic backgrounds in the regular classroom (Banks et al., 2005; Tomlinson et al., 2003). At the same time, emphasis on high-stakes testing and international competition continues to place high demands on teachers to raise student achievement. In order to ensure high learning standards for all students who bring a diversity of interests and experiences to the classroom, teachers must be provided with the appropriate knowledge and skills to help students achieve.

Formative assessment has been identified as one way that teachers can gather critical information about a student’s level of understanding in order to make informed instructional adaptations that meet the needs of all students (Moon, 2005; NCTM, 2000; Shepard et al., 2005). Over several decades, research has shown the potential of formative assessment to effectively improve student achievement (Black & Wiliam, 1998; Crooks, 1988; Kingston & Nash, 2011; Natriello, 1987). In many studies, providing teachers with support and meaningful learning opportunities regarding the implementation of formative assessment were critical components (e.g., Gotwals, Philhower, Cisterna, & Bennet, 2015; Phelan, Choi, Vendlinski, Baker, & Herman, 2011; Wilson, 2008). Despite its potential, issues in preparing teachers to implement formative assessment practices has kept its potential from being realized (Kohler, Henning, & Usama-Wilches, 2008; Schoenfeld, 2015) and many teachers have limited understanding of its use (Shepard et al., 2005).
While providing professional development for in-service teachers is one avenue for increasing formative assessment knowledge and practices in our classrooms, producing substantial change in experienced teachers can be a difficult challenge (Guskey, 2002; Remillard & Bryans, 2004). Shepard et al. (2005) suggests that novice teachers may be better positioned to incorporate new ideas into their teaching, including formative assessment practices. Providing preservice teachers with learning experiences that develop formative assessment knowledge and practices may be an ideal way to prepare novice teachers to successfully integrate formative assessment into their teaching practices, yet limited research exists on how this might be accomplished in a way that truly impacts teacher practice.

Therefore, this dissertation aims to further understand how formative assessment knowledge and practice developed in a practice-embedded teacher preparation course evolved as they transitioned from preservice to novice teachers. This study also aimed to explore the role of learning experiences in the course, contextual factors of their current classroom settings, and individual characteristics on the evolution of their formative assessment knowledge and practices. To address these primary aims, a multi-case study was conducted with four novice teachers who previously participated in a practice-embedded course focused on formative assessment during their teacher preparation program. Each participant was interviewed and observed to understand how their formative assessment knowledge and practices evolved after several years of teaching full-time. Analysis of observation and interview data also aimed to identify how the formative assessment course, individual characteristics, and participants’ current
classroom settings impacted participants’ continued development of formative assessment knowledge and practice.

Activity theory (Grossman, Smagorinsky, & Valencia, 1999) has been identified as a useful framework for understanding teacher development and the appropriation of the conceptual and practical tools of teaching within varied teaching contexts. Using activity theory as a lens can help understand the development of conceptual (knowledge) and practical (practices) tools for formative assessment while accounting for potential mediating factors, such as course materials, assignments, peers, students, teachers, administrators, and school cultures. Activity theory also recognizes that developing knowledge and practices for teaching occurs over time and in stages, or levels of appropriation. In order to describe the evolution of participants’ formative assessment knowledge and practices for this study, the Formative Assessment Levels of Appropriation Framework was developed and used to describe the varied stages through which participants progressed when learning to implement the five aspects of formative assessment (Wiliam & Thompson, 2007). Findings from this study will serve to inform a need for research on the translation of assessment knowledge and skills gained in preservice teacher preparation courses to future practice (DeLuca, Chavez, Bellara, & Cao, 2013; Kohler et al., 2008; Sabel, Forbes, & Zangori, 2015). It also provides a new framework for describing how teachers learn to implement formative assessment in mathematics as well as identifies salient contextual factors that support or impede novice teachers in continuing their use of formative assessment.

Working Definitions

Since many terms in educational research are not defined universally, several terms critical to this study are presented below.
1. Formative assessment – Formative assessments are formal (e.g., tests and quizzes) and informal (e.g., questioning and discourse) classroom-based assessments for which the primary purpose is to promote student learning. The process of formative assessment includes developing and administering assessments, collecting student data, interpreting student responses, and adapting instruction based on evidence of learning. Effectively implementing formative assessments is a collaborative process where the teacher and student work together to improve learning. Formative assessment and assessment for learning will be used interchangeably.

2. Diverse learners – Diverse learners includes students who differ in terms of culture, ethnicity, race, language, educational backgrounds, interests, and learning styles.

3. Novice teachers – Novice teachers refers to in-service teachers that recently graduated from a teaching preparation program and have been teaching for three years or less.

4. Practice-embedded course – A practice-embedded course is used to describe a teacher education course that aligns with field experiences in a way that preservice teachers are given multiple opportunities to enact knowledge from coursework in the classroom and reflect on its application in the classroom and to future practice.

5. Conceptual tools – Conceptual tools refer to the principles and ideas teachers use to inform pedagogical decisions in the classroom (e.g., theory of self-regulation).

6. Practical tools – Practical tools refer to the strategies or practices that can be applied directly in the classroom (e.g., self-assessment rubrics).

**Formative Assessment in the Classroom**

Formative assessment, or assessment for learning, is commonly understood as the process of determining where students are, where they are going, and how they will get there (Gotwals et al., 2015; Hattie & Timperley, 2007; Ramaprasad, 1983; Sadler, 1989). Defining characteristics of formative assessment include assessment that: 1) provides information about the learning process and product used to adapt instruction, 2) aids student improvement with meaningful feedback, 3) meets learning goals shared between student and teacher, 4) involves students through self- and peer-assessment,
and 5) actively engages student in the learning process (Harlen & Winter, 2004; Stiggins & Chappuis, 2005). Both the teacher and student play important roles in the formative assessment process—the teacher clarifies learning goals, provides feedback, and develops instructional activities that elicit student thinking, while the student assesses their own progress towards learning goals and support one-another’s progress (Wiliam, 2007).

Not only is formative assessment an important way for teachers to elicit student understanding, but it can contribute to teacher’s pedagogical content knowledge (Falk, 2012; Wilson, 2008). Formative assessment provides valuable and timely information for teachers making instructional decisions that meet the needs of all learners (Moon, 2005). Effective use of formative assessment that provides evidence of student thinking can add to teachers’ knowledge of common understandings and misconceptions and inform strategies that teachers use in future instruction, as well as features of the content that students should attend to in order to avoid similar misconceptions. At the same time, a reciprocal relationship exists where pedagogical content knowledge can also inform the way formative assessment is used in the classroom (Falk, 2012).

Because of the detailed information formative assessment can provide to the student and teacher, it is not surprising that formative assessment has been identified as one of the most effective interventions in improving students’ achievement (Banks et al., 2005; Black & Wiliam, 1998; Wiliam, 2007). Varied implementations of formative assessment have shown significant student gains in academic achievement, including: formal assessments (e.g., Frey & Fisher, 2009; Phelan et al., 2011), questioning (e.g., Franke et al., 2009; Ruiz-Primo & Furtak, 2006), feedback (e.g., Bruno & Santos, 2010;
Choi, Nam, & Lee, 2001; Harks, Rakoczy, Hattie, Besser, & Klieme, 2014; Hattie & Timperley, 2007), and self-assessment (e.g., Brown & Hirschfield, 2007; Ross, Hogaboam-Gray, & Rolheiser, 2002). In mathematics, various forms of formative assessments have also been shown to be beneficial in uncovering students’ mathematical thinking and contributing to teachers’ pedagogical content knowledge (e.g., Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Franke et al., 2009; Weiland, Hudson, & Amador, 2014).

**Challenges in Teacher Use of Formative Assessment**

Despite empirical evidence of the power formative assessment holds in improving both teaching and learning, many teachers have limited understanding of formative assessment and its use to shape teaching and learning (Shepard et al., 2005) and its use is limited by daily demands placed on teachers (Volante, Drake, & Beckett, 2010). Ohlsen (2007) conducted a survey with 262 NCTM members teaching in secondary schools on their use of classroom assessment and found that a majority of teachers used assessments, often taking the form of tests and quizzes, in summative ways rather than formative. This confirms early reports by Henke, Chen and Goldman (1999) that 80% of mathematics teachers use traditional tests to gather evidence of student knowledge without using that evidence to improve teaching and learning. The emphasis on summative use of assessments over formative use of assessments (Kilpatrick, Swafford, & Findell, 2001), despite the known efficacy of formative assessment practices, minimizes opportunities to enhance teaching and learning and more collaborative efforts to engage educators in adopting assessments for learning are needed (Volante et al., 2010).
Numerous studies discovered that teachers found it challenging to effectively alter their instruction even when they were successful in using formative assessments to elicit student thinking (e.g., Morris, Hiebert, & Spitzer, 2009). Others have found that “even when teachers have access to reform-based curriculum materials and professional development aimed at enhancing teacher knowledge, teachers still struggle to question students productively” (Weiland et al., 2014, p.333). Black and Wiliam (1998) described the need for teachers to experience how formative assessment can be used in the classroom and identify strategies that fit well into their instruction practices. Providing teachers with the knowledge and support to implement practices is critical, but simply presenting formative assessment as another strategy can inhibit teacher adoption (Buck & Trauth-Nare, 2009).

Preparing Teachers to Implement Formative Assessment

If formative assessment can provide teachers with the knowledge and skills to elicit student understanding and adapt instruction to meet varied needs in today’s diverse classrooms, then determining effective ways to incorporate such knowledge into teacher preparation programs is critical. Assessment to improve learning is often underrepresented in teacher preparation courses (Siegel & Wissehr, 2011; Stiggins, 1999; 2002) resulting in preservice teachers demonstrating limited knowledge about assessment and skills to implement formative assessment and adjust future instruction effectively (Maclellan, 2004; Volante & Fazio, 2007). While research on how to best prepare preservice teachers to implement formative assessment effectively and the knowledge and skills required for successful implementation is limited (Vingsle, 2014), researchers have claimed that formative assessment can and should be taught in teacher preparation programs (Buck, Trauth-Nare, & Kaftan, 2010) and skills for eliciting
student thinking can be developed as preservice teachers interact with students in the classroom (Darling-Hammond, 2010). Weiland et al. (2014) found that preparing preservice teachers to conduct interviews with students enabled them to understand students' thinking, adapt future instruction, and develop better questioning skills. Similarly, Wallace and White (2014) found providing learning opportunities for preservice teachers during coursework could develop their knowledge of assessment and its role in uncovering student thinking and adapting future instruction. While the findings in these initial studies provide some evidence of the impact of teacher preparation courses, there still remains a significant knowledge gap regarding the preparation of preservice teachers to implement formative assessment practices.

Practice-embedded courses may provide appropriate learning opportunities for preservice teachers to build their understanding of formative assessment, implement formative assessment practices, and increase the likelihood of those practices continuing into their first years of teaching. Such courses are aligned with field-experiences in order to provide preservice teachers with opportunities to make explicit connections between theory and practice through the enactment of coursework knowledge in the classroom setting. There often exists a gap between theory and practice in teacher preparation programs when students are unable to enact what is being learned in their coursework during their field-experiences (Darling-Hammond, 2010; Zeichner, 2010). Not all experiences are educative (Dewey, 1916) and many experts in teacher education argue that field experiences are not just opportunities to demonstrate previous knowledge but provide critical learning experiences for preservice teachers (Ball & Cohen, 1999; Hammerness, Darling-Hammond, & Bransford, 2005;
Such opportunities can provide preservice teachers with an understanding of what teaching concepts, like formative assessment, look like in a classroom and the level of impact on student learning.

Even when teachers demonstrate substantial growth in their knowledge and practices regarding formative assessment, these gains are not guaranteed to be sustained as preservice teachers transition to their own classroom. Particularly in mathematics education, there is a noted disconnect between the practices emphasized in teacher preparation programs (e.g., eliciting, interpreting, and responding to mathematical thinking) and the traditional, teacher-centered practices used in many classrooms (Gainsburg, 2012; Jacobs et al., 2006). Liston, Whitcomb, & Borko (2006) identify teacher preparation programs’ emphasis on theory over practice, the emotional stress of first year teaching, and limited school support structures as potential reasons for this disconnect. The challenge to overcome these obstacles and design teacher preparation courses that prepare novice teachers to be successful is persistent, yet few research studies have followed preservice teachers into their novice teaching years to determine how and why knowledge and practices gained in their teacher preparation programs are implemented (Clift & Brady, 2005; Gainsburg, 2012).

In order to understand the potential of teacher preparation courses to impact future practice, there remains a need to understand how practices, like formative assessment, developed during teacher preparation programs translate to the teaching contexts of novice teachers (DeLuca et al. 2013; Kohler et al., 2008; Sabel et al., 2015). In this dissertation, the connections between the knowledge and practices developed during a teacher preparation course on formative assessment for mathematics and
participants’ current use of formative assessment practices in their current classroom will be explored. Individual and contextual supports and constraints related to the development of formative assessment knowledge and practices in their current classroom settings will also be identified and discussed.

**Purpose of the Study**

The purpose of this study is two-fold. The first purpose is to understand how the formative assessment knowledge and practices of novice teachers that participated in a practice-embedded formative assessment course evolved as they became novice teachers in the field. A second purpose is to further understand the role the formative assessment course, individual characteristics, and current classroom settings played in the development of their formative assessment knowledge and practices. For this study, the development of formative assessment knowledge and practices in their current classroom settings will be understood through the lens of activity theory.

**Theoretical Framework**

**Activity theory.** Activity theory “describes the process through which knowledge is constructed as a result of personal, and subjective, experience of an activity” (Crawford, 1996, p.135). With foundations in sociocultural theory (Leont’ev, 1981; Luria, 1973; Vygostky, 1978), activity theory claims that learning emerges from activity and that activity cannot be understood without taking into account the context in which activity occurs (Jonassen & Rohrer-Murphy, 1999). When seeking to understand the construction of knowledge through the lens of activity theory, the primary unit of analysis is the activity itself (Grossman et al., 1999; Jonassen & Rohrer-Murphy, 1999) and the components of that activity comprise what Engestrom (1987) defined as an activity system. The activity system highlights how the production of activity involves several
intertwining factors including the subject (actors engaging in the activity), the object (desired product of the activity), tools (physical and mental tools used in transformation process), and actions (processes used to accomplish the object) that all interact to impact the knowledge gained within the activity setting (Engestrom, 1987; Jonassen & Rohrer-Murphy, 1999; Nardi, 1996).

Activity theory has been recognized as a powerful way of conceptualizing the process of learning to teach (Grossman et al., 1999) and how the settings in which learning occurs impacts teacher development. Three activity theory concepts of particular importance to the preparation of teachers include activity settings, tools, and appropriation. Activity settings describe the social contexts where learning takes place. In teacher preparation, these activity settings can include field experiences, observations, coursework, or the larger teacher preparation program. These activity settings often overlap and can have competing goals and differing cultural and historical backgrounds. When engaging in the process of learning to teach, preservice teachers encounter both conceptual and pedagogical tools that enable them to develop and enact teaching practices. Conceptual tools are the ideas and principles that guide preservice teachers decisions about instruction, planning, and assessment. Practical tools, on the other hand, are the classroom strategies, practices, and resources can be immediately implemented in the classroom (Grossman et al., 1999).

Finally, appropriation is the process by which preservice teachers develop conceptual and pedagogical tools in their teaching practices. Grossman et al. (1999) summarize the appropriation of teaching tools as five distinct levels: lack of appropriation, appropriating a label, appropriating surface features, appropriating
conceptual underpinnings, and achieving mastery (Figure 1-1). The first level, lack of appropriation, describes when a teacher is unable to understand the concept behind a particular teaching practice and they are unable to implement them in practice. Appropriating a label describes a scenario where a teacher may know the name of a tool but is unable to effectively describe how or why that tool might be used in the classroom. A teacher who is appropriating surface features may learn some of the elements to implementing the tool in practice but their conceptual understanding remains underdeveloped. When appropriating conceptual underpinnings, the teacher has a more robust understanding of concepts behind a teaching practice but limited experience putting that concept into practice. Finally, approaching mastery, often only reached after at least several years in the field, describes the stage at which the teacher's conceptual understanding is well-developed and their classroom practices frequently reflect that deep level of understanding (Grossman et al., 1999).

In this dissertation study, the activity in focus is teachers learning to implement formative assessment while teaching mathematics. The activity occurs in several settings: a formative assessment course, internship classrooms, and the current classrooms of novice teachers that previously participated in the course. During the course, participants engaged in learning experiences aimed to help them develop both conceptual (formative assessment knowledge) and practical (formative assessment practices) tools. In particular, the course was designed to support preservice teachers in developing the conceptual and practical tools needed to implement the five aspects of formative assessment defined by Wiliam and Thompson (2007) and summarized in Table 1-1 with the corresponding abbreviations used throughout the study. Participants
developed through varied levels of appropriation for each aspect of formative assessment during the course but all experienced growth in at least one aspect. The level to which appropriated conceptual and practical tools of formative assessment during the course was mediated by multiple factors, including teaching beliefs, personal experiences in mathematics classrooms, mentor teachers, and school culture.

The developmental nature of activity theory (Wertsch, 1985) also “makes it a powerful framework for studying teachers’ professional development, particularly in longitudinal studies that follow teachers as they progress through different social contexts” (Grossman et al., 1999, p.24). This dissertation study aimed to go beyond simply understanding preservice teacher development of conceptual and practical tools during the formative assessment course to how teaching full-time in a new classroom setting continued to shape the formative assessment knowledge and practices several years after completing the course. Again, contextual factors within the novice teachers’ classroom environments (e.g., students, curriculum, administrators) contributed to teachers’ use, or lack of use, of formative assessment knowledge and practices developed within the course.

**Research Questions**

The following research questions will help to frame this study:

- How do novice teachers’ formative assessment knowledge and practices appropriated during a practice-embedded teacher preparation course evolve after their first years of teaching?

- In what ways do prior learning experiences in the formative assessment course, current teaching settings, and individual characteristics influence the development of formative assessment knowledge and practices?
Significance of the Study

Findings from this study will serve to inform a significant gap in the literature on how assessment knowledge and practices gained in teacher preparation courses are sustained when preservice teachers transition to full-time classroom teachers (DeLuca, et al., 2013; Kohler et al., 2008; Sabel et al., 2015). If learning experiences in the formative assessment course translate to continued enactment of formative assessment in novice teachers’ classrooms, then this particular practice-embedded, online course design may show promise as an avenue for preservice teacher development of formative assessment practices for teaching mathematics if applied in similar university contexts. In addition, critical individual and contextual factors novice teachers encountered when developing and enacting formative assessment practices will provide insight into the affordances and constraints that require consideration in developing similar online courses that aim to prepare teachers to use formative assessment while interning in classrooms that mirror those included in this study. The supports and constraints within current school settings can also serve to inform how universities and schools might work together to support novice teachers with similar individual and school characteristics as those in the study to implement formative assessment practices taught in teacher preparation programs.

Dissertation Overview

This dissertation will include a total of nine chapters. In chapter one, an overview of the study was presented including an introduction to the problem, the theoretical framework, and the significance of the study. Chapter two provides thorough review of relevant literature that will serve to justify and ground the study. In chapter three, the design and methods used in the study will be presented. Chapters four through seven
will present results from each case included in this study, including: an in-depth description of the participants' settings, a comparison of the formative assessment knowledge and practices of the participant from the time of the course to the present, and a description of the supports and constraints that emerged from the participant’s data. Chapter eight will present the results from a cross-case analysis that identified themes across all four participants. In chapter nine, a discussion of the significance of these results, their connections to the results of other relevant studies, and limitations and future directions of the research will be presented.
Figure 1-1. Levels of appropriating tools for teaching.

Table 1-1. Five aspects of formative assessment.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Aspect of Formative Assessment</th>
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<tbody>
<tr>
<td>FA1</td>
<td>Clarifying learning intentions and criteria for success</td>
</tr>
<tr>
<td>FA2</td>
<td>Engineering effective classroom discussions and other learning tasks that elicit evidence of student learning</td>
</tr>
<tr>
<td>FA3</td>
<td>Providing feedback that moves learners forward</td>
</tr>
<tr>
<td>FA4</td>
<td>Activating students as instructional resources for one another</td>
</tr>
<tr>
<td>FA5</td>
<td>Activating students as the owners of their own learning</td>
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</table>
CHAPTER 2
REVIEW OF THE LITERATURE

Because of the need for assessment literacy in today’s high stakes environment and the call for integrating assessment and learning, multiple research studies have aimed to demonstrate the effect of formative assessment in improving student achievement (Black & Wiliam, 1998; Crooks, 1988; Kingston & Nash, 2011; Natriello, 1987). Due to the overwhelming evidence in favor of formative assessment, others have investigated how teachers and preservice teachers understand and learn about formative assessment (e.g., Buck, Trauth-Nare, & Kaftan, 2010; Gotwals et al., 2015; Graham, 2005; Wiliam, Lee, Harrison, & Black, 2004) in order to improve the persistent challenges in teacher implementation (DeLuca et al., 2010; Popham, 2004; Stiggins, 2002; Volante & Fazio, 2007). In this chapter, relevant literature on formative assessment and its role in teaching, learning, and the preparation of novice teachers will be presented. Because of the lack of studies on how teacher preparation courses impact novice teacher practice, the literature in this chapter will largely focus on the assessment knowledge and practices of preservice teachers with some discussion of how assessment is understood and used by practicing teachers.

Research Parameters

Multiple databases were utilized in the search of literature pertaining to formative assessment. Peer-reviewed journal articles, both empirical and conceptual in nature, were identified using the following databases: Academic Search Premier, JSTOR, EBSCO, ERIC, and Education Full-Text. Literature searches were generally restricted to the past 25 years, due to several critical meta-analyses and literature reviews being conducted on formative assessment (Black & Wiliam, 1998; Crooks, 1988; Fuchs &
Fuchs, 1986; Natriello, 1987) prior to 1998 that helped to establish both a modern, cohesive definition of formative assessment and the theories that support it. These primary sources of literature helped to organize and direct this field of research and are frequently cited throughout current studies on formative assessment in education. For this literature review, primary search terms included: formative assessment, assessment for learning, assessment, classroom assessment, achievement, performance, mathematics, teacher education, teacher preparation, preservice, teacher candidates, inservice teachers, novice teachers, and teacher practice.

**Understanding Formative Assessment**

In an age of accountability, assessment has become an important part of educational culture. As Clarke (1992) notes, “it is through our assessment that we communicate…which activities and learning outcomes we value” (p.1). Assessment is often viewed as serving one of three purposes in education: 1) to support learning, 2) to verify academic achievement or student potential, and 3) evaluating programs or institutions (Wiliam, 2007). These purposes are generally referred to using the terms formative assessment, summative assessment, and evaluative assessment, respectively. For many years, educators and researchers have focused on the use of summative methods of assessment (Schulman, 1996; Wiliam, 2007). These assessments are frequently used to identify a student’s level of existing knowledge and attainment of learning objectives instead of how assessment and learning intertwine to improve and build upon mathematical understanding (Glaser & Silver, 1994; Kilpatrick et al., 2001; Wiliam, 2007).

However, recent reform efforts and changing views about what it means to learn mathematics have challenged educators to implement assessment in ways that
supports student learning—commonly known as assessment for learning, or formative assessment. The *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) introduced different conceptions of assessment in mathematics education as the field began to shift from stressing the learning of skills and procedures to problem solving, reasoning, communication, and interdisciplinary applications (Schulman, 1996). Instead of using assessment to measure skills and procedures at the conclusion of learning units, assessment was to be integrated in instruction in order to enhance student learning and inform instructional decisions—two defining features of what we now term formative assessment (NCTM, 1995; 2000). Today, the importance of formative assessment continues to be stressed in mathematics education with *Principles to Action* (NCTM, 2014) stating “effective mathematics teaching elicits evidence of students’ current mathematical understanding and uses it as the basis for making instructional decisions” (p.53). With its growing significance in the field, it is important to understand the defining features and theoretical foundations of formative assessment—both of which will be outlined in this section.

**Defining Formative Assessment**

Scriven (1967) first made the distinction between formative assessment from summative assessment in terms of its role in educational evaluations, but Bloom (1969) was the first to suggest its use in informing classroom instruction. After years of different definitions and lack of consensus on the meaning of formative assessment, Black and Wiliam (1998) established a more cohesive definition through the analysis of 250 studies examining the use of what we now term formative assessment. For the purpose of this dissertation, the following definition will be used to frame this study:
Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. (Black & Wiliam, 2009, p.9)

In this approach to assessment, “good teaching is seamless—assessment and instruction are often one and the same” (Lambdin & Forseth, 1996, p.298). Formative assessment provides critical information about student understanding that can enhance the adaptations teachers make in their classrooms. Defining characteristics of formative assessment include: 1) provides information about the learning process and product used to adapt instruction, 2) aids student improvement with meaningful feedback, 3) meets learning goals shared between student and teacher, 4) involves students through self- and peer- assessment, and 5) actively engages students in the learning process (Harlen & Winter, 2004; Stiggins & Chappuis, 2005). More simply, using assessments formatively can be understood as the process of determining where students are, where they are going, and how they will get there (Gotwals et al., 2015; Hattie & Timperley, 2007; Ramaprasad, 1983; Sadler, 1989).

Formative assessments in the classroom can take many forms. Formal assessments are not necessarily equivalent with summative measures, but can be used appropriately to inform instruction. Examples of formal measures can include quizzes, tests, benchmarks, student interviews, or pre-assessments that are prepared in advance to gather data on student learning and provide valuable feedback (Baldwin & Yun, 2012). Formative assessment can also be approached in informal ways to seek student understanding, sometimes requiring on-the-fly decisions during a lesson (Bell & Cowie, 2001; Heritage, 2007). Informal approaches often include classroom
discussions and questions that probe for student understanding and provide opportunity for building on current levels of understanding (Ginsburg, 2009; McIntosh, 1997). Whether formal or informal, differences between approaches to formative assessment are also highlighted by the length of time between collecting evidence of student learning and making adaptations in response. Formal assessments like tests, quizzes, and benchmarks may require longer cycles for instructional adaptations ranging from a few weeks to a year. Other formative assessments like exit tickets, questioning, discussion, or journaling require shorter cycles of adaptation ranging from in-the-moment decisions to adapting next-day lessons (Wiliam, 2007). Regardless of the differences, the defining feature that makes an assessment formative is the use in enhancing student learning and making instructional adaptations.

Establishing a Theoretical Framework for Formative Assessment

In the early stages of developing a theory of formative assessment, Black and Wiliam (1998) relied largely on empirical research findings related to formative assessment. Since then, significant strides have been made in developing a theoretical framework for understanding formative practices. Five practices have been recognized as central to studies on formative assessment: 1) sharing criteria for success with students, 2) questioning, 3) feedback, 4) self-assessment and peer-assessment, and 5) using summative assessments in formative ways (Black, Harrison, Lee, Marshall, & Wiliam, 2003; Wiliam, 2000; 2007). To make theoretical connections among these practices, Ramaprasad’s (1983) three processes in learning and teaching (establishing where learners are, where they are going, and how to get them there) were used to develop the theoretical framework for formative assessment (Black & Wiliam, 2009; Wiliam, 2007, Wiliam & Thompson, 2007). In this framework, formative assessment is
not just a teacher-directed process but involves the learners as active agents in the learning process. At the same time, five key aspects are identified as critical to using of assessment in formative ways: 1) clarifying criteria for success and sharing learning intentions with students, 2) developing learning tasks and classroom discussions that elicit student understanding, 3) sharing feedback that moves learning forward, 4) activating students as resources for each others learning, and 5) activating student ownership of the learning process (Black & Wiliam, 2009; Wiliam 2007; Wiliam & Thompson, 2007).

Each of these key strategies is grounded in the literature. Clarifying criteria has been identified as important for success in mathematics as students are often unaware of or hold varied conceptions of the direction of their learning (Bernstein, 1975) and knowing what to attend to has been recognize as an element of expertise supporting greater achievement (Berliner, 1994; Glaser & Silver, 1994). Developing learning tasks and discussions that elicit student understanding has been established primarily in mathematics education research on mathematical communication (e.g., Cobb, Yackel, & Wood, 1992; Edwards & Westgate, 1994; Lampert, Rittenhouse, & Crumbaugh, 1998; Pirie & Schwarzenberger, 1988; Redfield & Rousseau, 1981). Using feedback to move learning forward connects to work on the impact of varied levels of feedback on student learning (e.g., Butler & Winne, 1995; Elawar & Corno, 1985; Nyquist, 2003) while activating students in each others learning is founded in work on reciprocal teaching (e.g., Brown & Campione, 1996) and collaborative learning (e.g., Cohen, 1994; Slavin, Hurley, & Chamberlain, 2003). Finally, activating students in their own learning relies on research in motivation (e.g., Ryan & Deci, 2000), metacognition (e.g., Hacker,
Dunlosky, & Graesser, 1998), attribution (e.g., Dweck, 2000), and self-assessment (e.g., Andrade & Valtcheva, 2009).

Formative Assessment in the Classroom

Since recent strides in establishing a common understanding of formative assessment, research on its effectiveness in the classroom continues to grow. Numerous studies have demonstrated the significant impact formative assessment can have on student performance. To achieve these positive outcomes in student learning, teachers enacting formative assessment in the classroom as intended requires significant work on the part of the teacher. During instruction, teachers must elicit student understanding, interpret that information, and appropriately adapt instruction. These processes require both teacher knowledge and skills that often need support to develop appropriately. In this section, relevant literature on the interaction between formative assessment, teachers, and students in the classroom will be presented.

Formative Assessment and Student Performance

Since the conception of formative assessment, empirical studies have rapidly grown suggesting the significant role it might play in improving student performance. Adding to early summaries of literature on classroom assessment by Natriello (1987) and Crooks (1988), Black and Wiliam (1998) wrote one of the most cited seminal works in the field of formative assessment. In their meta-analysis, studies were selected based on several criteria: 1) published after 1988, 2) focused on K-12 or college classrooms, and 3) relevance to defining features of formative assessment. In their analysis of over 250 relevant studies, they found that effective implementation of formative assessment improved student achievement between 0.4 and 0.7 standard deviations (Black & Wiliam, 1998; Wiliam, 2007). Or, as Banks et al. (2005) suggests
“formative assessment, effectively implemented, can do as much or more to improve student achievement than any of the most powerful instructional interventions, intensive reading instruction, one-on-one tutoring, and the like” (p.277).

While Black and Wiliam’s (1998) review has been foundational to the field and cited frequently, it has not been without critique. Dunn and Mulvenon (2009) cite multiple issues with conclusions drawn from their meta-analysis. First, several of the studies included were working with particular populations, like students with disabilities, and the results may not generalize to a larger population of students. Second, some articles were also of poor quality with several methodological issues that challenge the validity of the large effect sizes cited. Finally, issues with limited numbers of teachers involved in studies and accounting for other teacher variables, like experience or instructional design, may skew the conclusions made. Because of these issues, Dunn and Mulvenon (2009) suggest the continued need for studies on formative assessment and its impact on student achievement.

Recognizing issues in previous studies and the need for more research, Kingston and Nash (2011) also conducted a recent meta-analysis on formative assessment research. In their work, they aimed to determine the average effect size of formative assessment on educational outcomes and determine if the average effect size was moderated by content, grade-level, or specific formative assessment practices. Thirteen studies with 42 effect sizes were identified using the following criteria: 1) definition consistent with formative assessment or assessment for learning, 2) participants were from a K-12 setting, 3) control or comparison group design, 4) appropriate statistics for calculating effect size, and 5) published after 1988. A median
effect size of 0.25 was found with a weighted mean effect size of 0.20. Analyses also concluded that content area had the largest impact on effect sizes, with main effect sizes of 0.17 for mathematics, 0.32 for English language arts, and 0.09 for science. Another significant finding was that the effectiveness varied across treatment type with studies that incorporated professional development for teachers among the highest average effect size at 0.30. Particular formative assessment strategies, such as feedback, conversations, and curriculum-embedded assessments, showed potential but variations between study approaches resulted in large variations in effect size.

While reporting effect sizes has been used as in indicator of the impact of formative assessment, numerous other approaches to determining the relationships between formative assessment and student performance have been used. Many of the studies examining the impact of formative assessment on student achievement fall into three particular practices in connection to improved student performance: eliciting student thinking, providing timely, quality feedback, and incorporating student self-assessment that promotes self-regulation. Different approaches to eliciting have shown to improve student performance including formal measures (Frey & Fisher, 2009; Phelan et al., 2011), classroom tasks (Herman, Osmundson, Ayala, Schneider, & Timms, 2006), questioning (Franke et al., 2009; Ruiz-Primo & Furtak, 2006). Providing students with meaningful feedback that provides details on how to push knowledge forward has also been shown to improve student performance (Bruno & Santos, 2010; Choi, Nam, & Lee, 2001; Day & Cordon, 1993; Harks et al., 2014) and can lead to opportunities for students to assess and improve their own learning and the learning of their peers (Brown & Hirschfeld, 2007; Ross et al., 2002).
Formative Assessment and Teacher Knowledge

When implemented effectively, formative assessment provides current and continuous information to teachers about students' conceptions so that they might provide appropriate instruction that scaffolds student understanding (Moon, 2005). However, implementing formative assessment effectively requires several aspects of teacher knowledge. Areas of knowledge critical for formative assessment include assessment knowledge, content knowledge, and pedagogical content knowledge (Heritage, 2007). Knowledge of assessment is essential, as teachers must first know how to design or select assessment activities that will elicit the student thinking they require. In order to best develop instructional responses to knowledge elicited during formative assessment, an understanding is needed beyond what can be found in standards and curriculum materials.

However, content knowledge and assessment knowledge are not enough—a statement reinforced by the common reference to pedagogical content knowledge in formative assessment literature. Teacher knowledge of students’ understanding was identified by Shulman (1986) as a major component of pedagogical content knowledge, which is an important element of teacher knowledge for effective instruction. Instead of focusing on the how and why behind mathematical procedures and concepts, pedagogical content knowledge requires teachers to understand approaches that most effectively support students in gaining conceptual understanding of ideas critical in their field. Teachers demonstrating pedagogical content knowledge have a large repertoire of ways to represent concepts to students, as well as awareness of common student misconceptions (Shulman, 1986).
Formative assessment and pedagogical content knowledge have a reciprocal relationship (Falk, 2012). Effective use of formative assessment that provides evidence of student learning and thinking can add to teachers’ knowledge of common understandings and misconceptions. That knowledge can inform the strategies that teachers use in future instruction and the features of the content that students should attend to in order to avoid misconceptions demonstrated in classroom assessment opportunities. At the same time, pedagogical content knowledge can also inform the way formative assessment is used in the classroom. If a teacher knows what features of the content are important for students to know, they can better develop formative assessments that will help elicit student responses that demonstrate their understanding of the content.

Falk (2012) found evidence of this reciprocal relationship in his own work in science education. In a professional development for elementary science teachers, teachers met to look at student work and discuss content-specific ways to respond to student thinking in planning future instruction. Video of professional development sessions, work samples, and other teacher materials were analyzed to examine teachers’ construction and use of pedagogical content knowledge as a result of engaging with formative assessment. First, teacher use of pedagogical content knowledge in formative assessment practices was evident in teachers’ use of prior knowledge of the curriculum, instructional strategies, and previous student work when interpreting student work resulting from formative assessments. At the same time, teachers built knowledge for student understanding by interpreting responses to formative assessments, built knowledge of the curriculum when attending to learning
and assessment goals, and built knowledge of assessment when revising assessments after analyzing previous student responses.

Several studies looking to improve pedagogical content knowledge through variations of formative assessment have been conducted in recent years. Wilson (2008) conducted a professional development teacher study group aimed at improving use of formative assessment and developing teachers’ pedagogical content knowledge. Five middle school teachers volunteered to participate in the group where they read professional literature on assessment for learning and discussed their personal reflections on readings and teaching experiences. Structured interviews, field notes, and classroom observations aimed to uncover teachers’ knowledge and expressions of pedagogical content knowledge throughout a 15-week period. As a result of participation in professional development on formative assessment, teachers shifted in their views of assessment as grade-based to a process of informing instruction decisions. Teachers also demonstrated more integration of dimensions of knowledge related to pedagogical content knowledge resulting from discussions and reading on assessment for learning.

The relationship between pedagogical content knowledge and formative assessment was further examined in a study by Gotwals et al. (2015). In the study, researchers examined the instructional practices of 13 math and science teachers who were in a professional development program aimed to improve teachers’ formative assessment practices. Video was used to capture these instructional practices and was coded for specific formative assessment practices that were later turned in to weighted averages. Analysis revealed few teachers were considered to use formative
assessment at a level of expertise, but those who did included more student ideas into their teaching. These practices included high-level questioning, student self-assessment, constructive feedback and teachers with greater expertise appeared to integrate them in their daily practice. Research by Wylie and Lyon (2015) also found that integration of formative assessment strategies was not equal for all teachers. A professional development program recruited 202 teachers from high-needs school districts to participate in two workshop series, as well as monthly teacher learning community meetings. The professional development opportunities focused on developing knowledge of formative assessment and providing opportunities to implement new strategies and reflect on their progress. Assessment practice surveys, daily logs of teacher practices, and reflections on implementation of practices were analyzed. At the conclusion of the PD program, teachers were collecting more evidence of student knowledge, where questioning and learning tasks were most frequently used to gather this data. However, more than half of the teachers did not continue to make use of evidence in making adaption to instruction.

**Challenges in Teacher Change**

Despite empirical evidence of the power formative assessment holds in improving both teaching and learning, its use is limited by daily demands placed on teachers. Ohlsen (2007) conducted a survey with 262 NCTM members teaching in secondary schools on their use of classroom assessment and found that a majority of teachers used assessments, often taking the form of tests and quizzes, in summative ways rather than formative. This confirms early reports by Henke et al. (1999) that 80% of mathematics teachers use traditional tests to gather evidence of student knowledge without using that evidence to improve teaching and learning. The emphasis on
summative use of assessments over formative use of assessments (Kilpatrick et al., 2001), despite the known efficacy of formative assessment practices, minimizes opportunities to enhance teaching and learning and more collaborative efforts to engage educators in adopting assessments for learning are needed (Volante et al., 2010). This emphasis is likely due, in part, to the increased use of external assessments to determine student progress in core areas, like mathematics, and to evaluate the effectiveness of teachers and school districts and to make international comparisons. In many cases, the tendency to focus on summative high-stakes test results and course grades have contributed to the slow implementation of effective formative assessment (Harlen & Winter, 2004). In addition, teaching materials frequently lack the assessments teachers and students can use to make thinking visible and determine appropriate instructional decisions (Herman et al., 2006). Not only do they rely on summative measures due to emphasis on testing and lack of curricular resources, the majority of schools and teachers do not have appropriate professional knowledge to engage in more beneficial assessment practices (Heritage & Yeagly, 2005; Shepard, 2001; Stiggins, 2002)

Numerous studies discovered that teachers were often unable to effectively alter their instruction even when they were successful in using formative assessments to elicit student thinking (e.g., Morris et al., 2009; Wylie & Lyon, 2015). Other research (Franke et al., 2009; Sahin & Kulm, 2008;) has found that “even when teachers have access to reform-based curriculum materials and professional development aimed at enhancing teacher knowledge, teachers still struggle to question students productively”
(Weiland, et al., 2014, p.333). According to Black and Wiliam (1998), this is due to the fact that,

Teachers will not take up attractive sounding ideas, albeit based on extensive research, if these are presented as general principles which leave entirely to them the task of translating them into everyday practice— their classroom lives are too busy and too fragile for this to be possible for all but an outstanding few. What the need is a variety of living examples of implementation, by teachers with whom they can identify and from whom they can both derive conviction and confidence that they can do better, and see concrete examples of what doing better means in practice. (p.15-16)

If professional development can prepare teachers to assess current levels of understanding but not how to act on that knowledge, more research is needed on how to translate the knowledge gained about student learning into instructional adaptations that will improve learning. Yet, changing the practices of experienced teachers can be a significant hurdle and some have suggested that novice teachers may be better positioned to develop formative assessment knowledge and integrate that knowledge into practice (Shepard et al., 2005).

**Preparing Novice Teachers to Implement Formative Assessment**

The majority of teachers enter the teaching field with summative approaches to assessment rooted in their own “apprenticeship of observation” (Ball, 1990; Cowan, 2009; DeLuca, et al., 2013; Lortie, 1975; Volante & Fazio, 2007). Teacher preparation courses can and should provide opportunities for educators to deepen conceptual understanding and encounter “living examples” of more modern, formative conceptions of assessment (DeLuca, et al., 2013; Maclellan, 2004; Volante & Fazio, 2007). Such critical learning opportunities could support future enactment of high leverage practices, like formative assessment, as novice teachers. Particularly for future mathematics teachers, engaging in courses on formative assessment can contribute to deeper
understanding of how students think about mathematics and adapting instruction to more effectively target students’ misconceptions. In this section, literature recognizing the need for preservice teachers to better understand and implement assessment practices (e.g., Graham, 2005; Popham, 2004; Shepard, 2001; Volante & Ben Jaafar, 2008) will be explored as well as courses and programs that have made strides towards meeting that need (e.g., Buck et al., 2010; Otero, 2006; Wallace & White, 2014). Finally, the challenges novice teachers face in enacting knowledge and practices gained in teacher preparation courses during their first years of teaching (Gainsburg, 2012; Liston et al., 2006) and calls from voices in the field for more research on this difficult transition will be presented.

**The Need for Assessment Literacy in Teacher Preparation**

With increased focus on standards and accountability, teachers are now expected to be knowledgeable on the use of assessment (Popham, 2004). In fact, many educators acknowledge that assessment is a critical component of educational systems that impacts teaching and learning (Shepard, 2001; Volante, & Ben Jaafar, 2008). Because of the prominent role assessment plays in schools, greater attention to the assessment literacy of teachers and preservice teachers has developed. Popham (2011) defines assessment literacy as “an individual’s understandings of the fundamental assessment concepts and procedures deemed likely to influence educational decisions” (p. 267).

Teachers with such knowledge are better prepared to connect assessments to instruction that reflect best practices (McMillan, 2000). This knowledge of assessment does not require teachers to have extensive knowledge of technical measurement procedures, but rather understand primary concepts of assessment tied to instructional
decisions made in the classroom. Not only do teachers need to be assessment literate, but there are two primary reasons for preparing preservice teachers with assessment literacy: 1) preservice teachers need to understand the assessment measures that will be used to evaluate their performance and explain why such measures are appropriate or inappropriate to parents and policymakers; and 2) assessments have been shown to improve instruction and student learning but preservice teachers need the knowledge and skills to implement assessment effectively in the classroom (Popham, 2011).

Unfortunately, research continues to find preservice teachers often use ineffective assessment practices during field experiences that do not align with identified best practices for assessment (Bachor & Baer, 2001; Campbell & Evans, 2000; Galluzzo, 2005; Graham, 2005; Mertler, 2004). Even when preservice teachers can identify levels of understanding, many are still unable to effectively adapt instruction based on the assessment data collected (Otero, 2006). Volante and Fazio (2007) administered a survey to 69 preservice teachers at the conclusion of their four years in a teacher preparation program to obtain insight on their levels of assessment literacy. Open and closed questions were used to determine how preservice teachers described their own level of assessment literacy, the purposes of assessment, the assessment methods they used, and their need for continued professional development. The researchers found that preservice teachers identified themselves at low levels of assessment literacy throughout the program and the majority used traditional assessment practices for primarily summative purposes. However, the results did reveal that greater training on assessment led to decreased need for further training,
suggesting that receiving training may provide preservice teachers with the self-efficacy to implement those assessment strategies more frequently.

Despite the recognized need for assessment literacy, few teacher preparation programs require assessment education courses for preservice teachers (Stiggins, 2002). Because of the demands placed on teacher preparation programs, many preservice teachers will graduate without comprehensive knowledge of assessment theory and practice (Popham, 2004). DeLuca et al. (2010) suggest that efforts to integrate assessment literacy in teacher preparation programs might focus on “providing foundational understandings in assessment [to] promote these teachers’ desires for future professional development” (p.138).

**Formative Assessment in Teacher Preparation**

While studies on the broader concepts of assessment and assessment literacy have been conducted with preservice teachers, there continue to be limited studies on preparing preservice teachers to implement formative assessment. This is likely due to the lack of assessment training in teacher preparation programs, but several researchers have begun to investigate the potential impact of implementing formative assessment practices in teacher preparation courses. Wallace and White (2014) looked at the growth of preservice teachers developing knowledge and incorporation of formative assessment. Six elementary preservice teachers participated in the study and were selected from three reform-minded teacher education programs. While students were not enrolled in a specific assessment course, but multiple discussions, class meetings, and class assignments were centered on the incorporation of assessment in the classroom. Interviews were conducted at the beginning, middle, and end of practicum as well as two classroom observations at the beginning and end. Lesson
plans, reflections, papers, and statewide teacher performance assessment scores were collected for additional data on knowledge and use of assessment practices. Findings uncovered three distinct stages of preservice teachers’ change in regards to assessment: 1) an initial test-oriented stage reflected focus on assessment as graded tests, 2) a secondary task-oriented stage where preservice teachers began to see tasks as assessments and distinguished between formal and informal assessments, and 3) a final tool-oriented stage where students were able to distinguish between assessment for grading and assessments that support teaching and learning, or formative assessment. This progression shows the potential of teacher preparation programs as opportunities for preservice teachers to expand their knowledge of assessment and better understand its role in uncovering student thinking and adapting future instruction.

In science education, Buck et al. (2010) studied their own restructuring of a methods course to include more explicit and implicit approaches to formative assessment and the impact on preservice teachers understanding of formative assessment. Thirty preservice teachers enrolled in the methods course participated in the study and two of the researchers were the instructors for the course. The instructors decided to develop formative assessment as a core component of the course by providing four days of explicit instruction on assessment as well implicitly teaching formative assessment through the activities and practices the instructors demonstrated throughout the course. Preservice teachers were also asked to conduct a case study during an after-school science program where they developed instructional plans and were required to implement formative assessment into all plans within the unit. Pre- and post- questionnaires, field notes, focus group interviews, planning meeting
transcripts, and course documents were analyzed against four levels of understanding of formative assessment developed by the researchers to determine preservice teacher growth. Preservice teachers revealed a limited understanding of formative assessment before the course with general confusion about the distinction from other forms of classroom assessment and minimal acknowledgement of the connections between assessment, teaching, and learning. By the end of the course, the majority recognized connections between formative assessment, classroom planning, and conceptual development as well as the importance of engaging student in the process.

Unfortunately, preservice teachers still demonstrated a focus on monitoring content mastery over student construction of knowledge and instructional adaptations were viewed as behavior control instead of opportunities to promote understanding. Use of formative assessment remained primarily teacher-centered and preservice teachers often relied on reteaching over adapting instruction appropriately to student needs. In terms of the pedagogical approaches used, the researchers found that explicit instruction had some impact on preservice teachers knowledge of formative assessment, but implicit approaches had little impact as many preservice teachers were unaware when the instructors were using formative assessment during the course. Case study field experiences provided important opportunities to implement and reflect on formative assessment and preservice teachers did demonstrate growth from these experiences, even if not to the extent hoped by the researchers.

Like Buck et al. (2010), several others have noted that while preservice teachers show growth in their understanding and use of formative assessment, they still encounter challenges. Otero (2006) found that preservice teachers could develop
several different understandings of formative assessment and prior knowledge when learning about formative assessment in teacher preparation courses. When teaching a methods course with 61 preservice teachers, she found that many preservice teachers used a “get it or don’t conception” throughout the semester. From this view, preservice teachers believed formative assessment to be the process of determining if students had correct understandings of an academic concept, often measured by vocabulary use or having been taught a concept previously, and used that knowledge to determine if a lesson was appropriate or not. This approach to formative assessment often ignored what students did know, especially if that prior knowledge was described informally without correct terminology. Another common approach for preservice teachers was to focus on students’ experienced-based knowledge with little regard to learning objectives. Preservice teachers could accurately describe the experiences that students did have and create instruction that supported further learning, but those instructional adaptations would not align with their teaching objectives. Some preservice teachers even demonstrated a mixed view where they gathered information about students’ experiential knowledge but made no adaptations to their teaching and instructional objectives. While preservice teachers were developing understanding of formative assessment, Otero concludes that it is critical that teacher preparation not only provides the knowledge but help students to view their knowledge as evolving. This view of teacher as learner can help preservice teachers to reflect on their knowledge and practices when they enter educational contexts that may not align with what they learn in teacher preparation programs.
Gotwals and Birmingham, (2016) found comparable “get it or don’t” conceptions in their own preservice teachers. In their study, they looked at the formative assessment practices of seven secondary science preservice teachers over the course of a year. Course assignments, including lesson plans, teaching videos and teaching reflections, were analyzed qualitatively using recursive coding. Specifically, the researchers were looking for how preservice teachers elicited student understanding, identified and interpreted student ideas, and responded to those ideas. Over the course of the year, a major theme in the data was a shift in classroom practices from teacher-centered to student-centered. Preservice teachers provided more opportunities for students to share ideas through questioning and classroom discussions and were more likely to move around the room in order to elicit ideas from individuals or groups of students. However, similar to Otero (2006), the preservice teachers in this study primarily demonstrated a “get it or don’t” response to student ideas and did not display growth in conceptualizing students' ideas beyond correct or incorrect. Prior knowledge was understood as only previous classroom experiences despite course discussions about knowledge students may bring from outside the classroom. Despite growth in eliciting and identifying students' ideas, preservice teachers failed to recognize the complexity of those ideas and build on student ideas beyond identifying if responses were correct or incorrect.

Contextual factors have been identified as potential sources for varied or limited outcomes of preservice teachers using formative assessment. Graham (2005) tracked the growth of preservice teacher knowledge of classroom-based assessment and assessment-driven planning. Over two years, 38 preservice teachers participated in a
university teacher education assessment initiative. Preservice teachers and their mentor teachers had no previous experience with assessment for learning and were asked to develop assessments to gather student data, reflect on the data and assessments, and develop instructional units in response to measures of student progress. Specifically, researchers were looking to better understand preservice teachers’ assessment beliefs and practices, changes in those beliefs and practices, success in aligning planning and assessments, and continued concerns about assessment for learning. Preservice teachers were asked to provide written responses to five questions that addressed these five areas of interest and responses were coded by the lead researcher to develop themes.

Initially, preservice teachers had little understanding of the meaning of assessment, establishing learning goals, and how to assess student progress—largely drawing from their own experiences with assessment as students. After completing the semester, preservice teachers felt better informed about the definition and purpose of assessment, the use of formative assessments in aligning instruction to identified student needs, and the importance of daily, informal approaches to assessment. The sources of influence on these changes came from many different sources, including mentor teachers, readings, class discussions, professors, and peers. While preservice teachers felt better prepared to implement assessments, the kinds of assessment were greatly impacted by contextual factors such as the mentor’s ideas of assessment, student prior experiences with assessment, and community and school culture.

In mathematics education, research on formative assessment with preservice teachers has looked more narrowly at pieces of the formative assessment process—
mainly, eliciting and interpreting student understanding of mathematics or instructional responses. A common approach to focusing on student thinking in mathematics methods courses is through the use of interviews. In one elementary teacher education program, preservice teachers learned to conduct interviews with students to gain understanding of student thinking about math and science (Weiland et al., 2014). Insights gained by preservice teachers during those interviews were then used to inform whole-group instruction in the following week. Researchers conducted a case study with two of the preservice teachers over a semester to determine how their questioning changed over time. Analysis revealed that both teachers were able to effectively develop their questioning skills over time despite both preservice teachers having very different learning trajectories. However, missed opportunities to ask follow-up questions and the use of leading questions suggest there is still more to be understood about this challenging learning process for student teachers.

Sleep and Boerst (2012) studied how a course assignment to conduct a student thinking interview could support preservice teachers in their understanding of the use of formative assessment in mathematics instruction. Preservice teachers conducted one audio-recorded interview with a student where they asked the student to complete a mathematics task and pre-planned questions to probe student thinking. After the interview, preservice teachers were asked to review the recording and any collected work to identify at least two “assertions” about student understanding that were supported with collected evidence. Course instructors aimed to support preservice teacher learning by providing scaffolds, including providing a task pool, detailed feedback, and sample probing questions. Qualitative analysis of each kind of scaffold
revealed that the supports provided did enhance students’ learning about the use of formative assessment. At the same time, the researchers recognized that contextual factors, such as time for providing feedback and differential nature of tasks, can impede the productivity of such an assignment and must be considered in the design of similar practice-based assignments.

Others have looked at how preservice teachers make instructional decisions based on evidence of students’ mathematical thinking. For example, Cooper (2009) looked at how preservice teachers in a mathematics methods course analyzed student work to make conclusions about student levels of understanding, misconceptions, and develop instructional responses. Homework assignments were collected across three semesters, for a total of 86 student work assignments. Data was analyzed in three subsets: 1) identification of error patterns, 2) perceptions of misconceptions, and 3) recommended instructional strategies. Results of analysis using predetermined categories determined that all students were able to appropriately identify the error pattern and 80% of preservice teachers were able to provide an appropriate rationale for each error. However, students struggled to identify appropriate instructional moves with 67% focusing on reteaching with a focus on procedures and rules.

Potential of the Practice-Embedded Course

How to best prepare teachers to better understand formative assessment and feel prepared to implement it effectively in their classrooms continues to be an area for further development (Vingsle, 2014). Yet, the benefits of formative assessment have resulted in the recognition of the need for it within teacher preparation coursework (Buck et al., 2010), particularly as preservice teachers interact with students in the classroom (Darling-Hammond, 2010). Because teachers often face challenges in connecting
theory from their coursework to practice in the field (Darling-Hammond, 2010; Zeichner, 2010), the use of practice-embedded courses that integrate coursework with field experiences could aid preservice teachers in developing stronger connections between formative assessment theory and practice (Cowan, 2009). Educators have long argued that field experiences should not just be opportunities for demonstrating knowledge, but serve as critical learning experiences for preservice teachers (Ball & Cohen, 1999; Hammerness et al., 2005; Zeichner, 1996). While this kind of integrated course is not new, its potential in developing formative assessment knowledge and skills and the role it might play in novice teacher practice are equally understudied.

One study by Siegel and Wissehr (2011) examined preservice teachers’ understanding of assessment through the use of journals, teaching philosophies, and unit lesson designs as they engaged with students during student teaching. More specifically, the study aimed to understand how preservice teachers understood and planned to use both assessment tools and the purpose of those tools. Eleven preservice teachers in a required secondary science methods course participated in the study. The course was designed specifically around the principles of assessment for learning and preservice teachers were asked to develop assessments, implement them during a concurrent field experience, and identify instructional adaptations. First, percentages of participants mentioning assessment tools in each data source were reported, with questioning, tests, equitable assessment strategies, discussions, worksheets/homework, performance events, and journaling being the most prevalent (over 50% of students reporting their use). Inductive analysis for journal and teaching philosophies sources revealed that students learned about these tools not only through
the class, but also from their field experiences. Students expressed the beneficial nature of capturing student knowledge through several different modes, with a more positive outlook on formative measures such as questioning, journaling, and discussions. At the same time, students also began to express negative feelings towards the use of summative measures like tests and quizzes—feeling that they do not effectively demonstrate the breadth of student knowledge and caused challenges in student motivation. In terms of the purpose of those assessments used, students primarily identified checking for understanding, revealing student misconceptions, and gaining insight to students’ prior knowledge as reasons for assessment in the classroom. Participants talked about the importance of assessment in improving instruction and student learning.

While the course appeared to guide students towards a deeper understanding and use of assessment in the classroom, the instructional units that students planned reflected a very different approach to assessment in the classroom. The formative assessments aimed at improving student learning were used infrequently by preservice teachers as compared to what was claimed in their journals and teaching philosophies. In fact, traditional assessments like homework, worksheets, and written reports were the more frequently used during these units with students identifying assigning grades and classroom management as primary purposes of assessment. This study demonstrates the differences that continue to exist between what preservice teachers know and believe about assessment in theory and what they actually implement in a classroom context.
James and Pedder (2006) also found that providing authentic experience for preservice teachers with formative assessment was critical in promoting their learning to implement formative assessment while teaching. Students were prompted to identify and support specific pedagogical approaches from the course that they found effective in learning about assessment. Thematic analysis of the data found four primary themes: 1) classroom discussions, 2) connections between theory and practice, 3) modeling, and 4) reflection and planning for learning. Classroom discussions were meaningful due to the structured opportunities with peers for understanding multiple perspectives on assessment and subsequent reflections on their own learning through those conversations. During class, students were given multiple opportunities to apply their developing knowledge to teaching contexts and engage in class activities that required the use of assessment knowledge. At the same time, they appreciated that the instructor was also explicitly modeling both formative and summative assessment practices throughout the course. Finally, the incorporation of reflections into course assignments were identified by preservice teachers as beneficial to synthesizing their learning about assessment.

**Crossing the Border from Preservice to Novice Teacher**

Even if high-leverage practices, like formative assessment, can be developed within teacher preparation programs, does it ultimately impact teacher practice when entering the challenging field of education? With the many problems that face today’s schools, including teacher attrition rates and widening opportunity gaps, the need for highly-qualified teachers with the tools to implement effective teaching practices and do more than just “survive” their first years is greater than ever (Fantilli & McDougall, 2009). Liston et al., (2006) describe three primary barriers to knowledge and practices
gained in teacher preparation programs translating to the first years of teaching: coursework emphasis on theory over practice, emotional stressors related to novice teaching, and lack of school support structures. In addition, novice teachers often experience a disconnect between the university and school cultures—resulting in a struggle to find value in the concepts learned during their teacher preparation program when faced with the realities of teaching (Brown & Borko, 1992).

While research following preservice teachers through their first year of teaching is limited, one study by Gainsburg (2012) found similar contextual barriers for novice teachers implementing reformed mathematics teaching practices from their teacher preparation program. In order to determine the impact of the program on current practice, graduates within their first four years of teaching were interviewed and observed to understand their current practices, the role of teacher courses on their practices, and the supports and constraints in their teaching contexts. Although many students cited the program as significant to their use of practices emphasized in the program, students were less likely to implement practices that they did not have the opportunity to try in their coursework. In their current teaching contexts, a perceived lack of time to plan and implement practices was identified by most as a substantial barrier to implementation. On the other hand, those students who did report supportive administration and collaborative communities acknowledged that they played a role in encouraging their use of practices emphasized in their coursework. Aspects of formative assessment, such as high-level questioning to elicit student thinking, were included in their study but were not the primary focus. Nonetheless, the results confirmed the challenges of teaching context on novice teacher practice and the
importance of opportunities in teacher preparation programs to translate concepts into first-hand practice.

Conclusion

This literature review has presented a variety of studies suggesting the significant potential of formative assessment in helping teachers to effectively adapt their teaching practices to improve student learning and the need for preparing novice teachers to effectively implement formative assessment in the classroom. Yet, these studies are not without their limitations. First, many studies continue to gauge the impact of formative assessment and differentiated instruction in terms of external, high-stakes tests. These studies often lack critical details on how these practices were implemented in the classroom or fail to account for contextual variables that could also contribute to such increased test scores.

Second, because of continued challenges with multiple definitions of formative assessment, implementation is not standardized. This has resulted in mixed results in many studies on formative assessment, noted by Dunn & Mulvenon (2009) in a review of literature published after Black and William (1998). Again, consideration in providing better definition to how formative assessment is conceived and linking outcomes back to the critical features of implementation might improve conclusions drawn in future studies.

Third, studies on the use of formative assessment in mathematics have traditionally focused on subcomponents of the formative assessment process. While this research has been critical to the field, less is known about preparing preservice teachers with a more comprehensive understanding of the process of formative
assessment and its role in mathematics instruction. More studies on preparing teachers to implement multiple aspects of formative assessment are warranted.

Finally, there is a need for more knowledge on how teacher preparation programs can support teachers in developing and sustaining formative assessment practices. The research included in this review show great promise of teacher growth in using formative assessments to elicit student knowledge and make appropriate instructional decisions. However, this kind of pedagogical content knowledge is difficult to measure and there continues to be limited understanding of how teachers develop such teaching expertise and implement it effectively in the classroom (Gotwals et al., 2015). Continued exploration of the use of practice-embedded courses is needed to determine its effectiveness in connecting theory to practice for preservice teachers. In addition, studies did not follow teacher practices once entering the field to determine if teacher preparation courses led to sustained formative assessment practices. In the next chapter, a dissertation study aimed at addressing the final two limitations will be presented.
CHAPTER 3
METHODS

Overview

The purpose of this dissertation is to further understand how preservice teachers’ formative assessment knowledge and practices that were developed during a practice-embedded teacher preparation evolved as they transitioned from preservice teachers to novice teachers. In addition, this study analyzed the role that learning experiences in the course, individual factors, and current contextual factors influenced the continued development of their formative assessment knowledge and practices. To address these two aims, a multi-case study was conducted that addressed the following research questions:

- How do novice teachers’ formative assessment knowledge and practices appropriated during a practice-embedded teacher preparation course evolve after their first years of teaching?

- In what ways do prior learning experiences in the formative assessment course, current teaching settings, and individual characteristics influence the development of formative assessment knowledge and practices?

A qualitative case-study approach (Yin, 2013) was selected to deeply analyze the changes in formative assessment knowledge and practices developed in the formative assessment course as well as the supports and constraints in the development of that knowledge and practice related to the settings in which the participants enacted formative assessment practices. Activity theory (Leont’ev, 1981; Grossman et al., 1999; Wertsch, 1985) served as a lens for understanding how participants developed knowledge (conceptual tools) and practices (practical tools) for formative assessment while accounting for how different settings impact the development of those tools. In addition, the theoretical framework for formative assessment developed by Wiliam and
Thompson (2007) was used to establish a research-based understanding of the significant elements of formative assessment knowledge and practice. To address the research questions for the multi-case study, four novice teachers that previously completed the formative assessment course in the Spring 2014 and currently in their third year of full-time teaching were selected on a voluntary basis and represent four different cases in this multi-case study. Course assignment data, interviews, observations, and classroom artifacts were collected and analyzed to answer the previously defined research questions and will be further outlined in the following section.

**Methodology**

This dissertation study used a qualitative case-study methodology to understand the development of formative assessment knowledge and practices from preservice teacher to novice teacher and the role of individual and contextual variables in that development. Activity theory was used as a lens in the study, which has many consistencies with sociocultural foundations of case-study methodology (Stake, 1995; Yin, 2013). According to activity theory, knowledge is “constructed as a result of personal, and subjective, experience of an activity” (Crawford, 1996, p.135). With foundations in sociocultural theory (Leont’ev, 1981; Luria, 1973; Vygostky, 1978), activity theory claims that learning emerges from activity and that activity cannot be understood without taking into account the context in which activity occurs (Jonassen & Rohrer-Murphy, 1999). Activity theory has been used in educational research as a framework for understanding the complexities of learning to teach within varied settings including teacher preparation programs, individual courses, field experiences, and classroom contexts (Grossman et al., 1999).
Using activity theory as a lens for the study, the process of learning to implement formative assessment is understood as the primary unit of analysis. The practice-embedded formative assessment course (including online and internship contexts) and current classroom are the primary settings in which this activity occurs. Within the course, preservice teachers encountered both conceptual tools (formative assessment knowledge) and practical tools (formative assessment practices) and appropriated those tools at varied levels. Interactions with course material, mathematical concepts, mentor teachers, peers enrolled in the course, and students all contributed to the development of the understanding and use of formative assessment. As novice teachers in the field, contextual factors continued to shape the development of their formative assessment knowledge and practices—including prior experiences in the course, curriculum, colleagues, and school climate.

A multi-case study was conducted to 1) understand how formative assessment knowledge and practices developed in the formative assessment course evolved as teachers transitioned from preservice teachers to novice teachers, and 2) identify the ways in which the formative assessment course and current classroom settings supported and constrained the development of formative assessment knowledge and practices. Three primary reasons support the use of multi-case study methodology in this dissertation study. First, the research questions aimed to describe in detail the development of the participants’ conceptual and practical tools in a bounded context—during a teacher preparation course on the use of formative assessment in mathematics instruction and the third year of teaching following the course. Second, contextual factors, such as the assessment practices of mentor teachers or school-based support
structures, are assumed to be important contextual factors to understanding the
development of conceptual and practical tools during learning experiences. According
to Yin (2013), case study methodology is appropriate when conducting inquiries that
aim to describe “contemporary phenomenon within its real-life context, especially when
the boundaries between phenomenon and context are not clearly evident” (p.13).
Finally, the use of a multi-case was appropriate because of the inclusion of four
teachers with both distinct teaching contexts and developmental journeys during and
after the formative assessment course.

To address the research questions for this study, data analysis required both
deductive and inductive analysis approaches. Deductive coding using the levels of
appropriation developed for this study and outlined in the Formative Assessment Levels
of Appropriation Framework was conducted to describe how teachers’ development of
formative assessment knowledge and practices evolved between the course and their
current classroom. Once descriptions of development were created for each case, an
inductive approach was utilized to identify emerging themes related to the supports and
constraints related to each participant’s development. In the following sections, detailed
descriptions of participants, setting, data collection, and data analysis will be provided.

Identification of Participants

Participants in this study were selected on a voluntary basis after meeting
several inclusion criteria. First, participants completed the formative assessment course
during the Spring 2014 semester and expressed interest in using formative assessment
in their future classroom. The Spring 2014 semester was selected due to the large
number of participants (36 female, 2 male) as well as the high-quality assignments
submitted that provided the researcher with detailed insight into prior development of
formative assessment knowledge and practices while enrolled in the course. Expressed interest in using formative assessment was determined based on analysis of the final reflection assignment in the course, which required students to reflect on knowledge gained in the course and comment on if and how they envision using formative assessment in their future classrooms. Second, teachers were currently employed as a teacher and completed at least one full year of teaching. A minimum of one year of teaching was selected due to the challenging nature of first-year teaching demands that could potentially overshadow the novice teacher's focus on formative assessment (Fantilli & McDougall, 2009). All prior students that completed the formative assessment course in the Spring 2014 semester and met these criteria were invited to participate in the study. Contact information and employment status were identified through the university's student services office. A total of 29 prior course students were contacted via e-mail and a total of four teachers volunteered to participate in the study.

Description of Participants

Participants identified for the study were novice teachers that had previously completed a formative assessment course for mathematics instruction in the fifth-year of a masters teacher preparation program at a large southeastern university. Prior to participating in the formative assessment course, participants had obtained a Bachelor of Arts in Education and were required to complete a one-year Master of Education program to receive teacher certification in grades K-6 from the university. Before taking the formative assessment course, participants also completed two elementary mathematics content and pedagogy courses in the undergraduate degree program. As the participants were enrolled in the formative assessment course, they were also completing an internship at a local school that spanned the entire year of their masters
program. Descriptions of internship placement school variables can be found in Table 3-1. Since completing the course and at the time of the study, all participants were employed as full-time elementary teachers throughout the state. Table 3-2 summarizes the characteristics of the schools in which they are currently employed.

**Setting**

The formative assessment course at the focus of this study is part of a five-year teacher preparation program at a large southeastern university. Program coursework consists of two years of general education courses followed by two years of teacher preparation courses with a focus on core content, pedagogy, and inclusive classrooms. During the junior and senior year, students are assigned four practicum placements ranging from one-on-one tutoring to co-teaching. During the fifth year, students complete a one-year teaching internship as well as a series of eight-week master’s level courses that are to be completed while teaching in the classroom.

Prior to the formative assessment course, preservice teachers completed two undergraduate mathematics education courses where they developed background knowledge in elementary mathematics content and pedagogy. The first mathematics education course, *Mathematics Content and Methods for Teaching Mathematics in the Inclusive Elementary Classroom Part I*, occurred during the first semester of the junior year. Mathematics content included numbers and operations (whole numbers), algebra, and geometry and preservice teachers were introduced to student-centered teaching practices that help elementary students build conceptual understanding of these concepts. Assignments included readings, exams, abbreviated lesson plans, and a classroom demonstration. Preservice teachers were encouraged to plan activities that demonstrate the methods modeled in the first course. The second course,
Mathematics Content and Methods for Teaching Mathematics in the Inclusive Elementary Classroom Part 2, was taken in the first semester of preservice teachers’ senior year. Mathematics content covered in the second course included fractions, measurement, and statistics. The course continued to emphasize conceptual understanding and student-centered teaching practices throughout. Assignments for this course included readings, exams, student work analysis, classroom observations, and written lesson plans. During this semester, preservice teachers participated in a practicum one day a week in an ESOL classroom where they observed mathematics instruction and had opportunities to interact with students.

The formative assessment mathematics education course was taken during the second semester of the fifth-year internship and required that preservice teachers take an active role in the mathematics instruction in their classroom. The formative assessment course was taken online over a span of eight weeks with a goal to develop understanding of how formative assessment can provide critical insight to students’ understanding of mathematics and selecting appropriate instructional approaches that meet individual student needs. While taking place online, the formative assessment course was also designed to provide practical experience implementing formative assessment concepts as well as a professional learning community for preservice teachers to provide support and feedback throughout the learning process. Preservice teachers were placed in small groups online based on the grade level of their internship where they uploaded course assignments and engaged in discussion around those assignments. Each week of the course, class assignments and discussions focused on eight primary topics related to formative assessment with intentional ties to the five
aspects of formative assessment defined in the Wiliam & Thompson (2007) framework. In weeks one and two, preservice teachers learned about the importance of establishing learning criteria and sharing that criteria with students to involve them in the formative assessment process (FA1). Week 2 also focused on activating students in assessing their own learning and the learning of others (FA4, FA5). In week 3, interpreting formative assessment data discussed the use of discussions and tasks to elicit evidence of student understanding (FA2) and responding to formative assessment data included providing meaningful feedback that moves learners forward (FA3). While each aspect was introduced in the first three weeks of the course, they continued to be revisited throughout the remainder of the course in both readings and assignments. An overview of the topics covered in each of the eight weeks of the course is provided in Table 3-3.

Throughout the duration of the formative assessment course, students submitted assignments on the online course management page. Those assignments included weekly reading posts, classroom implementation posts (called “Try-Its”), and two formative assessment projects (see Appendix B for an overview of the course assignment schedule). Reading posts required preservice teachers to read conceptual literature on varied formative assessment topics, respond to a prompt asking them to evaluate and reflect critically on what they have read, and respond to classmates’ posts with detailed feedback. The classroom implementation posts required preservice teachers to implement formative assessments that correspond to that week’s reading assignment, post a reflection on their implementation experience, and respond to classmates’ posts with detailed feedback. Finally, both formative assessment projects
in the course required students to elicit student thinking, interpret the data collected, and develop instructional responses based on the data.

All the participants in this study were in their third year of teaching at four different elementary schools throughout the same state. All participants were continually employed since the completion of the course and their graduation from the teacher preparation program. Two of the participants remained in the same school where they completed their internship while the other two were hired into new schools. Detailed descriptions of their current, individual teaching settings will be presented alongside the results of this study.

**Data Collection**

Data collected to address the research questions for this study included archived course data for all four participants, classroom observations, pre- and post-observation interviews, and classroom artifacts (e.g., student work, lesson plans). All of the course assignment data were stored through the university’s online course management site, Moodle, during the Spring 2014 semester. The collection of interviews, observation, and classroom artifact data occurred during the Fall 2016 semester. All data sources and transcriptions were uploaded and stored in NVivo prior to the data analysis stage.

**Course data**

**Reading posts.** The first assignment of each week required that students complete conceptual readings on the use of formative assessment in mathematics instruction followed by posting their reflection on the reading assignment within their small groups. Because of the focus of readings on concepts of formative assessment, reading posts primarily reflected the development of conceptual tools. Readings also aligned with the five aspects in the Wiliam and Thompson (2007) framework. In week
two, readings covered the clarification of learning targets and sharing those learning targets with students (FA1) as well as involving students in assessment through self- and peer- assessment and providing feedback (FA3, FA4, & FA5). Weeks four through six include readings on integrating formative assessment practices in instruction, including the use of tasks and discussions within a lesson to elicit student thinking (FA2). The prompts used to guide reading posts are detailed in Appendix C. In addition to the prompt provided, preservice teachers’ posts were expected to include a description of new knowledge gained, presentation of new ideas, and discussion on how they have used or plan to use aspects of formative assessment in their teaching. Preservice teachers then responded to at least one peer’s post with substantial feedback that could include connections from the reading, similar personal experiences, responses to posted questions, or posing new questions or challenges for peers to consider.

**Implementation posts.** After reflecting on class readings, preservice teachers were asked to include formative assessment in their mathematics instruction each week based on new concepts presented in their reading. For example, after reading about the purpose of pre-assessments, preservice teachers were tasked with developing or identifying a pre-assessment related to a new mathematics concept being taught in class, administering the pre-assessment to their students, analyzing results and identifying adaptations that could be made in their lesson plans based on what they learned about their students’ mathematical understanding from the pre-assessment. Because of the emphasis on enacting concepts from their readings in the internship context, the implementation posts are designed to develop practical tools for formative
assessment. At the same time, enacting practical tools in their internship classroom resulted in many participants discussing the impacts of contextual factors (e.g., mentor teacher, students, school climate) on their development of practical tools.

Similarly to the reading prompts, each of the aspects of formative assessment (Wiliam & Thompson, 2007) were integrated in implementation posts. Weeks two and four engaged participants in activating students as owners of their own learning and as instructional resources for each other (FA4 and FA5). In weeks three through five, participants had to engineer tasks and questions that elicit student thinking (FA2). Finally, providing feedback and clarifying learning targets (FA1 and FA3) are integrated throughout weeks two through seven. Prompts for each of these weekly implementation posts are provided in Appendix C and a sample participant post can be found in Appendix D. Again, preservice teachers were required to provide substantial feedback for a peer as described for the reading posts.

**Projects.** Finally, preservice teachers were asked to complete two major projects in the course. The involving students in assessment project required the development of a pre-assessment (FA1 and FA2), involvement of students in evaluating their understanding of the math concept(s) (FA3 and FA5), and creation of an activity/assignment that students select based on a personal assessment of their learning progress (FA4 and FA5). The tiered lesson plan project required preservice teachers to detail a learning goal and levels of student understanding (FA1), use formative assessment to determine individuals' level of understanding (FA2), and develop a detailed tiered lesson plan that appropriately scaffolds all students towards the same learning goal based on the formative assessment data (FA3, FA4, and FA5).
Students posted all documents created for this assignment and a personal reflection on
the course site as well as provided high-quality responses to classmates’ submissions.
While the focus of both projects was to develop practical tools, participants also were
required to reflect on how using the aspects of formative assessment in practice during
these projects impacted their understanding of conceptual tools. Descriptions of the
projects that were provided participants in the course can be found in Appendix C and a
sample of each project submission is provided in Appendix F and G.

**Interviews**

Two semi-structured interviews were conducted with participants in their
classrooms during the fall of 2016. Each interview lasted approximately 60 minutes and
was audio-recorded in addition to the researcher taking notes. Semi-structured
interviews were selected to allow for flexibility in eliciting individual participant
perspectives and experiences while still collecting the necessary data to address the
second research question (Hatch, 2002; Turner, 2010). Interview protocols were
developed to guide both interviews (Kvale & Brinkmann, 2009) and can be found in
Appendix H and I. Each interview protocol included questions aimed at determining
teachers’ levels of formative assessment knowledge and practices and how the course
and classroom settings influenced the development of their knowledge and practices
and are noted in each protocol.

Interview protocols were pilot tested in two stages to refine the interview
questions. First, each protocol was reviewed by three previous instructors of the course
that were familiar with the dissertation study to determine alignment between the
dissertation research questions, interview protocol questions, and the objectives of the
formative assessment course. Two previous course participants were also involved in
the first stage to ensure the questions were understood as intended by individuals who had first-hand experience with course assignments. Once adaptations to the protocol were made based on preliminary feedback, each of the protocols was piloted with five classroom teachers who had completed the course and were similar to participants selected for the study (Turner, 2010). During this second stage of piloting, interviews were conducted as intended with the researcher taking notes and audio-recording each session. After completing pilot interviews, the researcher made note of questions that caused hesitation or misunderstandings, questions that resulted in divergent responses between individuals, and commonalities between individual responses. This process identified necessary clarifications, additions, and omissions for each protocol to ensure that interviews would best capture data to answer the second research question (Kvale & Brinkmann, 2009; Yin, 2013).

Interview questions included in the protocol probed participants about their current understanding of formative assessment, the ways that it is currently used in the classroom, and the impact of the course and the classroom setting on current use of formative assessment. In particular, multiple questions made explicit connections with the five aspects of formative assessment defined in the Wiliam & Thompson (2007) framework due to the objectives of the course and the classroom observations aligning closely with this framework. Questions included in the protocols were developed to specifically address the development and use of conceptual and practical tools as well as identify the influence of activity settings on the development and use of those tools. These connections to activity theory are noted in the protocols in Appendix H and I. Pre-observation interviews also questioned teachers about the upcoming observation
and the teacher’s planning process and expectations for the formative assessment built into the lesson. The formative assessment course was not included in the pre-observation questions in order to determine if participants would connect their current formative assessment knowledge and practices to the course without being prompted.

The post-observation interview focused on teachers’ selection and use of formative assessment during the lesson as well as instructional decisions that were or were not made based on the data they collected. The researcher also tailored open prompts to address specific events that occurred in the classroom and their connection to the participants’ development of conceptual and practical tools for formative assessment. Participants were then asked a series of questions designed to prompt reflection on the course and in what ways those learning experiences were or were not related to their formative assessment practices as a novice teacher. Excerpts from participants’ course assignments were selected by the researcher prior to the interview to prompt discussion about course experiences, reflections on knowledge and practices gained from those experiences, and to initiate comparisons and connections between the participant’s use of formative assessment in the course and the current classroom.

Observations

Because interviews relied heavily on teachers’ self report of formative assessment use, observations were conducted to develop a more complete understanding of formative assessment practices from the perspective of the participants (Hatch, 2002). Each participant was observed for one full mathematics instructional block at a time that they selected, lasting approximately 40-60 minutes. Each observation was videotaped to ensure all teacher practices were captured and lesson plans and any other documents relevant to lesson (e.g., PowerPoint, student
work, student feedback, handouts) were collected. All observational data were reviewed by the researcher prior to the post-observation interview and used to focus open-ended prompts in the protocol.

During the observation, field notes were recorded following the suggestions of Hatch (2002). Field notes included details about the context including a description of the research setting, classroom activities occurring during the lesson, and start and stop times for each activity. In addition, teacher and student participation in recorded activities, verbatim statements capturing classroom interactions, and activities characteristics of formative assessment were recorded. Immediately after each observation, field notes were converted to more detailed accounts (Hatch, 2002) and initial impressions and potential codes were identified and recorded as research memos in NVivo (Spradley, 1980).

After each observation, the researcher watched the video recording of the lesson and completed the AssessToday observation protocol (Oswalt, 2013) to collect additional evidence of participant use of formative assessment. The protocol (see Appendix J) includes five primary components (Learning Targets, Monitoring, Feedback, Self-Assessment, Peer-Assessment) with a total of 20 items measured on a five-point Likert scale where a score of 1 represented no evidence of the practice and a 5 represented pervasive use of the practice. The protocol was primarily used as a tool to identify and describe formative assessment practices in the classroom that may have been overlooked in the researchers’ field notes.

AssessToday was developed to align with the five aspects of formative assessment theoretical framework by Wiliam and Thompson (2007), which are key
concepts and practices taught in the formative assessment course. The instrument was developed by Oswalt (2013) due to the lack of instruments to measure teacher use of formative assessment beyond self-report. In order to validate the instrument, the definition of formative assessment established by Wiliam (2010) and five key aspects (Wiliam & Thompson, 2007) were operationalized through the development of observational items that would indicate use of each of those five aspects in the classroom. Validity was established by having experts in the education field review the items, demonstrating each item was grounded in the literature, and comparing items to relevant formative assessment items in commonly used general teaching observation protocols. The instrument was also field tested by the researcher and experts in the field using an observe-rate-compare-revise process for multiple classroom observations and video observations. Once the instrument was revised and finalized, three researchers were trained extensively on the use of the instrument and conducted a total of 47 classroom observations with sixteen elementary teachers during their mathematical instruction. An overall re-rater agreement of 81.9% (Cohen’s kappa = 0.75; Weighted kappa = 0.85) was established demonstrating reliability of scores across time with the same rater. Across raters, an inter-rater agreement of 60.7% (Cohen’s kappa = 0.48; Weighted kappa = 0.61) was established demonstrating a moderate level of agreement. Cronbach’s alpha was calculated at 0.87 when averaged across all sets of observations establishing a high level of internal consistency.

Classroom artifacts

Classroom artifacts were collected to add evidence of novice teachers’ use of formative assessment practices. Prior to the pre-observation interview, teachers were asked to provide three pieces of evidence that demonstrated their typical use of
formative assessment practices (e.g., lesson plans, examples of student feedback, samples of questions or tasks developed to elicit student thinking). Each piece of evidence was reviewed by the researcher and incorporated into the pre-observation protocol. Teachers were asked to describe how they believe the artifacts reflect their understanding of formative assessment as well as how they portray their use of formative assessment practices in the classroom. In addition, similar artifacts connected to the classroom observation were collected at the conclusion of the observation and reviewed by the researcher for inclusion in the post-observation interview.

Data Analysis

All data sources collected for this study were analyzed qualitatively using both deductive and inductive analysis to appropriately address the research questions. Deductive data analysis was used to answer the first research question due to participant development of formative assessment knowledge and practices being heavily influenced by the instructional design of the course. To address the second research question, an inductive analysis approach was used because of the unique teaching contexts of each case and resulting inability to predict the supports and constraints that would emerge from those particular contexts. For this reason, data analysis procedures for each research question will be presented separately. Prior to analysis, all course data was de-identified, randomly assigned a participant number, ordered chronologically, and uploaded into the qualitative research program, NVivo. Interview transcriptions, observation protocols, and field notes were assigned the same participant numbers and uploaded to NVivo.
Research question 1

Due to the strong alignment between the learning outcomes of the formative assessment course and the Wiliam and Thompson’s (2007) five aspects of formative assessment framework, it was determined that the participants’ development of formative assessment knowledge and practices would be understood through the same theoretical lens. A deductive approach to data analysis allowed the researcher to understand how teachers developed formative assessment through existing theory that strongly aligned with the course and aims of the study.

In the first phase of analysis, a framework describing the levels of appropriation (Grossman et al., 1998) for each aspect of formative assessment (Wiliam & Thompson, 2007) was developed in order to describe the evolution of participants’ knowledge and practices from preservice teacher to novice teacher. Since no framework existed in the literature, the researcher developed one using formative assessment course data as well as relevant literature on formative assessment and similar studies looking at levels of appropriation in educational settings. A typological analysis approach (Hatch, 2002) was used to develop what will be further referenced to as the Formative Assessment Levels of Appropriation Framework and outlined in Appendix K.

To create the levels of appropriation, the complete Spring 2014 course data for all 37 students enrolled was first chunked by individual assignment posts and coded by its reference to one of the five aspects. Next, data for each aspect was read through and examples of the five levels were coded based on Grossman et al. (1999) general definitions of each level of appropriation. Finally, all data in each levels were re-read and summarized as one to two sentence generalizations that can be found in the codebook in Appendix H. However, in some cases certain levels were not found in the
data and generalizations were developed based on formative assessment literature and compared to levels identified in similar studies. For example, level five is generally characteristic of experienced teachers and the limited teaching experience of the participants of the study often resulted in few examples in the data.

Once the framework was developed, it was used as the coding structure to identify teachers’ level of development both during the course and as novice teachers. The five aspects of formative assessment were considered the parent codes and the levels of appropriation the child codes. In order to better structure the application of these codes and establish reliability, the research selected particular units of analysis for each kind of data source. For the course data, the unit of analysis used was each online post corresponding to the course assignments. For the interviews, each question response was considered a unit of analysis. Finally, for the classroom observations each instructional activity that occurred throughout the lesson was used as the unit of analysis. Selecting larger units of analysis was selected to make the coding process with two coders simpler as well as increasing the reliability of coding (Campbell, Quincy, Osserman, & Pedersen, 2013).

Deductive analysis for the first research question occurred in several phases. In the first phase, data sources were grouped by participant and placed in chronological order prior to coding (course assignments, pre-observation interview, observation, and post-observation interview). The researcher supplied the second coder with the Formative Assessment Levels of Appropriation Framework and referenced research memos on the creation of these codes to provide examples of how they were developed. Both coders then read through Ashley’s course data together and coded
any of the parent codes found in the text. After discussing and reaching a consensus on the parent codes applied, both coders re-read to apply the child codes to meaningful units with the text. Again, coding was compared and discussed until any disagreements were resolved. In the second phase, each coder independently coded the rest of Ashley’s data in the established chronological order while completing memos and noting any potential codes they recognized in the coding process. When completed, coded data was compared and an inter-rater reliability was calculated by dividing the number of coding agreements for each unit divided by the total of agreements and disagreements (Miles & Huberman, 1984).

In the final phase, the primary researcher coded the remaining participant data on their own. Once all the data was coded, data for each participant was re-read individually and an extensive description of their practice related to each formative assessment practice was developed. For example, all of Ashley’s data coded as “FA1” was read in the chronological order (with data pulled from preservice vs novice teacher noted) and used to describe how Ashley’s understanding and use of learning targets for formative assessment developed in the course and changed as a novice teacher. In some cases, there were a few units of text coded under the same aspect that reflected different levels of appropriation. In this case, all data was for that aspect was reviewed holistically to make a final decision on which level of appropriation best described the participants’ knowledge and practice. This was then repeated until rich descriptions of formative assessment knowledge and practice were created for all four participants across all five aspects.
Research question 2

Inductive analysis (Hatch, 2002) was selected to answer the second research question. This was considered an appropriate fit due to the unique classroom environments of each participant and the lack of prior theory regarding salient contextual variables impacting the development of formative assessment knowledge and practices. Hatch (2002) describes the steps of inductive analysis as the process of identifying domains relevant to the research questions, coding data based on those domains, revising domains based on coded data, identifying relationships within and between domains, and using relationships to create broader themes to address the research questions. Domains are defined as categories of meaning that aim to address the research question and describe relationships with the data, such as cause and effect.

In the first phase, all pre- and post- interviews were read in their entirety and meaningful units were chunked and coded for their description of supports or constraints on participant use of formative assessment. Next, all data coded as supports were carefully read and potential domains were annotated. For example, a unit of text where Ashley describes how her administration trusts her to make decisions on how to teach math was given an initial domain of “administrative support for professional decision-making”. The same process was repeated for data initially coded as constraints. In the second phase, all initial domains were combined into a master list and any potential relationships were noted. An initial list of 75 support domains and 24 constraint domains were ordered hierarchically based on those relationships resulting in 7 first-level domains with 10-15 second-level domains in each. For example, “administrative support for professional decision-making” was now combined with
domains like “school expectation for teaching math” and “flexibility to make professional decisions” under the larger domain “support for professional decision-making”. This master list was then used to code all participant data sources and any domains without sufficient support from the data were removed and overlapping domains were combined. In the third phase, each participant’s coded data was reviewed individually to look for relationships between domains and develop larger themes to describe the most salient contextual factors supporting or constraining their individual development. For example, the frequency with which Ashley described supports provided by her administration and professional freedom to teach as she saw fit led the researcher to identify administrative support as a theme for Ashley in her use of formative assessment. In the final phase, coded data for all participants was reviewed to identify any common themes across more than one participant.

In addition to incorporating a secondary coder, which is described in the following section, hierarchy maps were created to establish the reliability of the coding processes. The hierarchy maps demonstrate the frequency with which each of the parent and child codes (domains) were applied in each participants’ data by creating rectangles of representative size. The hierarchy maps were created using NVivo, compared against the themes developed for all participants, and will be provided for each of the four cases.

**Methodological Rigor**

Methodological rigor was established in multiple ways during different stages of the research process, as suggested by Yin (2013). Measures of reliability and validity were confirmed through inter-rater reliability and agreement (Campbell et al., 2013) as well as several additional strategies often used in qualitative research: triangulation,
reporting potential researcher bias, member checking, and providing rich descriptions (Creswell, 2012).

**Inter-rater reliability and agreement**

In order to increase the level of reliability in the data analysis process, a second coder was involved in the application of the coding schemes. The secondary coder was a doctoral student in mathematics education who was familiar with formative assessment in mathematics and the formative assessment course offered at the university. Prior to coding, the secondary coder was provided a codebook that included rich descriptions of the meaning of each code. The primary researcher reviewed the codebook with the secondary coder to establish a base of understanding in how the codes were developed and applied. To establish inter-rater reliability, the secondary coder worked with the primary researcher on coding a sample of the data (Campbell et al., 2013) with a goal to reach a level of 80% inter-rater reliability (Miles & Huberman, 1984). For the first research question, this included applying the deductive analysis plan for all data sources for one participant. In the second research question, the inductive analysis was likely to result in different codes for each participant so a random sampling of meaningful units coded by the researcher were selected. In both cases, breadth of data sources coded by both well exceeded the 10% sampling suggested by Hodson (1999).

All disagreements were discussed at length and recorded in memos in order to maintain coding consistency moving forward. For example, the researcher and secondary coder disagreed several times on levels two and three of FA2 consistently across different units. Through discussion, they realized this discrepancy originated from a misunderstanding in using the abbreviated Formative Assessment Levels of
Appropriation Framework. Level 3 in the framework was intended to capture teachers interpreting/discussing student thinking elicited from a discussion/task whereas Level 2 teachers were not making any connections to student thinking, only talking generally about a task/discussion approach. These distinctions needed to be added to the framework and wording of teacher versus student-centered distinguished so that units were not coded simply on the discussion of student-centered approaches being present or not.

At the conclusion of the initial phase of coding, an 81% level of reliability was reached. Once the desired level of reliability was attained, the primary researcher continued to code the remaining data. While it is acknowledged that reliability remains a challenge with qualitative data due to the subjectivity in interpreting meaning within text (Miles & Huberman, 1984), the procedures used to develop a level of reliability in the coding process were important to increase confidence that the coding procedures would be consistent if more than one primary researcher were involved (Campbell et al., 2013).

**Triangulation**

Both reliability and validity were established through the use of multiple data sources for each study in order to triangulate the data (Creswell, 2012; Lincoln & Guba, 1985; Merriam, 1988; Patton, 1990). For each case, primary data sources included course assignments, interviews, observations, and classroom artifacts. Data analysis was conducted first for each case followed by analysis across cases to identify any convergence of findings. In addition to primary data sources, secondary data sources, including field notes, research memos, and an extensive codebook, were collected and referenced throughout the coding process.
Reporting potential researcher bias

Merriam (1988) suggests that making the role of the researcher clear and addressing any potential sources for bias are an important way of providing validation in a qualitative study. For this dissertation study, the researcher has experience both as an instructor of the course as well as prior experiences using formative assessment as a public school teacher. The researcher did not teach the formative assessment course during the semester from which the data for this study was collected. As a result of these experiences, the researcher has substantial belief in the importance of formative assessment and may naturally orient her focus on positive impacts of the formative assessment course being studied. These experiences and orientations were acknowledged and reviewed by the researcher prior to data analysis to further validate the findings. The use of a secondary coder also helped to illuminate any primary researcher bias and establish a greater degree of reliability throughout the data analysis process.

Member checking

According to Stake (1995), participants play a critical role in case study research and should be involved in the construction of interpretations and conclusions of the study. For this reason, member checks were conducted during the analysis of data in second case study to establish the trustworthiness of the researcher’s interpretations (Creswell, 2012; Lincoln & Guba, 1985; Merriam, 1988). Each participant were presented with initial findings and asked for feedback on the credibility of the findings in order to inform any changes.
Providing rich descriptions

When presenting the results of the case study, the detailed description of the context inherent to the methodology contributed to the audience determining transferability of the findings (Creswell, 2012; Lincoln & Guba, 1985; Merriam, 1988). Descriptions were provided for both the context of the study as well as each of the themes resulting from data analysis. In addition, descriptions of data analysis procedures were supported with the use of detailed memos that supported the reliability of the coding process.

Conclusion

Understanding how preservice teachers’ formative assessment knowledge and practices evolved as novice teachers and the contextual factors that impacted their development can inform how similar courses can effectively prepare preservice teachers to use assessment formatively beyond their teacher preparation programs. The literature suggests that there is a need to make explicit connections between concepts and practice during teacher preparation courses. However, few studies follow preservice teachers into the field to understand if such courses help novice teachers sustain formative assessment practices. This study was designed to determine how conceptual and practical tools developed in a practice-embedded course evolved in the classrooms of novice teachers who previously completed the course.

In the remaining chapters, the results of the study will be presented as four separate case studies corresponding to each participant. Each case will include detailed descriptions of the context in which each participant completed their internship as well as where they currently teaching. For each of these contexts, an overview of their evolving formative assessment knowledge and practices will be presented and
summarized through the levels of appropriation described earlier in this chapter. In addition, the impact of the course, individual characteristics, and supports and constraints within each current teaching context will be described. Individual results will be followed by a chapter describing the results of a cross-case analysis and concluding with a discussion chapter summarizing the significance of the results.
### Table 3-1. Descriptions of participants’ internship placements

<table>
<thead>
<tr>
<th>Participant</th>
<th>Grade Level</th>
<th>School Type</th>
<th>Location</th>
<th>School Enrollment</th>
<th>School % Low SES</th>
<th>School % ELL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>K</td>
<td>Public K-5</td>
<td>Suburban</td>
<td>872</td>
<td>43.5%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Megan</td>
<td>2/3</td>
<td>Lab K-12</td>
<td>Urban</td>
<td>1146</td>
<td>24.3%</td>
<td>0%</td>
</tr>
<tr>
<td>Nicole</td>
<td>2</td>
<td>Public K-5</td>
<td>Suburban</td>
<td>1162</td>
<td>50%</td>
<td>10.6%</td>
</tr>
<tr>
<td>Victoria</td>
<td>3</td>
<td>Public K-5</td>
<td>Urban</td>
<td>578</td>
<td>56.6%</td>
<td>21.8%</td>
</tr>
</tbody>
</table>

### Table 3-2. Description of participants’ current school employers

<table>
<thead>
<tr>
<th>Participant</th>
<th>Grade Level</th>
<th>School Type</th>
<th>Location</th>
<th>School Enrollment</th>
<th>School % Low SES</th>
<th>School % ELL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>K</td>
<td>Public</td>
<td>Urban</td>
<td>569</td>
<td>30.8%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Megan</td>
<td>2/3</td>
<td>Charter K-6</td>
<td>Urban</td>
<td>1150</td>
<td>28.1%</td>
<td>0%</td>
</tr>
<tr>
<td>Nicole</td>
<td>3</td>
<td>Public K-5</td>
<td>Rural</td>
<td>1162</td>
<td>88.6%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Victoria</td>
<td>3</td>
<td>Public K-5</td>
<td>Urban</td>
<td>650</td>
<td>38.3%</td>
<td>28.3%</td>
</tr>
</tbody>
</table>

### Table 3-3. Weekly summary of course topics.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The importance of assessment and defining formative assessment.</td>
<td>FA1, FA2</td>
</tr>
<tr>
<td>2</td>
<td>Involving students in the assessment process.</td>
<td>FA1, FA4, FA5</td>
</tr>
<tr>
<td>3</td>
<td>Interpreting and responding to formative assessment data</td>
<td>FA2, FA3</td>
</tr>
<tr>
<td>4</td>
<td>Adapting instruction for low achievers based on formative assessment data</td>
<td>FA2, FA4, FA5</td>
</tr>
<tr>
<td>5</td>
<td>Adapting instruction for high achievers based on formative assessment data</td>
<td>FA2, FA4, FA5</td>
</tr>
<tr>
<td>6</td>
<td>Integrating formative assessment into established classroom routines—time-saving approaches</td>
<td>All</td>
</tr>
<tr>
<td>7</td>
<td>Making formative assessment sustainable through collaboration</td>
<td>All</td>
</tr>
<tr>
<td>8</td>
<td>Reflecting on shifts in perspective about formative assessment</td>
<td>All</td>
</tr>
</tbody>
</table>
The Evolution of Formative Assessment Knowledge and Practice

Ashley is a young, white female teacher that has experience teaching in both public and charter school settings. During the course she progressed in all five aspects of formative assessment, in some cases progressing through several levels of appropriation. After three full years of teaching, she has maintained or improved her formative assessment knowledge and practices. Detailed descriptions of her teaching settings and appropriation levels for each aspect of formative assessment will be provided in this section in order to address the first research question of this study.

Formative Assessment Course

Internship setting

While enrolled in the formative assessment course, Ashley was interning in a kindergarten classroom of 19 students at a large public elementary school. Ashley was hired as the sole classroom teacher and was responsible for planning and instruction for all subjects, including mathematics. The school had a large, racially diverse student body (55% white, 29% Hispanic, and 11% black) with approximately 40% of students on free and reduced lunch and 11% ESOL students. Ashley described strong personal connections with her students and their parents, as well as positive interactions with staff members. However, she did not meet regularly with other teachers within her grade level for co-planning and support structures, such as volunteers or paraprofessionals, were almost non-existent. She stated that “I have sat in many meetings silently because I have felt not as knowledgeable as the others” (P8, R7) but
by the end of the semester identified a growing rapport with her colleagues as she gained confidence in her teaching skills.

In her internship classroom, Ashley described a warm, inviting environment where students felt comfortable and moved flexibly from whole group to small group instruction. Ashley primarily taught from the textbook, *GoMath*, but noted that she was trying to move to a math block design that engaged students in more student-oriented centers. A typical class started with calendar math followed by a whole group teacher-directed introduction, time for students to practice individually, and concluded with centers. Usually, there were five centers where students could review skills, preview new content, or work in a small, teacher-led support group. She determined these groups based on “skills these specific students need” (P8, R3) but did not always identify specific data used to make those decisions.

**Appropriating formative assessment knowledge and practices**

Ashley is a motivated learner and demonstrated growth in her formative assessment knowledge and practice while participating in the formative assessment course. Her changes from the beginning to the end of the course are summarized in Table 4-1 and will be described in detail in the following sections.

**Clarifying learning intentions and criteria for success.** At the beginning of the formative assessment course, Ashley was appropriating the label of “learning targets” and readily admitted that her use of learning goals and criteria was limited. In her first reflection assignment, she wrote

I am not always on top of conveying unit targets up front. I do list and read the lesson essential question for reading each week but do not always review the LEQ’s and objectives for other subjects. Also, I do not restate the LEQ’s everyday. This is an area that I need to strengthen (P8, R1).
Learning goals and criteria appear to be equated with standards, rewritten as essential questions, and posted per school requirements but rarely referenced during mathematics instruction.

As the course progressed, she demonstrated on multiple occasions an understanding of the learning goals for her lessons and how her students are performing in regards to those targets. Her reflections showed a shift from being overwhelmed with reaching learning goals in the curriculum to working more collaboratively with her Kindergarten team to understand the connections between goals—giving her a “snapshot of how each day and week are supposed to look like” (P8, R6). She also expressed an interest in meeting with the first grade teachers in an effort to make sure she was establishing learning goals that were consistent with future learning experiences her students would have. In addition, Ashley began to understand the connection between sharing learning goals with her students and their ability to assess their own learning and she stated “it is imperative that all students know the goals they are expected to achieve…if they are involved in their own assessments they will know these specific goals” (P8, R2). While demonstrations of this conceptual understanding in practice were limited, trying the implementation activities in the course pushed her to establish levels of understanding that she looked for to assess student progress toward established learning goals and be more intentional with sharing those goals and performance criteria with students.

**Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding.** In the beginning of the formative assessment course, Ashley could be described as appropriating a label when
engineering discussions and tasks for eliciting student understanding. During the first week of the course, she stated that she assessed her students “on a daily basis using informal and formal techniques” (P8, R1) but provides few details on what that looked like and what they told her about her students’ learning. She also noted the importance of having “data behind all of [her] decisions” (P8, T1) but only described using this data to create groupings for her centers with no specific evidence that these centers were supporting student learning. One example that she does provide is the use of small-group instruction, primarily focused on supporting struggling learners, where she can “monitor the use of [manipulatives], making sure we are doing it the correct way, we are not playing, and are not building misconceptions” (P8, R2). While this could have been used to effectively elicit student understanding and move students forward, there was no evidence that it was used in this way prior to starting the course. In a similar manner, she identified open-ended questions as ways to elicit student understanding but was unsure of what this would look like in her math instruction.

Throughout the course, Ashley slowly built her way to appropriating the conceptual underpinnings of eliciting discussions and tasks. When implementing the T2 assignment, she had students complete an analysis of their mistakes and conferenced one-on-one with those students once they completed their analysis. During this time, she demonstrated how she gained specific knowledge about her students’ mathematical thinking.

[My students] had to write addition sentences by using a ‘picture addition sentence’…many of my students first counted all of the pictures and just wrote the total down. Some have not grasped the concept that they are adding two groups of objects together…for example, there was 5 red circles and 3 yellow circles in a ten frame. My students understood that this meant 8 total circles but did not view this problem as $5 + 3 = 8$…they
described the two different colors as a pattern. This showed me that my students lack the understanding of adding two groups together and complementing this with an addition sentence. (P8, T2)

She then described an instructional response that presented students with additional strategies that helped them distinguish between groups in order to write addition sentences that corresponded to the distinct groupings.

In a later project, she gave students a preassessment for the first time and demonstrated again that she was able to make interpretations from student work. For example, when giving students the problem 5 - _ = 2, she had informal discussions with students about their work to determine why only 9 of her 19 students got the answer correct despite performing well in subtraction prior to this lesson. She was able to determine that the location of the missing number was why many of her students had struggled and added problem-solving contexts, drawings, and manipulatives to her instruction to aid students in being successful in reaching their learning goal.

By the end of the course, her repertoire of eliciting strategies expanded beyond small-group and one-on-one discussions to also include tools like questionnaires, whiteboards, feedback forms, and preassessments. More importantly, she expressed understanding that the design of the task or question is critical in evoking the information that she needs to identify misconceptions and respond to student thinking. When she implemented T3, she stated “instead of asking my students simple questions with pictures like: what is 5 - 3 = _? What is 5 - _ = 1; I decided to challenge my students by asking them to show me all the ways they could subtract from 5. I provided 6 rows of five counters on the smart board and asked my students to show each possibility” (P8, T3) and found that her students were engaged while still providing her important information about their thinking.
Providing feedback that moves learners forward. Ashley had appropriated the surface features of providing feedback when beginning the formative assessment course. She made distinctions between evaluative and descriptive feedback and the power of quality feedback in motivating students. In the first week she stated,

I am very particular in the feedback that I am giving. Most of the time, I do not simply tell my students, "great, fantastic, good job!" This has been proven not successful and I, first handed, have seen disaster with using this technique. During all subjects, I give specific feedback related to the activity that we are working on. I focus on the positives so my students are aware of the correct way. For example, "I love how you placed your yellow and red counters in the ten frame to show that 2 red + 8 yellow = 10!" (P8, T1)

She used small-group instruction and one-on-one conferences as opportunities to provide feedback to students beyond grading. For her T6 assignment, she used a structured feedback approach for a small group of students who continued to make mistakes while subtracting. Through this assignment, she found that by using a more robust approach to feedback she “was able to guide [her] students and put an end to any misconceptions forming” (P8, T6). While demonstrating an initial understanding of feedback during mathematics instruction, this was the only example of how her feedback served to move student learning forward.

Activating students as instructional resources for one another. Early on, Ashley stressed making her classroom a supportive environment where students felt comfortable sharing and working together. As she described,

I believe I am successful in cultivating a supportive climate. My students know that we are all a team and if one is not making good choices, does not understand, or needs additional assistance we have to work together to become better. My students also know that fair does not mean equal. My kindergartners have such big hearts and teamwork has not been an issue. (P8, R1)
She also described the use of grouping in her classroom, but small groups appeared to be primarily for the purpose of the teacher to re-teach content to struggling students. However, she generally concluded that centers allowed her students to “work with their peers and practice higher order thinking during center time” (P8, R1) and “team building skills” (P8, R4) but if and how the structure of group work resulted in higher-order thinking cannot be determined. Although she did not provide examples from practice, she recognized that the design of group work can impact how student learning moves forward when she discussed how poorly designed collaborations, like peer-tutoring, “does not engage or help students achieve their highest potential” (P8, R5). Instead, she described some positive outcomes when creating a structured collaborative environment for her tiered lesson plan:

I put a lot of thought into grouping my students for this lesson and it went well. All students were able to work with peers that they normally would not work with. The structured groups controlled the talking and behavior (to an extent), as well as, provide each student with a challenge. This special consideration prompted a sense of togetherness, a community building activity, and a productive work environment. (P8, P2)

Ashley was working towards providing meaningful collaborative activities where student could play a role in moving one another forward, but explicit connections to how student learning is engaged through collaboration were absent from her descriptions of practice. Yet, she did make a strong argument for formative collaborative work when she described her work with fellow teachers. She noted,

Teacher collaboration systems are imperative towards success because teachers need to support and motivate one another to truly change their teaching practices…we must support one another in changing old habits and the traditional teaching structures. All teachers need to be on the same page so that all of our classrooms are deemed effective…We must build a strong, trusting relationship with our fellow staff in order to genuinely engage in each other’s professional development. We must feel safe to ask each other questions and to learn from one another. This also
goes hand and hand with accountability. We must all hold each other accountable for the learning that is taking place in each of our rooms. (P8, R7)

This provides additional evidence that she was moving towards a conceptual understanding of how collaborative learning can serve in moving learning forward, but still faced the challenge of what that looks like with young learners.

**Activating students as owners of their own learning.** Helping students take ownership in their learning was another aspect where Ashley made significant progress during the course. While she described the importance of motivating students during the first week, she expressed concern over how appropriate student involvement was at the Kindergarten level. Evidence of involving students in assessment was primarily focused on having students complete work independently and receiving feedback from her. She referenced the label of students “owning their learning” but was unable to articulate what that concept entailed, as she summarized in her first post: “I think it is very important for students to develop a sense of ownership in their studies as well as being able to make choices. I do allow my students to have small choices, such as manipulative choices, during math stations but that is about it. However, I am not too sure this even covers [ownership]” (P8, R1).

Her participation in the course, however, gave her several opportunities to practice involving students in the assessment process and build conceptual understanding of how students can be activated in their own learning. During the fourth week, she planned and implemented a “Plan to Improve” based off of the reading on self-assessment where students reviewed their scores and feedback on assignment, identified where they went wrong or continued to struggle, and determined steps they could take to make sure the improved moving forward. Her students demonstrated
improvement and motivation following her implementation. In particular, she believed her provision for student choice in the self-assessment process was critical as she described in her reflection:

I also allowed my students to choose how many days they might need to review this skill until they were ready to show me their subtraction skills all by themselves and eventually other skills...They then will have a choice to demonstrate their knowledge with manipulatives or on white boards...whether a written assessment or verbal assessment, I believe choosing their own assessment method sheds light on the students' interests and provides them with a sense of motivation. (P8, T4)

She also discovered how tailoring instruction and formative assessments to the interests of her students resulted in student ownership and motivation to learn mathematics. When creating an extension activity, she found that "allow[ing] multiple solutions prompted abstract thinking and allowed flexibility in reasoning… and [she saw her] students think deeply about their math as well as take pride in their work" (P8, T5) and she saw this ownership as leading to increased learning as students were invested in making sure they achieved the goals set for them.

**From Preservice Teacher to Novice Teacher**

**Current classroom setting**

Three years later, Ashley is now teaching in a very different school environment than that of her internship. She is now working in a K-6 public charter school where she teaches 18 first grade students. The school heavily emphasizes the use of technology in learning and students must apply and be selected to attend this school and subsequent middle and high schools. The student body is about half the size of her internship school with much less racial diversity (71% white, 13% Hispanic, 11% black) and very few ESOL students enrolled. Approximately 30% of the students accepted are on free or reduced lunch, which is a lower but similar level to her previous internship
setting. Ashley maintains strong, personal relationships with her students and speaks highly of her administration, support staff, and parents.

In the classroom, it is evident that Ashley maintains a positive classroom environment where students feel comfortable and invested in their learning. Her classroom is physically small, but well organized and structured around collaboration. Students sit in groups of 5-6 and regularly work in small-groups and partners during mathematics instruction. Even when students are in a whole-group setting, it is clear that they are comfortable with procedures for talking with one another and sharing their strategies. A regular math instruction block consists of whole-group instruction attending to learning goals and prior knowledge, introduction of new material with time for students to discuss and share, individual student practice with intermittent questioning and discussion, and a conclusion of student centers where most students get an opportunity to sit down with Ashley for small-group instruction. Students are very comfortable talking about mathematics and seem motivated to learn and engage with one another.

**Shifts in formative assessment knowledge and practice**

As a whole, Ashley has effectively maintained much of the conceptual understanding gained in the formative assessment course and has also experienced growth in her practice since working in her current classroom setting. A summary of changes from her role as an intern to novice teacher can be found in Table 4-2 and a detailed description of each aspect of formative assessment will follow.

**Clarifying learning intentions and criteria for success.** Ashley has demonstrated continued growth in clarifying learning intentions and sharing them with her students. It is evident that engaging in discussions with her students about learning
targets and assessing their progress towards those goals is now a regular part of her mathematics instruction. In fact, Ashley notes “reminding them of the learning goal and their expectations during class everyday...helps tremendously and I know if I don’t do it...its almost like they’re going to ask me ‘we didn’t do that [Miss Ashley], we didn’t review what we’re supposed to be doing’…it sets the mindset up [which] is important and I do feel like I’ve grown in that.” (P8, I2).

During the classroom observation, Ashley began math instruction by having students first repeat the learning goal for the day: “I can use patterns in numbers to help me understand and solve problems”. Prior to the lesson, students had been introduced to doubles and the intention of this particular lesson was to have students use doubles as a strategy when solving addition problems—particularly what she termed “number bonds”. This was not simply a repetition routine, but students were asked to engage in whole-group and partner discussions about what this goal could mean to them and how it connected to what they know about doubles already. Included in this discussion were some examples of how students could use doubles to solve different addition problems guided by her but also including student input. While students were completing the lesson using a NearPod activity, Ashley used this technology to share exemplars on all students’ iPads as another way of sharing criteria for success with her students. While she presented substantial evidence of continuing to build on her conceptual understanding and implementation of learning goals and criteria in class, there was limited evidence of having students continually reference learning goals past the beginning of the lesson and for that reason achievement of mastery could not be established from the data collected for this study.
Engineering effective classroom discussions and other tasks that elicit evidence of student understanding. Although a novice teacher, Ashley really shines in this particular aspect of formative assessment. Both the interviews and observation revealed many examples of how Ashley frequently used discussions and tasks in meaningful ways to gather critical information about her students’ understanding of mathematics. When asked about this particular aspect, she is quick to list examples from her practice including “showing fingers in the air, whiteboards, using manipulatives, interactive centers, interactive whiteboard games,…play-based kind of stuff where the kids are able to manipulate and use applications on the iPad” (P8, I1) as well as “verbal questioning, thumbs up, thumbs down, a lot of NearPod activities,… [and the] guided math table” (P8, I2). Although she can identify a list of particular approaches she uses, she also recognizes that most anything in her classroom can be used as a formative assessment that elicits information about student thinking—even traditional assessments.

As she did in the course, she strongly emphasizes the use of small-group instruction time for getting a detailed look at her students’ understanding and provide timely and detailed feedback so that they can continue to improve. As she describes,

[When] I can pull my kids six to a table in a small group is when I can really see are we getting this skill that we’re working on this group or are we not?…I think unless you pull the small groups you can't in a whole group setting get a full picture of who’s struggling and who’s not. (P8, I1)

During the classroom observation, students alternated between choice centers and pre-determined groups meeting at a table with Ashley. Students use whiteboards and manipulatives to show their thinking in response to her questioning and Ashley makes notes about student responses. Instead of simply asking for solutions, her questioning
remains open as she asks students to expand on the strategies they used to solve and how they might relate to the use of doubles.

Not only do they discuss and do mathematics in small groups, but students seem very comfortable engaging in whole-group and partner discussions about math, and she emphasizes students sharing their strategies for solving frequently. She is particular with the questions she asks and the tasks students engage in because she wants to be able to see their “mind work” (P8, I2), not just final answers. This detailed information is what she uses to determine how her students are progressing so that she can make instructional adaptations. Technology is often used to elicit mathematical understanding and promote discussion, particularly the iPad app called NearPod. All students can work through eliciting tasks independently or in groups on their iPads and Ashley can view their work in progress in real time and share work on student’s iPads to prompt discussions. Of course, she notes that the questions she uses during these discussions are not on the fly but planned in advance with a focus on students explaining their thinking to one another. She believes this is a significant area of growth since her internship and that questioning reveals critical information about student understanding, particularly student misconceptions or surprising responses.

A lot of times the kids will say something and I'll think Ah, I didn't even know you were going to take it to this over here so I think again it just gives me knowledge as a teacher to address even those misconceptions that I'm not even thinking they're going to have. (P8, I2)

She has come to recognize that there is much that can be missed about a students’ mathematical thinking when those questions are not asked. This level of understanding is not just data collection but she uses this data to make instructional decisions, as well. As she summarizes, “Having them be able to explain their thinking is
going to help me understand do they really know how they’re coming to that sum or are we just guessing… those questions are needed to extend their learning” (P8, I2). During the classroom observation, she was able to identify a group of students who were not making connections with using near doubles and designed a small-group activity the next day that used a different teaching approach and hands-on manipulatives to specifically address those not yet reaching their goal of using doubles to solve addition problems.

**Providing feedback that moves learners forward.** Ashley continues to use feedback that goes beyond grades in the classroom and often notes the importance of drawing student attention to the strategies they used to solve a problem.

I think if you’re not prepared for that specific feedback it is more difficult, but the more practice you have the better. I still full-heartedly believe that’s highly important because...there’s so many strategies they can be using let me point out the strategy that I see you using and praise you for that so that you know in your mind that that’s what you’re doing. (P8, I1)

The purpose of pointing out the strategies and talking through what she sees in the steps they’ve taken in their work is to help students identify where they are struggling or how a strategy they are using may be incorrect or inefficient in solving a problem. At the same time, it helps students identify their strengths and what problem-solving approaches may be most useful. She has found if students are left to identify how they can improve their understanding at this age, “they often say they’ll practice more...practice makes perfect” so specific, quality feedback helps her students “to figure out which [strategy is] going to help me figure it out and…have in my toolbox.” (P8, I1)

While she has a solid conceptual understanding of the importance of meaningful feedback and how it can move student learning forward, it was difficult to determine if
this was a frequently used practice as this level of feedback was not observed in the classroom lesson for this study despite her use of the small-group instruction format.

Ashley also notes that she uses avenues beyond small-group instruction verbal feedback, but these approaches would not represent her daily practice. For example, she is able to utilize technology to provide feedback to students on how they are progressing towards their goals. When students submit their work via the app, they are provided with instant correct/incorrect results as well as video examples that walk them through the steps. This allows for students receive some individualized feedback when Ashley is not able to individually conference with students. In addition, she also frequently monitors student progress in a whole group setting by circulating and providing feedback to students as she checks their work and engages in conversation.

**Activating students as instructional resources for one another.** Ashley has been intentional about setting the stage for this aspect of formative assessment. Students in Ashley’s classroom feel very comfortable sharing ideas with one another and collaborating on tasks. A collaborative, student-centered environment has become a more comfortable setting for Ashley, as well. Although, she notes that trusting students and letting go of control to students still impact the frequency with which she uses group structures and that she would like to use collaborative environments “more consistently, really allowing students to use each other” (P8, I1).

While the use of collaborative tasks that promote students as instructional resources for one another may be limited, she has shown much growth in her conceptual understanding of this aspect since her internship. During her internship, she often referenced the supportive classroom environment and use of grouping without
reference to how students could support one another’s learning. Now that she strongly focuses on discussions and tasks around students’ strategies, she understands how that can impact student interactions. As she states,

With having partners and its first grade they love to help each other…they are starting to learn what strategies work best for them so sometimes I will just completely go well just count up, count up and then somebody says but lets use the number line on the wall and so things like that its interesting if they use each other as resources that…of course always they’re going to listen to their friends even more than they listen to their teacher at times. (P8, I1)

Because of the environment she has created and the emphasis on multiple solutions and sharing strategies, students will share different approaches and push each other’s thinking to see the problem in a new way. She recognizes that these kinds of interactions open an opportunity for students to improve their own understanding of a concept as they learn from one another. At the same time, her time in the classroom has helped her to see that simply grouping is not enough and that collaboration must be well structured so that it supports individual responsibility and “gives them the autonomy to independent” (P8, I2).

Activating students as owners of their own learning. Students in Ashley’s class are engaged in their own learning primarily through student reflections and self-assessment. Everyday students are asked to rate themselves on the learning target by holding the number 4-3-2-1 on their chests. This strategy is selected as an approach to self-assessment appropriate for first graders. Again, she feels strongly in the community that she has developed that students “can feel comfortable telling the truth” (P8, I2) about their level of understanding. Another method that was used in the observed lesson was the use of a reflective math journal. At the end math instruction, students were asked to pull out their journals and summarize their mathematics learning
and reflect on their progress towards the day’s learning goal. While she would love to use this journal piece everyday, she would not characterize it as a part of her daily practice.

Although she feels constrained to involve students in their own assessment on a daily basis, she does demonstrate understanding of the importance of activating students in their own learning. First, she describes that sharing learning targets and criteria with her students helps them to “know in their mind that that’s my goal towards mastering” (P8, I1) and students take ownership when reflecting on progress towards this goal and identifying ways to improve. Her focus on students selecting strategies that work for them is how she envisions giving students the tools and motivation to improve their own progress towards those goals. As she describes,

That’s what I always tell them that's why math is so cool so you choose what you like best, I've given you the tools now giving you that autonomy of I don’t know who you figure it out, just do it...it just makes my heart happy that if they get stuck… they know these [strategies] that I taught them to do. (P8, I2)

Providing students with choice in their learning she also describes as motivation for students to continue improving and to engage in mathematics. She says, “I can tell them there are so many different ways to find an answer and that’s what I try to instill in them is that love of math” (P8, I2).

Understanding the Impact of Setting and Individual Characteristics on the Appropriation of Formative Assessment

Both the internship and current teaching settings have played an important role in Ashley’s formative assessment knowledge and practice. The formative assessment course, technology, and administration were factors that supported her continued use of formative assessment. However, she also encountered several constraints within her
current school setting, including that lack of time and classroom management. Analysis also revealed several individual factors, professional growth and positive mathematics knowledge and beliefs, were also important supports to Ashley reaching higher levels of appropriation. Themes summarizing the supports and constraints that emerged from the course setting, current classroom setting, and individual characteristics for Ashley will be described in this section.

**Supporting Factors**

Ashley had multiple supports for her appropriation of formative assessment knowledge and practices. In her current setting, two major themes of technology as an instructional resource and a supportive administration emerged. The UF Teacher Preparation program, including the formative assessment course, mathematics knowledge and beliefs, and professional growth were also themes related to her setting and individual characteristics. A hierarchy map demonstrating the relative weights of RQ2 support codes applied to her data can be found in Figure 4-1. This hierarchy map highlights that individual factors, like mathematics knowledge and beliefs and a reflective disposition were the most frequently coded units in Ashley’s data. After individual factors, the most frequently coded were the formative assessment course, UF program, instructional resources, and administration. These supportive code frequencies aligned with the themes developed for Ashley that will be described in the following sections.

**Formative assessment course**

Ashley is a strong advocate for the teacher preparation program at the university, including the formative assessment course. She believes that the learning about formative assessment while interning is an important part of why she uses formative
assessment three years later. One of the primary reasons for the impact was that she
was because she was implementing the ideas she read about in the class while taking a
meaningful role in the classroom. As she describes, “you can obviously learn from a
book and text and its fine and dandy and picturesque but until you get into the
classroom and actually present it to students, that’s when you’re doing your own
learning” (P8, I2). She recognizes that she may have developed conceptual
understanding of formative assessment in earlier course experiences, but it was when
she had the opportunity to build on those concepts and put them into practice with
students that she could see the impact it made on student learning. In particular, she
contrasts this to other practicum experiences:

I think it definitely hit home more so when I was in the classroom everyday
because then I’m there the following day and the following day to kind of see it play out. To where you’re seeing you’re asking me the same
questions and you think I know based on what I saw but I wasn’t able to see afterwards and I think that’s a huge thing even when we were in
classes. You go to a practicum for a couple hours and practice them but then you leave and you may not even see those kids again. You miss the whole after math. (P8, I2)

A critical piece in understanding formative assessment is to be able to not just elicit
student understanding, but to interpret students’ thinking and adapt instruction based on
those interpretations. In earlier courses, the opportunity to follow-up with students and
see how formative assessments could shape future learning were not feasible because of the limited role she played in other practicum experiences.

Working alongside experienced teachers has helped her to recognize the impact
of the course on her current use of formative assessment. Over the past three years,
she has seen many fellow teachers struggle with how to use assessments in formative
ways. When meeting to collaborate and discuss assessment, the focus is primarily on
summative or high-stakes assessments with no discussion on how to use those results to shift instruction. She believes there is a “big disconnect across the board how serious formative assessments really are” and that “UF put that in our hearts to know we have to [use formative assessment] to be good teachers” (P8, I2).

**Technology**

The school in which P8 teaches is a technology-focused school and it is evident that this is an important factor in continued use of formative assessment. When asked about formative assessment in her current classroom, she immediately notes her use of technology and her excitement to share how she uses it with the students to collect data. She expresses several reasons why technology has become an important factor in her use of formative assessment. First, she cites student engagement when interacting via technology and says “my kids they absolutely love it and its taking formative assessment to the next level” (P8, I1). By contrast, she has found students often disengage when she tries using tasks from the curriculum at her school, *Go Math*. This level of engagement was evident during her classroom observation when students were working on a doubles lesson through the app *NearPod*.

In addition to student engagement, technology has made the facilitation of formative assessment in a small classroom with 18 students a manageable endeavor. There is very little room for movement within the classroom and having students use tools, like whiteboards or manipulatives, to demonstrate their mathematical thinking is a challenge when working in limited physical space. Yet, these are tools she has identified as important to helping her elicit evidence of students’ thinking both now and when she was in her internship. In order to continue using these approaches to gather evidence of student understanding, she has used iPad apps to engage students in
similar processes. For example, instead of using whiteboards she uses an app called Educreations that allows her not only to elicit evidence of student learning but allows her to access that evidence beyond an instructional period. She also emphasizes the use of manipulatives in the classroom for her students to build conceptual understanding and providing them the opportunity to show her and their peers how they solved a problem. She shares that she “still use[s] those [manipulatives] but I have the availability to do it more digitally now on the iPad” (P8, I2) and it alleviates some of the “chaos” of hands-on learning in a small space.

**Administrative support**

Ashley frequently notes that her use of formative assessment is supported by the administration. She knows administrative support is key to her continual growth as an educator and explains that “my administration trusts me a lot” (P8, I2). Because of this trust, she has the freedom to implement formative assessment practices that often vary drastically from her fellow grade-level teachers and do not necessarily follow the math curriculum she was provided. As long as she demonstrates students are progressing in their knowledge of the standards for their grade level, she can implement formative assessment practices as she sees fit. As she summarizes,

> I am blessed that our administration believes in us I do not have anyone breathing down my back...we have curriculum but I am not made to follow it. I have to teach standards and no matter how I teach those is up to me. As a teacher, that gives you total free range and…it is a blessing it truly is. (P8, I1)

The administration has also put in place structures that help her implement formative assessment practices. One that she emphasizes is the availability of paraprofessionals everyday in the classroom. Having this extra set of hands allows her to collect
formative assessment data easily and implement instructional responses that can help her students move forward.

**Mathematics knowledge for teaching**

When implementing formative assessment practices during mathematics instruction, Ashley constantly refers to content and methods knowledge that she gained during her teacher preparation program. In particular, she describes the importance of understanding and sharing students’ strategies for solving mathematics problems. She sees those strategies as critical to understanding the thinking of her students and being able to identify teaching strategies she can use to build on what students already know or address misconceptions. As she describes them to her students, “if you linking cubes, if you need number lines, count up/down, fingers... that's why math is so cool ...you choose what you like best, I've given you the tools now I'm giving you that autonomy” (P8, I1). Ashley feels confident in working with her students’ strategies and is open to working off of students’ ideas. She attributes this development in content and pedagogical content knowledge to earlier math methods courses in the university teacher preparation program.

I just remember when we were trying to learn place value when we were in college, it was like oh my gosh, I don't understand you're taking 10 + 15, take the tens first you have two tens which is twenty and the five ones and now I get it because I've been teaching it...[but] I did not have a strong foundation of place value and I love that they started us thinking about it in college because at least I got started thinking about it so that when I got into teaching it I could start to understand through my own practice...speaking for myself, I didn't learn math in that way of how they add now. (P8, I1)

Learning to see and understand mathematics in ways that differed from her own experiences supported her in trying out new practices in the field—practices that support her growth in eliciting and acting on student thinking.
**Professional growth**

Of all four participants, Ashley demonstrates the highest level of personal drive and commitment to improving her professional practice. She frequently describes the impact of her coursework at the university and how she is constantly seeking out ways to get involved with university projects and professional development opportunities. In fact, she participated in this study because she believes that working with the university will only “make [her] better” (P8, I1). Ashley even notes her commitment to improvement and implementing research-based practices has put her at odds with other teachers in the past.

Somebody said to me, and it's almost my pet peeve, but a few coworkers said 'you're just fresh out of college so that's why you still use a lot of the stuff you learned from [the university]' and I'm like 'no no no, I fully believe...I love the [university] and I think coming from there we all use something that we learned from [the university] every single day'. A lot of people say 'I just learned it by going into the classroom, I don't use anything I learned in college' and maybe it's just because I love [the university] so much that I feel that way but I do feel like I've learned so much that I still use to this day in the classroom. I just feel blessed ... I think that program is just completely different from everything else. (P8, I2)

While she never directly states it, her motivation to continually improve her practice is certainly an important factor in her steady growth in formative assessment knowledge and practices into her novice teaching years.

**Constraining Factors**

For Ashley, two themes of limited instructional time and classroom management as constraints emerged. In Figure 4-2, a hierarchy map summarizing the RQ2 constraint codes applied to Ashley's data is provided. This map demonstrates that instruction and student characteristics were the most frequently applied parent codes for Ashley's data. In particular, time, student ages, and behavior were frequently cited
constraints and aligned with the themes of limited instructional time and classroom management described in the following sections.

**Limited instructional time**

Ashley felt the tension of wanting to implement formative assessment as frequently as she knew she should with the realities of time in the classroom. At her school, the math block is in the afternoon and she often struggles to get in all the elements of the lesson that she knows would benefit her students. For example, she identifies reflective math journals as an important way that she elicits evidence from her student yet she admits “some days we get to it and some days we don’t” (P8, I2). Similarly, small group instruction is a critical time for her to learn about her students’ thinking and provide feedback, but she often can only meet with a portion of her students during math instruction and describes implementing small groups as a “hard balancing act” (P8, I2). Not only is she challenged to fit formative assessment into an instructional period, but she notes the constant interruptions of testing and special events at her school: “God help us, if I didn’t get to it that day because we have honor roll, field trips and all that stuff…we’re a very active school with different functions” (P8, I1).

Time is also a challenge when it comes to interpreting the evidence that she elicits from students. This is particularly true for the large amount of data that technology allows her to collect. While she does look at student data and use it to plan instruction, she finds it difficult to be able to review everything that she collects. For example, she has students log on to an math app during centers and homework that provides her with valuable information and she explains that “it could definitely be used
for formative assessment but I can't personally sit here and tell you I look at it every single day” (P8, I1).

**Classroom management**

Ashley recognizes the importance of involving students in the assessment process and works hard to engage them in their own learning. This is personally challenging for her because, as she describes,

“Sometimes I can have that controlling nature of myself… I would like in an ideal world to be able to have them work together freely and not have to worry about noise…I know is part of it, but I think that's where I get caught up and forget the importance of what goes on between the students. (P8, I1)

Having students collaborate and discuss in ways that are conducive to formative assessment also bring challenges of “keeping them engaged during that group time so they are not over at my table” (P8, I2). Working with younger students is part of this challenge of managing collaborative work as she feels they are still new to school and learning to work together.

**Conclusion**

During the course, Ashley experienced significant growth and was able to translate and continue improving her practice during her novice teaching years. She showed the greatest growth in engineering eliciting discussions and tasks, which was supported by her mathematics knowledge and beliefs. Utilizing learning intentions and criteria and activating students as instructional resources for each other also showed gradual improvement over time as she gained more teaching experience and was provided opportunities to grow professionally by her administration. Feedback and activating students as owners were two aspects where Ashley showed less development. Despite developing conceptual understanding, they were difficult to enact
in her current settings due to time and concerns regarding the age and behavior of her students. Overall, a supportive school setting and strong drive to improve her mathematics teaching contribute to the high levels of appropriation she has reached in just a few short years of teaching.
Table 4-1. Summary of Ashley’s levels of appropriation as preservice teacher

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<th>FA1</th>
<th>FA2</th>
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<tr>
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<td>Appropriating a Label</td>
<td>Appropriating Surface Features</td>
<td>Appropriating Conceptual Underpinnings</td>
<td>Appropriating Surface Features</td>
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<tr>
<td>End of course</td>
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<td>Appropriating Conceptual Underpinnings</td>
<td>Appropriating Surface Features</td>
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Table 4-2. Summary of Ashley’s levels of appropriation as novice teacher

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<tr>
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<tr>
<td>Conceptual Underpinnings</td>
<td>Appropriating Conceptual Underpinnings</td>
<td>Achieving Mastery</td>
<td>Appropriating Conceptual Underpinnings</td>
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Figure 4-1. Hierarchy map of Ashley’s RQ2 support coding

Figure 4-2. Hierarchy map of Ashley’s RQ2 constraint coding
CHAPTER 5
CASE 2: MEGAN

The Evolution of Formative Assessment Knowledge and Practice

Megan is a young, white female teacher that has taught in the same K-12 research school for both her internship and novice teaching years. During the course she progressed one level in all but one of the aspects of formative assessment, never going above an appropriation of surface features. After three full years of teaching, she has maintained those levels of appropriation but did not experience additional growth outside of providing feedback. Detailed descriptions of her teaching settings and appropriation levels for each aspect of formative assessment will be provided in this section in order to address the first research question of this study.

Formative Assessment Course

Internship setting

During her internship, Megan was placed in a K-12 developmental research school that engages in a research partnership with the local university. Because of this, the student body approximated the demographics of the state in both racial diversity (49% white, 23% black, 17% Hispanic) and socio-economic levels (24% free and reduced lunch). In addition, this school reported no ESOL students and only 7% students with disabilities. The elementary grades at the school are organized by the following learning communities: K/1, 2/3, and 4/5. Learning spaces were designed to be open with students moving between classrooms throughout the day. Teachers were provided with planning rooms where they were expected to collaborate on planning for all subject areas and Megan described her fellow teachers as very supportive and engaged in the collaborative process. The school had just adopted a new research-
based, reform curriculum, *Investigations*, the year she completed her internship and teachers were committed to implementing the curriculum to fidelity.

Throughout her internship, Megan worked with three different mentor teachers who are novice teachers and brand new to the school and the curriculum. She was primarily working with third grade students for mathematics instruction, but does teach second grade students for other subject areas. When teaching mathematics, she had 20 students in her classroom. Because of the nature of the curriculum, students were often working in groups and she notes that additional support in her classroom, like paraprofessionals and learning support teachers, were a regular occurrence allowing for tiered instruction. At the time of the course, she had just started teaching math.

**Appropriating formative assessment knowledge and practices**

Megan found opportunities in the course to try out new approaches to formative assessment at her internship placement and demonstrated strengths in her conceptual understanding. However, her knowledge and practice of the five aspects of formative assessment only resulted in slight changes during the span of the course. Her evolving levels of appropriation from the beginning to the end of the course are summarized in Table 5-1 and will be described in detail in the following sections.

**Clarifying learning intentions and criteria for success.** In the beginning of the course, Megan defined learning intentions and criteria for success as “goals for the students and helps the teachers to gauge learning and understanding” (P17, R1). At her internship setting, those goals were written as “I can” statements and Megan shares that her grade-level community teachers created them. These “I Can” statements were shared with students at the beginning of the week and students were asked to assess their understanding of those statements at the end of every week. Megan described
that sharing these learning intentions helped students build ownership of their learning, but did not make any connections with how sharing led to improved student learning or shaped future instructional decisions.

Megan also demonstrates understanding the importance of sharing criteria with students when she recalled a moment in her pre-internship where the teacher asked students to draw a flower and graded them according to criteria that was not shared with the students as a way to introduce them to rubrics and the importance of knowing the criteria they would be evaluated on. This teachable moment clearly had an impact on her and she adds “if [students] don’t know the expectations, how can [they] possibly meet them?” (P17, R2). She connects this to the importance of the rubrics that are used for each assessment in their learning community in order to “grade their assessments and assignments, to see the whole part of the question, and recognize the students’ thinking and effort” (P17, R2). However, she does not articulate their importance in moving student learning forward and revealed that she does not know what engaging her students with this criteria would look like in her classroom. Although she demonstrated some conceptual understanding of the role of learning intentions and criteria for the purposes of teacher planning and grading, she primarily looked to her mentors and learning community to establish how she implemented those ideas in practice.

Engaging in the course assignments did result in a slight shift in Megan’s appropriation of clarifying learning intentions and criteria for success. For an assignment later in the course, she decides to involve students in rating themselves against the “I Can” statement for that day by sharing that statement with the students,
providing time throughout the lesson for students to rate themselves on rating sheet and then rating her students on the same sheet. While she identified some challenges in this process, it did result in greater understanding of how and why sharing learning intentions with students could lead to improved student learning. This shift in understanding was captured in the final assignment when she stated, “I realize now that…I was not using things like clear objectives and "I can" statements to inform all learning, or for formative assessment…Through this class I took a closer look at these [statements], and how I could change them to better meet the needs of my students” (P17, T8).

**Engineering effective classroom discussions and other tasks that elicit evidence of student understanding.** Megan began the course with a limited background in the nature of eliciting tasks and discussions and their role in the formative assessment process. The kinds of tasks she identified are largely teacher-driven and included pre-assessment and a vague reference to taking notes during informal assessments. The learning community developed the pre-assessments and Megan implemented them when prompted by her mentor teachers.

Throughout the course, Megan did implement some different types of tasks and discussions that elicited student thinking. In week two, her in-depth analysis sheet was used with students to identify what kinds of errors students were making with their multiplications facts and she used the results to facilitate a discussion about students’ solving processes. Afterwards, she wrote in her reflection

I sat all of the students down together, and in a sort of dramatic way, I did problems on the bored with no double-checking and just racing through them using multiplication facts. A student raised their hand and said "I don’t think that is right." pointing to one of my answers, and I said, "okay,
prove it to me.” They came up to the board and drew a picture. I asked if someone else could prove me wrong in a different way. After a few examples, we had repeated addition, grouping pictures, and one student used blocks. I asked them which was more reliable, memorizing facts that I might not get right every time, or using strategies that made sure I was right, all of the time. (P17, T2)

The following week she opened up a single-answer multiplication question and, despite struggling with how to do it at first, discovered “there are many ways for them to [solve]….this opened up the discussion of what multiplication actually is and I was able to reach all levels of learners” (P17, T2). While Megan has developed some understanding of how to implement tasks that elicit information, reflections on the depth of information elicited, what it meant about student learning, or specific connections to student learning and instructional adaptations were not made. Instead, her interpretations were generally centered around student performance levels, not student thinking, and instructional responses continued to focus on homogenous groupings and additional practice. For example, when implementing the improvement plan assignment she used conversations with students to elicit their understanding of multiplication yet went on to describe the following response:

Based on their answers, I have broken students into [performance-level] groups…each student will spend one ten-minute math session making their own flash cards for that set of math facts, to give them extra practice…they will work with students in their same group, to quiz each other on their facts with students about their answers. (P17, T4)

This kind of interpretation of the data and her response demonstrated a disconnect between conceptual understanding of the importance of eliciting mathematical thinking through discussion, but effectively focusing on products instead of process when interpreting evidence and moving student thinking forward.
Providing feedback that moves learners forward. At the beginning of the course, Megan provided no evidence that she provides students with feedback beyond grades. She did make reference to the pre-made rubrics that are provided to her and how they could be used for descriptive feedback. Yet, when describing the nature of that feedback she primarily mentioned the use of rubrics to “grade their assessments and assignments” (P17, R2).

Megan makes a slight shift later in the course to providing more specific feedback after using the structured feedback form for an implementation assignment. Students first worked with a partner to identify mistakes they made on an assignment and possible ways to improve. Then, Megan met with students individually and talked through the form with them. After the assignment, she was able to articulate a distinction between this approach to feedback compared to providing only a score. She described,

I think [this feedback model] works because the students are taking an in-depth look at their work and their mistakes, definitely. But I also think that the setting they are in plays a big role. Students feel special and cared about when you pull them aside to discuss their mistakes and it is much more meaningful for them, versus having a paper returned with an X on it, that they never take the time to look at. (P17, T6)

While this reflects a subtle shift in her conceptual understanding of the importance of feedback in the formative assessment process, it should be noted that this is the only evidence from the course that her approach to feedback goes beyond the use of grades in practice.

Activating students as instructional resources for one another. In her classroom, Megan described a supportive, welcoming environment where “all of the students are very understanding of others’ needs” (P17, R5). This type of classroom
community helped her set the stage for students working in groups and being respectful of the different needs of their peers. She frequently discussed the use of groups and it is evident that this was critical structure in her learning community. Groups were determined before each unit using a curriculum-based preassessment and students remained in that group throughout the unit. She described very clear distinctions between the groups in her classroom:

We have clear enrichment and support groups. Our support children are pulled out at different times of the day for their small group time, and our enrichment students are pulled for the last 20 minutes of the lesson to work on their project. Students who are low but not in the group that needs to be pulled, are usually grouped together and work closely with myself or my mentor teacher during independent time. (P17, P2)

Even though students are frequently grouped and working from a curriculum that emphasizes collaboration, Megan articulates limited conceptual understanding of how collaborative structures that were in place were related to students acting as instructional resources. It is also unclear how the tasks given to students in those groups were structured or if they promoted students pushing each other's learning forward. Her reflections gave the sense that she primarily implemented what her curriculum and mentor teacher dictated, which is to be expected as an intern, and she was not given the opportunity to develop conceptual understanding behind the collaborative work that does take place in the classroom. The course assignments do not impact her appropriation of this particular aspect.

Activating students as owners of their own learning. In the beginning of the course, Megan described how students are frequently involved in the assessment process by rating themselves on the weekly “I Can” statement at the end of every day and keep track of these ratings in a personal graph. According to her reflections, this
was an existing practice in her classroom that she was “seeing going on already, without recognizing it as [activating students]” (P17, R2). She was able to connect that engaging student in assessment in this way develops ownership of their learning and “motivates [her students] intrinsically” (P17, R2). Beyond articulating some understanding of why and how students can be involved in assessment, she also was able to identify that there is room for improvement and that that may not fully represent how students can own their learning. However, at this point she was unsure of what that might look like in practice.

As the course continues, the readings and implementation assignments help her to expand beyond students rating their progress against learning goals. For the first project, she gave students a preassessment where she asked them to rate themselves on different skills and complete open-ended tasks. After she had students look at these self-assessments and discuss them with her, she provided two homework options that provided students with choice based on their assessment of their skills. Engaging with this assignment pushed her to envision how students can use self-assessments to identify next steps that direct them towards their learning goal. She also began to recognize that providing her students with choice based on their assessments of their own learning led to increased motivation when completing their work, such as the choice homework assignment she created.

The next day, all homework was returned which is not something that always happens...[my students] said they just enjoyed having the choice because sometimes homework is too hard, and sometimes it is too easy, and if all assignments were designed this way, they would enjoy homework more during each unit. (P17, P1)

During another implementation activity, she had students select ways to improve their learning based on a self-assessment of their understanding of basic multiplication.
facts. Students identified “using flashcards and practicing at home or during ten-minute
math” (P17, T4) and she planned to have students assess their learning by “keeping
their own chart and record[ing] their own progress in memorizing these facts (P17, T4)

While she made some progress beyond numerical assessments at the end of
each week, Megan’s reflections revealed a continued dependence on the mentor
teacher to direct self-assessment opportunities. She recognized the potential of self-
assessment and builds a foundation for conceptual understanding, but continues to
question the feasibility of implementing these structures for student involvement,
describing the process of involving students as “extremely time consuming” (P17, T7).
Her language also reflected a hesitation in trusting students to successfully identify their
strengths and weaknesses and select appropriate strategies to improve, often choosing
to grade assessments herself and provide suggestions of how to improve for them.

From Preservice Teacher to Novice Teacher

Current classroom setting

Unlike many of her peers in the formative assessment course, Megan was able
to secure a position in the same school after her internship. In many ways, her context
has not changed. She has remained in the same grade-level community with a similar
number of students in her class. The school continues to use the Investigations
curriculum and similar support and enrichment groupings. However, she notes that the
teachers in her learning community have become less strict about teaching the
curriculum to fidelity.

In her classroom, students sit at circular tables in groups of four to six. Her “I
Can” statements are clearly posted at the front of the room for all subject areas, as well
as anchor charts summarizing ideas from recent lessons, and various reminders about
behavior in the classroom. Everyday class usually begins at the front of the room on the carpet with students repeating that day’s “I Can” statement and completing a short, interactive introduction activity as a whole class. Next, students usually break into groups to complete a discovery activity provided in the curriculum or select among a series of “workshop” activities.

**Shifts in formative assessment knowledge and practice**

Megan’s levels of appropriation remained mostly constant as she transitioned to novice teacher. A summary of changes from her role as an intern to novice teacher can be found in Table 5-2 and a detailed description of each aspect of formative assessment will follow.

**Clarifying learning intentions and criteria for success.** Presenting learning intentions as “I Can” statements continues to be part of Megan’s practice. She describes,

> When I provide learning goals for them and for me I'm identifying the intention of this lesson and what are we trying to learn and what are we trying to get out of that and so it's formative in the way that if that is the end goal how are we working our way towards that and what are the most important pieces to get there. (P17, I1)

She sees learning goals as impacting student understanding because “being very clear and open about what our goals are in this lesson will definitely help [them] understand [their] learning better” (P17, I1). It is clear that she shares these goals daily with students and having students repeat the “I Can” statement at the beginning of the observation was a central feature in the beginning of her lesson. Students are still asked to rate themselves on their progress towards the learning goal with a 4-3-2-1 on their chests, but she still is hesitant to involve students beyond this self-assessment measure. Unlike her time in the course, she no longer describes the use of rubrics to
assess student thinking and identifying student progression towards a learning goal. In all, her use of learning goals and criteria in her mathematics instructions has effectively remained at the same level of appropriation.

**Engineering effective classroom discussions and other tasks that elicit evidence of student understanding.** Megan continues to use informal and formal approaches to eliciting student thinking that often originate from the curriculum. Informal uses include “classroom observations day to day, the reflections, having conversations with them” (P17, I1) but she notes that she tends to use formal measures more than informal during mathematics instruction. Unlike her internship, she does not discuss any formal measures used for formative purposes like the preassessments that were frequently mentioned during the course.

In order to elicit information in math, she stresses looking for understanding through student work on worksheets, listening to student conversations, and conferencing one-on-one with students. One particular strategy she frequently references as an example of her use of formative assessment is the checklists from the *Investigations* curriculum. These checklists are used as a “quick and easy check” (P17, I1) where she can note when a student demonstrates mastery of particular math skills. She also demonstrates connections between checklist data and instructional responses by stating that “its also a place for me to reflect and ok who is missing what, where can I add that back in, or on the whole is everybody really confusing this concept…maybe this is something we need to reteach and things like that” (P17, I2).

It is important to note that these checklists are not designed to capture detailed evidence of student thinking but rather if students are meeting benchmark skills or not.
In fact, Megan may emphasize this kind of approach to formative assessment because of her beliefs that mathematics evidence is “not as abstract like reading” (P17, I1) and that “if [she] had to choose one subject that would tell [her] the most about a student from one snapshot it would be math” (P17, I2). Yet, she has come to see students’ mathematical thinking as more complex as she spends time in the classroom and her curriculum plays a large role in her use of open-ended tasks and discussion questions that leave room for multiple responses. While she can still identify the role of tasks and discussions in identifying levels of student understanding, she feels less confident in making interpretations and instructional adaptations based on more complex data. In practice, she tends to make broader adaptations from elicited data such as reteaching in small groups.

Providing feedback that moves learners forward. Megan continues to use one-on-one conference time to provide students with feedback that goes beyond grading. However, what this feedback looks like and how frequently it is used is still vague when it comes to mathematics instruction. She demonstrates a level of conceptual understanding of how feedback can be used to move learning forward when she discusses her approach to writing conferences,

When I'm doing their writing conferences we usually identify one to two goals of what they're working on like check for capitalizing about handwriting...some of them will be skill-based like the mechanics and some will be you're working on telling more and working on adding dialogue or adding sensory details so then that sticky note stays with them in their writing and it'll be like okay I'm visiting you again for conference again on this day at this time so when I come back I want to see what happened towards that goal. (P17, I1)

In the case of writing and reading, she is able to describe how she gives specific feedback related to learning goals in the course and connects that to student progress.

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Yet, those same connections are not made in mathematics and she feels challenged to provide detailed, quality feedback because, as she describes, “math is not a place where I feel as confident trying to work off of misconceptions” (P17, I2). The rubrics she once identified as useful in providing feedback are no longer referenced.

**Activating students as instructional resources for one another.** Megan continues to use the grouping structures and tasks as a result of the curriculum at her school. The same groupings of support, core, and enrichment are used to supplement her math instruction and one of the ways she identifies as providing opportunity for students to be instructional resources for one another. Her description of the work that is done in this grouping structure reflects a very teacher-centered structure with no connection to students supporting one another.

In contrast, students frequently work in partners or small groups to complete discussion-based tasks during regular instruction and she describes this as an opportunity for students to be instructional resources for each other because they are “hearing each other’s ideas” (P17, I1). During her classroom observation, students did work in partners on task from their text and a level of comfort with group work was observed. The degree to which partners built off one another’s ideas and helped them reach learning goals varied by group and the use of the task was due to its inclusion in the curriculum. In many ways, her classroom is student-centered due to the mathematics curriculum and the trust that she places on the curriculum to address this aspect of formative assessment may be impeding her growth in conceptual understanding of how students can move one another’s learning forward.
**Activating students as owners of their own learning.** Student self-assessments using a 4-3-2-1 system are still a significant piece of Megan’s use of formative assessment. Similar to her internship, students will rate themselves based on their understanding of the daily “I Can” statement. During the classroom observation, students summarized their learning at the end of the class period by holding a number to their chests while Megan scanned the room for understanding. One difference in this approach is that she now stresses the use of informal conversations during group time or one-on-one conferences to follow up with students on their ratings. As she describes,

> They’re going to have to tell me so why do you think you’re a four, what does that mean. Not prove it to me you know but have a conversation about it so I find that with that conversation piece, with that accountability, they’re much more likely to own what truly they’re understanding or truly not understanding. (P17, I1)

As with other approaches to formative assessment, Megan uses other subject areas, like reading and writing, or behavior to provide examples of what these conversations might look like and provides limited evidence that this occurs during math instruction claiming it is “harder in math” (P17, I1). Megan admits that she would like to involve students more in assessment but maintains concerns about the ability of third graders to accurately monitor their learning and feeling protective of their feelings and not wanting her students to “feel badly about themselves in any type of way” (P17, I1).

**Understanding the Impact of Setting and Individual Characteristics on the Appropriation of Formative Assessment**

The growth in formative assessment knowledge and practices that Megan experienced during the course was maintained, but did not continue to develop during her novice teaching years. Because the school where she completed her internship
hired her, the consistency in setting impacted her formative assessment knowledge and practices. In particular, the mathematics curriculum was a salient theme in the data that both supported and constrained her understanding and use of formative assessment during math instruction. The formative assessment course was also a support, but the degree of impact was lesser than her peers. On an individual level, her knowledge and beliefs about mathematics were acted as a constraining factor on her development as a novice teacher.

**Supporting Factors**

The mathematics curriculum at Megan’s school has been an important part of the elementary teaching community. This curriculum supported her use of formative assessment because the five aspects were in many ways embedded in the research-based design. While the curriculum was the most prominent theme in the data, the formative assessment course was also found as a support to a lesser degree. The hierarchy map in Figure 5-1 demonstrates the relative weighting of the codes applied to Megan’s data. Instructional resources was the most commonly used parent code with curriculum as the most frequently used child code, confirming that the curriculum was an important supportive structure for Megan. The formative assessment course was also coded as a supportive structure but the smaller area allotted for the parent code demonstrates the lesser role it played in her use of formative assessment. The supportive themes of mathematics curriculum and formative assessment course will be presented in the following sections.

**Mathematics curriculum**

The most influential factor of Megan’s current classroom setting is the curriculum that her school has adopted, *Investigations*. This curriculum is consistent from her
internship to novice teaching years and shapes the types of formative assessment practices she continues to use. Preassessments and checklists are two particular practices that she mentions in both settings and are a part of the curriculum that her learning community uses frequently. Having these resources readily available to be implemented and shared amongst her colleagues are important reasons she continues to use them.

The curriculum emphasizes a student-centered approach to learning mathematics that includes many group tasks designed to elicit student thinking and allow for multiple responses. The tasks and discussions inherent to the curriculum might not be a part of her classroom if she were placed in a different setting. She describes how she is challenged by this approach to teaching mathematics because she learned mathematics in a very different way and she worries that students may not respond as she expects them to. However, she trusts the curriculum because it is research-based and this trust leads to implementation of formative assessment practices she may not have used otherwise.

The curriculum is very open-ended and sometimes...I'm scared that there's going to be like crickets and you know as much as struggling is a good thing and working to that point it is very hard especially I guess coming from such a formal school setting and trying to teach in a different way from how I learned. Some students have a really hard time with that. But yes, I think that knowing how much research went into our curriculum and what I see when we do teach it...I feel like I can trust the curriculum that it does include a lot of that...and I use it in that way. (P17, I2)

While she still has room for growth in interpreting and responding to the student thinking she elicits through the curriculum, being continually exposed to it has gradually supported her ability to recognize student thinking the curriculum aims to elicit.
Formative assessment course

Megan believes that the practice-embedded design of the course did have some impact on her current use of formative assessment, but is quick to claim that she does not remember many details of the course. In many ways, she has retained the conceptual ideas behind the five aspects of formative assessment but the context in which she did her internship and her limited teaching experience as an intern has impeded her use of some of the practices she utilized during the course.

I needed to get the assignments done and they’d be like okay take these five students go over there and come back it didn’t always feel super authentic and I think that probably I was doing…[the assignments] with a small group during math and then doing it at the end of the unit and it was just like three or four kids that I did it with and it felt so disconnected whereas we were doing our own pretests and checklists and all sorts of things in the curriculum and I don't think I was connecting those or whatever the assignment was asking me to do didn't allow me to use what we were already doing. (P17, I2)

She identifies now that there were elements of her math instruction that could have aligned well with the assignments for the course, but she was unable to recognize that at the time and felt that integrating assignments with the existing instructional activities would no longer be considered implementing their new curriculum to fidelity, as required.

Despite feeling these tensions when implementing assignments from the formative assessment course, she reflects positively on the practice-embedded structure of the course. She is quick to note that she doesn’t think she would continue to use the formative assessment practices she does use if she had taken the course before her internship. Having this course, and others like it, while in an internship setting made the theoretical ideas more relevant and she was able to see how they fit in the complexities of the classroom. As she describes, "I definitely feel like being in the
classroom setting and seeing could this fit in to my day actually is this something that I could realistically could happen in this room with these 18 students” (P17, I2). In contrast to pre-internship practicums, Megan feels as if her application of course concepts during internship were more beneficial because of established relationships with students and the ability to see their growth as she implemented new ideas.

**Constraining Factors**

Although the mathematics curriculum in Megan’s current setting supported her formative assessment practices, adhering to that curriculum also emerged as a constraint on her continued development as a novice teacher. On an individual level, her knowledge and beliefs about mathematics were also found to be a factor restricting her growth. The hierarchy map in Figure 5-2 summarizes the relative weight of constraint codes applied to Megan’s data.

**Dependence on mathematics curriculum**

The consistency between curricula from internship to novice teaching that supported Megan in maintaining her levels of appropriation also placed constraints on her opportunities to improve her formative assessment knowledge and practices. Megan views the structure of the curriculum as a barrier to building on formative assessment knowledge and practices from the course. Because she puts a lot of trust in the curriculum, she continues to follow it very closely and does not often seek additional resources that could be used in formative ways. When asked about the frequency with which she uses the five aspects of formative assessment, she most often describes her use in terms of the curriculum: “some weeks it can be daily and some weeks it might be three out of five days it just really depends on the curriculum. You know, the format of it just changes so much” (P17, I1).
When she does try and implement formative assessment practices, whether provided by or in addition to the text, time was a strongly related factor. Not only is she limited by the time allotted for mathematics instruction, but she feels rushed to fit in all the activities from the curriculum as it is. Implementing additional eliciting activities like discussions is often not viewed as feasible.

I think the hardest place [for formative assessment is] with math because our lessons are kind of designed to go full circle. I don't really give you everything and I'm waiting for you to discover and come back and have that discussion sometimes that discussion doesn't connect all the way in math time because once we're finally done the whole lesson there's not a whole lot of time for that then another set of conversations. (P8, I1)

She understands that there are formative assessment opportunities, like discussion questions, built into the curriculum but finds it difficult to always implement all that is planned. This may also be related to limits in her conceptual development around formative assessment, as she describes: “there could totally be things that I'm doing that I'm not recognizing” (P17, I1). There may be missed opportunities to grow in her use of formative assessment because she has remained focus on surface features of the formative assessment aspects—particularly the names of certain strategies provided by the curriculum. This mirrors a similar struggle during her internship where she often implemented the course activities separate from the curriculum for both a fear of diverging from the set curriculum and also because, as she described, “I don't think I was connecting [that] whatever the assignment was asking me to do could allow me to use what we were already doing” (P17, I2).

Mathematics knowledge and beliefs

Megan is honest about her struggles in teaching mathematics and being open to seeing mathematics in a different way than she learned it herself. Because formative
assessment in mathematics requires delving into student thinking and supporting students in identifying their own levels of understanding, she has found that her limited knowledge of mathematics for teaching keeps her from utilizing the curriculum resources, like tasks and discussion prompts, in ways that could help her to grow. She notes, “math is not a place where I feel as confident to go off [the curriculum] and trying to work off of misconceptions” (P17, I2). In fact, she maintains a certain level of fear about the unpredictability of student responses and admits that she sometimes will lean towards more teacher-centered practices in order to minimize the unpredictability that comes with eliciting evidence of mathematical thinking from her students.

Math is where I feel least confident as a teacher only because in reading you tend to get the same questions and you can head in the same direction...you could have the most varied amount of learners in math at one point in time and your discussion can go a whole other direction and they never say what you want them to. (P17, I1)

In addition to not feeling confident in her own background knowledge for teaching mathematics, she generally continues to view mathematics in much the same way she learned it. Mathematics, to Megan, is primarily a subject focused on algorithms and procedures that lead students to right or wrong answers. These beliefs are evident when she makes distinctions between using formative assessment in mathematics versus language arts.

I tend to think of formative assessment just has a really strong place in math just because I feel like sometimes its easier I guess to address yes you’ve mastered this skill in math but I find myself doing the informal a lot more in reading and writing...[math is] not as abstract I guess as reading. In reading, did you visualize? I have no idea what’s happening in your head honestly you know and in math it’s either on the paper and you know it could be happening in your head and you’re not writing down but it’s obviously much more clear cut. (P17, I1)
She notes that working with the mathematics curriculum and its emphasis on student strategies and exploration has helped her to recognize that math is not as “clear cut” as she has always believed, but it is still a struggle to overcome these beliefs ingrained from her own experiences learning mathematics.

**Conclusion**

Megan was supported by the formative assessment course and the curriculum at her internship in developing her formative assessment knowledge and practices. At the same time, by continuing to work in the same setting her first years of teaching under the same curriculum played a role in limiting continued growth towards higher levels of appropriation. At the individual level, Megan described challenges associated with her mathematics knowledge and beliefs when implementing formative assessment and this was also found to be a relevant theme in her evolution of knowledge and practice.
Table 5-1. Summary of Megan’s levels of appropriation as preservice teacher

<table>
<thead>
<tr>
<th>FA1</th>
<th>FA2</th>
<th>FA3</th>
<th>FA4</th>
<th>FA5</th>
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Table 5-2. Summary of Megan’s levels of appropriation as novice teacher

<table>
<thead>
<tr>
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<th>FA2</th>
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Figure 5-1. Hierarchy map of Megan’s RQ2 support coding

Figure 5-2. Hierarchy map of Megan’s RQ2 constraint coding
CHAPTER 6
CASE 3: NICOLE

The Evolution of Formative Assessment Knowledge and Practice

Nicole is a young, female teacher who has transitioned between two very
different public elementary schools. During the course she progressed in all five aspects
of formative assessment, in some cases progressing through several levels of
appropriation. Despite challenges in her current teaching context, she has maintained
or improved her formative assessment knowledge and practices. Detailed descriptions
of her teaching settings and appropriation levels for each aspect of formative
assessment will be provided in this section in order to address the first research
question of this study.

Formative Assessment Course

Internship setting

Nicole completed her internship in a second grade classroom in a large (1100
students) K-5 public school in the southeast. The student population at this school had
a moderate level of racial diversity (46% white, 20% black, 25% Hispanic) with 50% of
the student population on free and reduced lunch, and approximately 10% of student
population considered ESOL. At the time, the school was using the curriculum, GO
Math, which was aligned with the Common Core State Standards for Mathematics.
While it was the official curriculum for the school, many teachers in her grade level did
not use the text and curricular resources and were given the flexibility to do so.
Unfortunately, teachers in her grade level did not regularly collaborate and preferred to
plan mathematics independently of one another. The administration made efforts at the
time to increase teacher collaboration by providing co-planning time in their weekly
schedules, but Nicole laments that this did not result in increased collaboration for her, her mentor teacher, and the other second grade teachers.

In her second grade classroom, Nicole has approximately 20 students in her class and describes their performance as “varied levels of ability” (P32, R1). Nicole teaches all subjects and took over mathematics instruction for her mentor teacher from her first day at the internship. The typical mathematics lesson began with a review of yesterday’s lesson, a whole-group teacher modeling of a concept, followed by individual student practice and a small support group led by Nicole. The classroom environment was supportive in that students felt comfortable sharing ideas and expressed excitement for learning and helping their peers. Nicole noted that her students were competitive due to a significant number of high-performing students in the class.

**Appropriating formative assessment knowledge and practices**

Nicole experienced growth in each aspect of formative assessment while participating in the formative assessment course. Her changes from the beginning to the end of the course are summarized in Table 6-1 and will be described in detail in the following sections.

**Clarifying learning intentions and criteria for success.** At the beginning of the course, Nicole describes her use of learning intentions, referred to as essential questions in her classroom, as a daily component of her mathematics instruction. Students referenced the essential question at the beginning of every math lesson and she was able to provide specific examples of how she shares these learning intentions with students and how it impacts student understanding and future instruction.

I tend to give my students the objectives for every lesson. I find that this helps the students gain understanding during the lesson. At the beginning of every math lesson, we go over the essential questions and review what
we are trying to learn, and how we are going to learn it. For instance, the main topic of the chapter we are in is two-digit subtraction and there are many ways the chapter presents this information. The students know that they are working on subtraction and the essential question, like “how can breaking apart numbers help us subtract” will help them preview what they will be doing. Answering this question after the lesson will help me gauge whether or not the students truly understand why they are learning the concepts. (P32, T2)

Nicole demonstrated some conceptual understanding of how those essential questions relate to student learning and instructional decisions. Her practice included sharing those learning goals with her students but there was no mention of students using the goals to monitor their own learning or students using those criteria when working together. Nicole only referenced this aspect in terms of learning targets aligned to standards and did not make connections to any criteria she used to assess student learning or sharing criteria with students.

As the course continued, learning to engage her students in the assessment process led to increased conceptual understanding and practice regarding learning intentions and criteria. In the course, several assignments prompted her to have students assess their own understanding and she implemented this through the creation of a rating scale. She demonstrates understanding of the importance of sharing learning intentions and criteria with her student in order to effectively make an assessment of their own understanding. For these assignments, she was also prompted to identify the levels of understanding her students demonstrated in relation to stated learning goals. By taking the time to identify these levels, she was able to better articulate what student progressions towards those learning goals looked like in order to improve her instruction and provide appropriate student supports.
Engineering effective classroom discussions and other tasks that elicit evidence of student understanding. Nicole used several approaches at the beginning of the semester to elicit evidence of learning from students. One primary way she identified was paper and pencil work collected in class. She used this to access student thinking and identify potential challenges. She states, “I collect and review all class work assignments daily to see where my students are at…this helps me see the areas that my students struggled and the kinds of mistakes that they are making” (P32, R1). While this could have been a great source of student thinking, her reflections suggested that the student work was used to monitor student performance levels rather than a detailed understanding of students’ understanding. Instructional responses based on this information were broad and generally included reteaching.

Nicole did describe some more informal approaches to eliciting student understanding but she noted that they are less frequently used. Her daily math instruction often included a small-group instruction time where she worked closely with students who were identified as struggling. During this time, she reflected on how this was an opportunity for her to “see where my students are struggling and how I can help them move past their misconceptions and confusion and move into understanding” (R32, R2). She appeared to be comfortable accessing student thinking in small groups prior to the course, but expressed concern over using open-ended questions and tasks when working in the whole-group setting.

By the end of the course, she demonstrated growth in understanding the importance of eliciting more detailed information from students, used new approaches to elicit that information, and made stronger connections between the evidence she
collected and the instructional adaptations made from that data. One significant experience she had in the course is transforming questions from closed to open. She recognized she was “resorting to single answer questions when teaching [her] students…[which was] causing my students to think in terms of single answers…and having a harder time explaining their thinking” (P32, T3). After using open-ended questions in the classroom, she noticed her students become more willing to participate and discovered much more about their mathematics thinking than anticipated.

It [helped] me see how the students think through the content and what their strategies are for solving problems. For instance, I asked my students this week to “share how we can break apart numbers to add” and they came up with many different answers and they all showed the different strategies that we have used. It helps me see that some of my students like to make tens when adding, while others would rather break the numbers into tens and ones and add, and still others would rather just use the whole numbers and standard algorithm. This gives me more insights into how I can alter my teaching methods to meet the needs of all of the students. (P32, T3)

Several course assignments supported her use of small groups and centers with all students, not just those identified as struggling. She notes that these new opportunities led her to discuss math in more depth with students and “gain insights and understanding” (P32, P2) for all learners in classroom so that she could make more informed instructional decisions that move all learning forward.

**Providing feedback that moves learners forward.** Nicole recognized that feedback entails more than just grades from the very beginning and made connections to how it can move student learning forward. Early on she described a “second chance” opportunity that she provided her students as a form of feedback. Using this approach, she circles problems where students had errors and encouraged them to find and fix these errors. She also used feedback to help students “see where there errors are
coming from, letting them know that they are using the correct process…not only does this help my students achieve mastery, but…it gives them more opportunities for success which increases their self-efficacy” (P32, R1). This demonstrated a deeper conceptual understanding of the purpose of feedback than many of her peers in the course.

During the course, she maintains this view of feedback and continues to gain experience using more structured feedback. As she completes course assignments, she finds begins using small groups more frequently in her instruction and uses these opportunities to get more practice monitoring student understanding and provide individualized feedback based on the evidence she gathers. When using the feedback forms later on in the course, she describes having the opportunity to talk with students about their mistakes and give them feedback to help them improve and also identify appropriate ways to move forward.

The students were truly able to understand their mistakes and learn from them, while making autonomous decisions about their learning. I hope that this is something I could do in the future with my students because I believe it will help those students who simply check their work without thinking about what they did wrong and reflecting on it. Just like I reflect on my students’ wrong answers and think about how I can improve, I want to encourage my students to reflect on their mistakes and think about what they or we can do to be more successful. (P17, T6)

Seeing the impact this more structured approach to feedback with students makes her hopeful about using detailed, quality feedback in the future because of the impact she has seen with her internship students.

**Activating students as instructional resources for one another.** Early on, the classroom that Nicole interns at is described as a supportive one where students can feel comfortable working together and students are “genuinely kind and helpful to
one another” (P32, R1). Students are encouraged to help one another but she recognized that many times students didn’t know how to appropriately support one another’s learning. For example, students often rushed to give a struggling peer the answer without helping guide them or exchanging ideas. Nicole made general statements about the important role group work can have in student learning, but knew that structuring tasks and a classroom environment where that could occur is an area she wanted to grow in. When she did describe group work, the tasks were teacher-led with a goal for students to move to practicing independently.

By the end of the course, the way Nicole uses group structures in practice does not change, but she does demonstrate growth in her understanding of how group work should be structured to lead to student success. Peer tutoring, an existing structure in her mentor teacher’s classroom, is something she once cited as a demonstration of student collaboration but she later recognized that this may not be a productive structure for student growth. She noted that peer work “only works if the students are taught how to [work together] and all students have the opportunity to participate” (P32, R5). She understood that students, like teachers, need to feel comfortable sharing in their groups, have shared goals and roles to play, as well as tasks that require participation from everyone. However, she still felt challenged to implement this in her current classroom and group work throughout the semester continued to be an artificial structure aimed at students becoming independently successful in meeting learning goals.

**Activating students as owners of their own learning.** Nicole demonstrated an interest in involving students more in the assessment process at the start of the course,
but reported that it was not a part of her classroom practice. Helping students own their learning in this way was viewed as an idealist goal that took years to acquire and potentially something she would not achieve until in her own classroom.

I believe this is something that teachers need to slowly work their way up to, not only to help them become accustomed to the ideas but to help the students become aware of the evaluation process as well...when hired as a teacher this is something we can all start from the first day, making it easier on our students than starting halfway through the year. (P32, R2)

Early in the course, another peer shared how they use a rating system for their students, and she became interested in the potential use of this kind of self-assessment with her own students amidst concerns that students “may simply wait to be told what to do” (P32, R2).

After reading about involving students in the assessment process, she was able to articulate how involving students in their assessment could lead to greater student motivation and independence in monitoring their own learning. Developing a greater conceptual understanding of how assisting students in owning their learning could significantly impact their mathematics understanding, she was determined to find a way to make this possible in her classroom. Participating in course assignments gave her the structure and support to begin making progress towards a goal of engaging students in assessing their learning.

During the second week, she had students reflect on mistakes made during classwork and identify ways to improve based on the mistakes they made. However, she was honest that this did not go as hoped and recognized that developing student ownership will take time.

While my higher achieving students were able to understand why it was important and how they can alter their own process of doing class work, some of my other students did not see the point in completing the
assignment and I have not seen changes in their class work at this time. While many of my students were able to identify what they did wrong and how they could fix it, they have yet to apply it or see how it can be applied to their work as a whole. The lack of change I have seen in most of my students, shows that they did not understand that the analysis could be applied to all of their work, and not just the one problem. (P32, T2)

A couple of weeks later, she had students assess their work again for the first course project. To help structure the process and aid students in assessing their own learning, she developed levels of understanding and provided examples to her students so they could best identify their strengths and weaknesses. She continued this support by providing the class with a chart describing the connection between those levels and homework choices and found that almost all her students were able to make appropriate selections. After soliciting student feedback, she found that students really enjoyed being involved in their learning and demonstrated motivation to choose options that challenged their thinking.

Observing the positive outcomes in her students’ learning motivated her to continue growing in this particular practice. By the end of the course, she describes implementing levels of understanding on a weekly basis where students selected group-based centers on their assessments of their understanding and she began to see the improved student outcomes that she read about so early in the course. Nicole makes substantial growth in her appropriation of this aspect and understood how to “give students choices, allow them to correct mistakes and reflect on their learning, and engage in activities that will challenge each student on their own level” (P32, T8) even if it still “frightened” her to change her status so that her students would have the space to develop ownership of their learning.
From Preservice Teacher to Novice Teacher

Current classroom setting

Nicole makes a substantial shift in school environments as she transitions from intern to novice teacher. Her current school is much smaller with a total size of 395 students, a result of its rural location. Compared to her internship, a greater portion (87%) of the student body comes from economically disadvantaged homes, with increased racial diversity (39% white, 38% Hispanic, 20% black) and second-language learners (14%). The school has struggled with standardized assessment scores and administration has become vigilant about checking teacher lesson plans and grade books, as a result. Because of an administrative oversight in textbook adoption, teachers have been working without a math textbook for several years but recently adopted a new curriculum several weeks before the interviews and observations for this study began. While teachers are given these textbooks, they are not expected to adhere to any pacing guide.

Nicole currently teaches a third grade class of 18 students. She has cultivated a positive and welcoming environment in her classroom where students show enthusiasm for mathematics. Student desks are placed in groups of four to five with a carpet area near the smartboard for whole group instruction and discussion. A typical class period begins with a number talk at the board, whole-group introduction to the day’s learning objectives, group work and/or independent practice, followed by a summarizer often in the form of an exit ticket. Students appear comfortable talking about their solving strategies, discussing one another’s work, working in teams, and using technology to demonstrate their understanding.
Shifts in formative assessment knowledge and practices

Although Nicole began her novice teaching years in a very different teaching environment, one that came with high stakes and less support systems, she is able to maintain or improve her levels of appropriation for each aspect of formative assessment. Of the four participants, she has maintained the strongest formative assessment knowledge and practice. Formative assessment is not seen as a set of strategies or something that she adds to her instruction, but she sees everything she uses as an opportunity to assess her students’ understanding and inform her instruction so all students can improve. A summary of changes from her role as an intern to novice teacher can be found in Table 6-2 and a detailed description of each aspect of formative assessment will follow.

**Clarifying learning intentions and criteria for success.** Sharing learning intentions and criteria with her students continues to be a focal point of her classroom. As she describes her formative assessment practices, they are often tied back to the learning goals she sets and providing students with examples and feedback related to her expectations for their work. She starts by making sure to create and post her learning criteria and engaging students in talking about those goals and comparing their work against them. As she describes,

I think that just goes to the learning targets and having the students be very aware of what are we working on today…like at the end of the lesson you should be able to do this and then letting them know almost how are you going to determine if they met it…or even give them a rubric…just making sure the students know if we’re talking about division that's where our conversations are heading. (P32, I1)
This is not seen as a surface-level activity to address her school’s push to post learning targets, but she sees the use of these learning targets as important for students to be able to move forward in their learning both individually and with their groups.

While she has maintained her conceptual understanding of the importance of learning goals and criteria in shaping student progress, one change from her internship is that she no longer develops a 4-3-2-1 level of understanding rubric for students to guide their self-assessment. Instead, she has her students keep data notebooks where students collect their math work and track their own progress towards learning goals. She finds this is a better way to share learning goals with her students and assess their progress towards those goals. She will also use student work as examples of the criteria she is looking for when students are reviewing the work that will be included in their data notebooks. This is a relatively new practice, not one that she would say occurs frequently at this point in time.

**Engineering effective classroom discussions and other tasks that elicit evidence of student understanding.** Like Ashley, Nicole has a level of expertise and comfort in using tasks and discussions to inform her teaching and improve student learning. She can list of many strategies that she uses to elicit information from her students, including exit tickets, whiteboards, classwork, quizzes, and conversations. While she uses some approaches more than others, she strongly believes that most anything during her math lessons can be used as evidence of student learning.

Her use of discussion as insight to student thinking is one of her strengths and something that she has been able to develop since her internship. Observing her classroom and watching her students easily engage in conversations about math and
work in teams reinforces that she effectively creates a classroom environment where this kind of information is frequently elicited. One example is her use of number talks with her students at the beginning of class. During number talks, students are given what she describes as “open ended tasks…focused on kids coming up with their own solutions” (P32, I1). Students must solve the task using mental math and then share and discuss their solution strategies with one another. She cites this as an important opportunity to get into students heads, see which strategies her students are using, and identify any misconceptions that may be occurring.

As she does with number talks, Nicole constantly engages students in meaningful conversations and tasks throughout the class period. Students often work in small groups and, instead of sitting with a support group like she did in her internship, she uses this time to circulate with all the small groups and ask questions and listen in on conversations to get a deeper understanding of students’ mathematical thinking. This valuable information is then used to move students forward by providing feedback on students’ strategies—discussing what strategies seem to work well and adapting inefficient solutions so students can be more successful. She notes that it also plays a role in her future instruction in that she uses the strategies her students are using as a way to speak their language. This is exemplified when she describes her response to information she elicited during a group task on division during her classroom observation.

During the activity that they did in groups, it was really interesting to see because I feel that the way I expected them to do it was very different than how my higher kids did it because they were dividing 24 up into 24 animals into 2 playpens and they used addition rather than dividing them up one by one...they're like well I know this because I know that 12 plus 12 is 24... and then that activity showed me that my lower kids definitely
needed that one to one and still now they still need that one to one because they can't count what they draw so they need to manipulate things and that really affects how I teach each lesson. I want the kids to get it that's the point, so if they're going to do it a different way then I thought about it then I need to address that and use that. (P32, I2)

Providing feedback that moves learners forward. Nicole emphasizes feedback as an important component to student learning and growth. She believes this is critical in math because, as she says, “if you have no clue that you're on the wrong track you're just going to keep doing every problem that way” (P32, I1). Feedback is more about just letting students know if they are right or wrong, however. She strives to give students feedback on their process and strategies and feels this is an important part of the formative assessment process. For example, looking at student data collected on a formative assessment might lead her to conclude “Oh, your processing is right but you made a counting error. That shows me that you really do know it but you're just making simple mistakes and that's when I'm going to have a chat with you” (P32, I1) and she uses that one-on-one time with students to walk through what she sees and helping students identify the next steps in trying to improve their understanding. She articulates clearly that students need to understand what their strengths and weaknesses are in order to understand how they can progress towards a learning goal.

In many ways, Nicole's practice regarding feedback has remained the same. She still values timely, verbal feedback over returning graded papers. This varies slightly from her internship as her mentor teacher graded all assignments and she did spend more time providing written feedback than she does now. Verbal feedback occurs throughout class, whether students are engaged in whole, group, or individual work. During the course, she tried out a feedback strategy called a “checking station”
and she notes that she continues to use this approach frequently and remembers specifically being introduced to it during the formative assessment course. Students use the “checking station” to get feedback on their progress against an answer key that can provide anything from a final answer to diagrams and steps, depending on the math content being covered that day. She notes,

This gives them the opportunity to just sit and read through those problems and try them first before they come to me to tell me oh I don’t get it because they want to check their work they want to get to mark it and see that they’re getting it right its like that instant gratification and I can spend more time focusing on other students. (P32, I2)

Because she now facilitates group work more frequently, she has also found this beneficial in helping student groups to progress when she cannot physically be available to provide feedback for everyone.

**Activating students as instructional resources for one another.** Shifting classroom environments has led to substantial changes in how Nicole is able to activate students as instructional resources for one another. Previously, her opportunities to engage students in meaningful partner and group work were limited because “the way we work to structure our math block is very different from the way it was in [her] internship” (P32, I2). As she explains, her mentor teacher primarily used whole group instruction and if there were any grouping activities it was because she was teaching that day. Now, she has discovered the power in students learning from one another and works hard to provide as many opportunities for students to work together as possible.

When using groups before, the end goal was for students to work independently and now she values how collaborative work can allow students to push each others thinking forward. Students take turns acting as leaders and students “share out…and
piggy back off of each other’s ideas” (P32, I1). This exchange of ideas allows her students to reflect on their own understanding of math concepts and assess their progress towards learning goals. She does not explicitly talk about the importance of structuring group time so that these meaningful conversations can occur, but when observing her classroom it is clear that students have routines and roles in place. She provides each group with tools, like manipulatives, to be able to represent their thinking in multiple ways and she always strives to assign tasks that are application-based that require higher-order thinking and collaboration. Although she has made huge strides in her practice, she recognizes that there is still room for improvement in making sure students are engaged in productively working together and keeping students individually accountable for their own learning when working with others.

**Activating students as owners of their own learning.** Nicole still has a well-developed understanding of the importance of students as owners of their learning. She articulates that involving student in the formative assessment process means making sure students understand learning goals, what it looks like to meet that goal, and have the tools to know if they are meeting that goal or not. When students have these skills, they can take control of their own learning and be active in identifying ways to improve. She also recognizes the ties to motivation and notes that when students are a part of monitoring their own learning, “the students are going to be more engaged and that's going to get them really invested into learning it and having a purpose for learning rather than just doing it because they're there” (P32, I1). Despite understanding the role that students can play in the formative assessment process, she
notes that this continues to be something she still works on and she “wants for [her] kids” (P32, I2).

However, she has not continued to use some of the practices she implemented while in her internship. Students are working in groups more frequently than before but this shift towards collaboration led to fewer opportunities during class for students to reflect on their learning individually and make choices based on those reflections. Before, Nicole utilized rubrics with levels of criteria for learning goals so that students could select amongst choices of homework assignments or math center activities tailored to their level of understanding. While this worked well in her internship, she now finds the idea time-consuming and still fears that her students are not able to correctly assess their own level of understanding.

Nicole may have discontinued some of her approaches to self-assessment from her internship, but she has identified new methods of involving students in her current classroom. Instead of the 4-3-2-1 rating system, she has moved towards having students collect and analyze their own assessment data.

"In my internship it was like I feel like I know this I'm a 4 but they didn't have any data to look at and say well are you a 4? So I'm trying to do that more with the students...let's look at our scores on our tests and where are we struggling and what can we do to fix it and more goal setting as a way to self-assess did I meet my goal, do I know what's going on?" (P32, I2)

She notes that this continues to be a work in progress to implement, but she has begun having students keep data notebooks where they keep different formal and informal assessments that demonstrate their growth over time. She plans to use this as an opportunity for students to reflect on what they learned over time.
Understanding the Impact of Setting on Appropriation of Formative Assessment

Although Nicole began her novice teaching years in a very different teaching environment, one that came with high stakes and less support systems, she is able to maintain or improve her levels of appropriation for each aspect of formative assessment. Themes emerging from her data regarding support include the formative assessment course, accountability initiatives, gaining professional freedom, and knowledge and beliefs about mathematics. On the other hand, she faced several constraints including time and shifts in student dynamics. Each of those supports and constraints will be presented in this section.

Supporting Factors

Nicole had multiple supports for her appropriation of formative assessment knowledge and practices. The formative assessment course as well professional freedom and accountability initiatives were salient themes related to her development. She also demonstrates strong interest and background in mathematics that impacts her approach to using formative assessment. A hierarchy map demonstrating the relative weights of RQ2 support codes applied to her data can be found in Figure 6-1. This map reveals that administration and math beliefs and knowledge were the most commonly applied parent codes in Nicole’s data. With lesser frequency was the formative assessment course and instructional resources. Within administration, assessment policies and initiatives was one of the most frequently applied child codes. Each of these frequencies closely aligned to the themes of described in the following sections.

Formative assessment course

Like her classmates, Nicole only remembered specific details for a few assignments in the course, but believed the practice-embedded design did impact her
current practice. In particular, the formative assessment course stands out to Nicole because of the opportunity she was given to apply concepts to practice.

It was nice to be able to apply it and just because it clicks so much more in you brain oh I did this and it worked or it didn't work and to think about it rather than just reading about it...I can't tell you things that I learned in classes before that because I didn't get a chance to apply them. Some things I hold on to and I was like Oh that's a good idea and I have that saved somewhere you know. But it's so much better when you can apply it so it definitely had an impact. (P32, I2)

Compared to other courses during her internship, she notes the considerable focus the formative assessment had on applying concepts in practice, which she believes contributes to her continued use of formative assessment as a novice teacher.

She also describes that being able to apply ideas in practice during her internship stood out as more impactful than pre-internship courses because she was more involved in the classroom and developed relationships with students. She notes that this was a time when she also could receive substantial feedback on the formative assessment ideas she was implementing—from her mentor teacher, university supervisor, and administrators. For example, she specifically remembers the lesson plan she completed for the second project in the formative assessment course for this reason.

For that lesson we had to teach it was observed and it was videotaped and so someone is giving me feedback on it like this went well this didn't go well you should have done this and just even if you just wrote out a lesson plan but you didn't do it you have no idea how its actually going to go because so many things happen during the lesson where you have to just on the fly reflect on so I think it gives you a more real world knowledge of formative assessment. You could teach us about formative assessment until you are blue in the face but if we're not given the opportunity to practice it then it's kind of worthless. (P32, I2)
**School accountability initiatives**

For many teachers, a school’s movement towards accountability initiatives aimed at improving standardized test results might be considered a barrier to a teacher’s practice. Working at a Title I school, Nicole has been working in such an environment where formative assessment use is mandated and micromanaged through weekly grade book checks. Yet, she frequently identified this feature of her school setting as an opportunity to grow and encouragement to continue using the formative assessment knowledge and practice she brought with her from the course.

Before in internship...no one saw our grade books. No one was checking them so we only put in grades for those end of unit tests... whereas when I started in 2nd grade in my county now, people check your grade books all the time. Like someone is looking in your grade book and making sure you...have your ducks in a row. (P32, I2)

Because someone was checking her grades and she was expected to have evidence of student understanding available for parents and administrators, she felt it kept her accountable to make sure she implemented formative assessment every week and be able to describe each student's progress in math with real data.

As a part of the school's focus on meeting academic performance goals in math, they also have appointed “math liaisons” as well as provided professional development opportunities for teachers serving in that role. Nicole took this opportunity to build on her interest in mathematics and serve as the liaison for her school. With the professional development she received, she was able to grow in her use of formative assessment. For example, her use of number talks is a result of a professional development through her new role and a substantial element of being able to elicit her students' mathematical thinking and engage students as instructional resources for one another that she did not use before.
Gaining professional freedom

During her internship, Nicole often felt restricted in how she could apply her knowledge of formative assessment because of the mentor teacher she worked under. While she admired her in many ways, she also described her classroom as very teacher-centered versus student-centered. Even though her current school has become restrictive in some ways, she notes that she has gained a lot of professional freedom to make choices in how she runs her classroom. For example, the school provides some formative assessments for teachers to use but gives her the choice to use them or seek out better alternatives based on her students. She does not feel restricted to stick to a curriculum, but instead can determine what types of activities to use in the classroom that she sees best fit to gather the evidence she needs about students’ mathematical thinking.

In the internship we followed the book and just let the book guide what we did but here it’s like here I need to spend another day on this and I have that flexibility to do that because I’m coming up with my plans and not picking pages from the book to do. The book is there as an extra as a resource if I need it. (P32, I1)

This has given her the space to adopt more group-oriented, problem-solving tasks that she feels have helped her elicit more information from students, engage students as resources for one another, and encourage students to be more active in assessing their own learning. It has also left space to use new technology to collect and analyze the evidence she elicits as well as opportunity for students to be more involved in assessing their own learning.

Knowledge and beliefs about mathematics

Nicole enjoys teaching mathematics and describes it as a subject she always liked as a student. In her classroom, she feels strongly about having students explore
in mathematics and engage with real-world applications so that they can see how it applies to their own lives. She emphasizes student collaboration and discussion, particularly engaging students in talk about different solution strategies. Part of this is from the math methods courses in the teacher preparation program, but she also seeks out new knowledge as a novice teacher. For example, she volunteered for professional development to learn about number talks and collaborative learning.

Because of her positive beliefs and strong content and pedagogical knowledge for teaching math, she finds implementing formative assessment in math “very comfortable” and simply “what good teachers do” (P32, I1). Having students share strategies and discuss mathematics have become critical features in her current classroom that allow her to understand student thinking and identify misconceptions. Her existing knowledge base supports her in facilitating these conversations or group tasks to make sure future teaching and learning are impacted.

**Constraining Factors**

Time and differences in student characteristics were significant constraints that Nicole faced in her setting. A hierarchy map summarizing the coding for constraints can be found in Figure 6-2. Both instruction and student factors were frequently applied to Nicole’s data, with instructional time, planning time, and shifts in student characteristics between schools as the most often cited constraints. The hierarchy confirmed the themes of time and student characteristics that will be described in the following sections.

**Time**

Nicole is motivated to use formative assessment in multiple ways on a daily basis with an emphasis on discussion and group work. Yet, being able to implement all the
ideas that she has and all the evidence she wants to collect takes time that she admits she does not have enough of. She laments that “our math block is only an hour, really it’s actually less than that. It’s only 55 minutes because it’s the end of the day so its hard to get a whole group lesson, a small group lesson, and a debrief in that time. Especially with all the things they have to learn in third grade” (P32, I1). Because she does not work strictly from a curriculum and many of her colleagues do not use formative assessment, there is also substantial time needed to find the appropriate tasks, discussion questions, and general materials ready to be able to use assessment in the ways that she would like. To add on to issues of time, she notes that there are often several interruptions during her math block for “interventions” and this can also disrupt her time with students and complicate her planning for classroom activities.

**Differences in student backgrounds**

Nicole had to quickly adjust to very different student dynamics in her classroom versus her internship classroom. In her internship, many of her students were considered on level in mathematics. In her current setting, she has a much more diverse set of students in terms of their academic backgrounds.

I think the difference too is the levels of my students. I have a much broader range of students’ abilities than I did in my internship where all of our students were pretty much on level and we we’re really concerned about any of them being academically...maybe one or two but not the amount I have now where seven children in my classroom of 13 are working below level so it’s a big difference. (P32, I2)

In addition to academic backgrounds, she now has far more ESOL students in her class and experiences less parental involvement overall. The differences in student characteristics makes it challenging to find tasks that she knows all of her students can productively engage in and pull meaningful evidence from. During the course, she
provided more opportunities for students to choose their centers in class or homework assignments based on their assessment of their own learning. Now, she feels like she needs to make these decisions ahead of time for the students because she is concerned that students will not pick appropriate choices.

**Conclusion**

Nicole is the participant who experienced the most significant shift in settings from her internship to novice teaching, yet substantial growth in her formative assessment knowledge and practice. One might expect her current setting at a Title I school concerned with high-stakes mathematics assessments might diminish the significant gains made during the course due to administrative pressures. However, Nicole continues show high levels of formative assessment knowledge and practices, which she partly attributes to the supports provided through assessment and accountability initiatives. She also demonstrates mathematics knowledge and beliefs that support her understanding and use of formative assessment during math instruction. Limits on instructional and planning time as well as shifts in student dynamics are constraining factors practicing formative assessment in the ways she would like to.
Table 6-1. Summary of Nicole’s levels of appropriation as preservice teacher

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Table 6-2. Summary of Nicole’s levels of appropriation as novice teacher

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Figure 6-1. Hierarchy map of Nicole’s RQ2 support coding

Figure 6-2. Hierarchy map of Nicole’s RQ2 constraint coding
CHAPTER 7
CASE 4: VICTORIA

The Evolution of Formative Assessment Knowledge and Practice

Victoria is a young, white female teacher that has remained in the same K-5 public elementary school from her internship through her first years of teaching. During the course she progressed one level in three of the aspects of formative assessment, never going above an appropriation of surface features. After three full years of teaching, she has maintained those levels of appropriation and experienced growth in using learning intentions and feedback. Detailed descriptions of her teaching settings and appropriation levels for each aspect of formative assessment will be provided in this section in order to address the first research question of this study.

Formative Assessment Course

Internship setting

Victoria completed her internship at a K-5 public school with approximately 600 students. The student body is one of the more diverse in the county (38% white, 17% Hispanic, 29% black, and 11% Asian) with a large ESOL population (22%) and 57% economically disadvantaged students. Students at the school represent many countries and the school has been recognized as the ESOL Center School for the school district. Teacher collaboration is expected and supported by the administration. In addition, the proximity of the school to a local university results in a significant number of volunteers and students completing field experiences. The school uses the curriculum, GOMath, and Victoria describes her school as curriculum-driven where teachers feel pressure to make sure they are meeting state standards and preparing students for standardized assessments.
In her classroom, Victoria taught 13 third grade students that she describes as high achieving in math, five of which were English language learners and representing five different countries. She was even working under a mentor teacher from a Latin American country at the time. Victoria describes her classroom as a supportive environment where students feel comfortable sharing and students can be found “cheering on their classmates when they reach their goals and do well” (P35, R1). She describes a strong connection with her mentor teacher who she admires and strongly relies on her judgment and the classroom structures she has created. A significant characteristic of the environment her mentor teacher has created that she stresses is the differentiation of her instruction to meet the needs of a very diverse classroom of students.

**Appropriating formative assessment knowledge and practices**

During the course, Victoria was able to make modest progressions in her appropriation of each of the formative assessment aspects. Her changes from the beginning to the end of the course are summarized in Table 7-1 and will be described in detail in the following sections.

**Clarifying learning intentions and criteria for success.** Before the course, Victoria describes the posting of essential questions as an important way they made their students aware of clarifying learning intentions. While she and her mentor teacher made sure they are displayed, there is no evidence that students were engaged in conversation around those essential questions. She did not develop these essential questions. Rather, they were determined by the curriculum and her mentor teacher and this lack of involvement in creating these learning goals may be part of her disconnect from engaging students with them.
By the end of the course, there was little evidence that her knowledge and practice regarding the sharing of learning targets and criteria changed. One slight difference was her knowledge of what levels of understanding for particular learning goals may look like. When completing an earlier assignment, her approach to creating levels of understanding did not connect to the math content of her learning goal, but rather relied on existing classroom groups of support, on level, and enrichment. Later on, she created levels of understanding based on what evidence of learning she was going to look for particular to the math content goal of her lesson. She stated that “the readiness levels with the three groups was very new for me and was something I had never tried before. I loved how it made the preassessment so much more meaningful and helped me to really dissect the levels of content covered in this lesson” (P35, P2). Instead of using existing groups determined by unrelated assessments, she specifically pushed herself to determine who would be in each group based on how they performed in regards to the levels she created. While she demonstrates growth, her development of levels of understanding was primarily teacher-centered and students were not engaged in the process. There was no additional evidence of growth in this particular aspect during the course.

**Engineering effective classroom discussions and other tasks that elicit evidence of student understanding.** In order to collect evidence of student understanding, Victoria primarily used formal assessments and informal conferencing to elicit evidence of students’ learning. Occasional opportunities to collect evidence also included whiteboards and short preassessments. Classroom discussions and tasks during mathematics instruction were primarily driven by the teacher and used to elicit
single answers solutions. Victoria encouraged students to use multiple strategies in mathematics, but collected evidence focused on mistakes and not student strategies. She did not describe any connections between eliciting evidence of learning to student thinking and future instructional decisions.

By the final week of the course, Victoria reflected on her learning in the course and noted that she didn’t realize there were so many different ways to assess formatively and how easy they are to implement” (P35, T8). One new way that she felt substantially impacted her practice was the use of preassessments. Prior to the course, she did not use them but now she describes how beneficial they have been to her and her mentor teacher in “driv[ing] my instruction and differentiation” (P35, T8). During the course, she learned to assess the results of preassessments and used those results primarily to create groupings. This certainly was a step forward for her in connecting evidence to instruction and student learning. Although, it is important to note that her instructional responses have not changed drastically, as having small group instruction with support, on level, and enrichment students was an existing structure in her classroom. What changed was which students were in each group and making sure her instruction was more targeted towards student understanding of particular learning goals based on current evidence of learning.

In some cases, she used the course assignments as an opportunity to tweak existing formative assessment practices. For example, at the beginning of the course she listed whiteboards as a way for collecting evidence of student learning. She later clarifies that this technique was often used for other subject areas and when it was used for math it was generally used as a quick check to see if students got the correct answer
or not. For one of the try it assignments, she decided to use this as a more open-ended task where students have to show their work and were encouraged to try different strategies. In addition, she notes that she used the time while students were writing on their whiteboards to circulate and ask students prompting questions about their work.

**Providing feedback that moves learners forward.** Victoria wants to “get better at giving specific, descriptive feedback” (P35, R2) but admits she found the idea of implementing this kind of feedback as impractical due to time. Feedback given to students often focused on where students made mistakes without details on how a student might move forward. Student conferences were the primary example of where feedback might occur, when there was time available to do so. She understood that providing quality feedback is more than grades and believes it should look at both the strengths and weaknesses of student work and provide some prompts on how the student could improve. At that point in the course, it simply was a matter of not having the time to implement this kind of feedback on a regular basis.

During the course, some of the assignments provided the opportunity to give more detailed feedback during conferences. Towards the end of the course, she stated that “I feel like this Try-It, as well as other Try-Its in this course, have helped me get better at conferencing with students about their mistakes” (P35, T6). She used conference time to talk about strengths and weaknesses in their solving and feedback on ways they could continue to improve.

We talked through the analysis form and I took notes on things the students said. As I met with each student, I pointed to the problem they missed and asked them what was right as well as where they went wrong in their solution. Next, they explained the steps out loud as they solved the problem correctly. Finally, together we came up with a plan so they wouldn’t make the same mistakes next time. (P35, T2)
She described going beyond just discussing grades or correct and incorrect responses, but the level of detail to which they discussed the mathematical thinking is difficult to determine. Most of the “mistakes” she described are rushing and not reading directions and when she does encounter a misconception (part versus whole when writing fractions) her feedback focuses on a memorization device of what number goes where instead of reinforcing the concepts behind the error being made by the student. It appears that while she gained more experience giving feedback, the depth of that feedback and her understanding of how it pushed students’ mathematical understanding forward are similar to the beginning of the course.

Activating students as instructional resources for one another. The classroom in which Victoria is placed for her internship primarily used teacher-centered instruction. The typical lesson began with Victoria or the mentor teacher providing instruction followed by independent practice. Victoria described a positive environment for collaboration to occur—where students felt comfortable sharing ideas, celebrating differences, and encouraging one another. She did not articulate how or why this connected to students as instructional resources for one another, but does make some broad statements recognizing that students working together was important to student learning. Student groupings did occur in the classroom, but these were generally homogenous groupings aimed at providing time for a teacher to sit with struggling students or an enrichment teacher to meet with students in the gifted program.

During the course, Victoria continued to stick to the three small-group structure where she worked with the support group as other students work with each other. When completing one of the projects for the course, she placed students in these
groups to complete different, tiered assignments and notes that “it was also nice to see group members helping each other since they saw I was busy with a small group at the back table” (P35, P2). This is the only insight into how students worked together and she did not describe how tasks were structured for group work and how that structure was critical to making sure students were contributing to one another’s progress towards learning goals versus working independently at the same table.

**Activating students as owners of their own learning.** At the start of the course, Victoria confidently reports that “fostering self-directed, independent approaches to learning, is a practice my mentor teacher and I use often” (P35, R1). Supporting students in becoming active was accomplished by allowing students to select their own strategies when solving mathematics problems. She connected this provision of student choice as a way to get students engaged in learning and, as a result, makes their learning more meaningful. This demonstrated an existing connection between theory and practice as it relates to activating student in their own learning that many of her peers did not begin the course with. However, she did not yet articulate how students can become involved in assessing their own learning—especially in mathematics. In fact, she notes that this was an area of growth for her and her mentor and she hopes to examine “how we are involving students in assessments in reading and how can we translate that into other subject areas” (P35, R2).

Several of the assignments in the course pushed Victoria to try engaging her students in assessing their own mathematics learning. She implemented this primarily through conferencing with her students about their mistakes and identifying methods for improvement. Like other participants have noted, the engagement of the students
encouraged her to continue finding ways to have students assess their own work and have more choice when selecting ways to improve. After implementing two activities where students reviewed their work and identified ways to improve, she was excited to share with her course peers that she and her mentor had “started incorporating more goal setting in my classroom and I love it” (P35, T4).

**From Preservice Teacher to Novice Teacher**

**Internship setting**

Like Megan, Victoria also remained in the same school when transitioning from intern to novice teacher. She did have to move down two grade levels and is now teaching a class of 17 first-grade students. The demographics of the school have largely stayed the same with significant population of ESOL students (30%), racially diverse student body (34% white, 21% Hispanic, 27% black, 12% Asian), and a moderate level of economically disadvantaged students (38%). Her school is currently using the *MyMath* curriculum and they are also provided with mini-assessments from the district aligned with the standards. Even though she is teaching in a different grade level community, she still describes strong collaboration with her grade level colleagues and support from administration to meet with one another.

In her classroom, student desks are placed in groups of 4-5, which she describes as their “teams”. Her desk and the classroom carpet are placed at the front of the room with the smartboard focused in the center for all students to see. Around the classroom, student work is displayed as well as anchor charts and lesson objectives. There is a large table and a computer station in the room to facilitate math stations. Victoria describes the typical math block as beginning with reviewing what they learned the day before, introducing the goal for the day’s lesson, introducing the new topic with some
guided practice as a whole group, and then a mixture of independent and group work in math stations. One of her math stations is on the computers where students will work independently on web-based math activities. She always sits with her support group during math stations and this is generally used as a re-teach opportunity for students struggling with the material.

**Shifts in formative assessment knowledge and practices**

**Clarifying learning intentions and criteria for success.** Victoria has built upon her conceptual understanding since completing the formative assessment course. She now articulates the importance of progressions in student learning and how important it is to share learning goals and make connections to prior and future learning explicit with students. She contrasts this to her previous use of learning goals as objectives posted and sometimes stated, but not connected to student learning.

> I don't sit there and formally say our objective for today is that you will be able to do this and this but I'll talk to them and say today were going to learn with missing addends and sometimes in a math problem we're going to be missing one of those numbers and they give use the answer so just talking through what were going to be doing and why were doing it…I think it helps them understand I'm not just giving these things to just fill up time in the school day there’s a purpose and I think it helps put that purpose and kind of unify everything that were doing. (P35, I1)

Before, these goals were not set by her but taken directly from her mentor teacher and the curriculum. While she does continue to use curriculum as a guide, gaining experience in the classroom has supported her understanding of how different math concepts are related so she feels more confident making decisions about how to order learning targets and recognize different levels of understanding.

**Engineering effective classroom discussions and other tasks that elicit evidence of student understanding.** Victoria continues to use similar approaches to
eliciting information from her students as she did in her internship. For math, she is quick to describe whiteboards and exit tickets as her primary ways of eliciting evidence of understanding. She does not continue using preassessments to identify student understanding prior to a lesson. The tasks she provides can take many forms, both closed- and open-ended, but she recognizes that it is still challenging for her to come up with open-ended prompts in math. However, she does still stress students using different solution strategies and this one element of her formative assessment that she is able to get more detailed information about student thinking.

Class discussions in mathematics do not occur frequently in her class, which she attributes to not feeling confident in asking open-ended questions as well as being concerned about the language barriers that exist in her classroom.

I can remember at the beginning of the year how it took time to teach that as a procedure with reading and now they know exactly what to do when I say turn to their shoulder partner...but [in math] I have 4 ESOL students and I think one could definitely handle it but I just picture the other three just sitting there kind of in silence not really understanding what to do. But at the same time it could still be a really beneficial thing for the other fifteen kids. (P35, I1)

She recognizes that having conversations during math instruction could be important learning experiences for her students and opportunities to learn more about their understanding, but finds its challenging to put into practice.

The way she connects elicited information to student learning and instructional adaptations is also much the same. Even if she asks for student solution strategies, she primarily looks at final answers to determine if students got a concept or not and uses re-teaching in small groups as the primary mechanism for responding to that evidence. For example, during her observation she gives her students an exit ticket where they must solve an addition or subtraction word problem and she encourages
students to select their own strategy. When looking at those assessments, she looks briefly for any incorrect responses and meets briefly with those students to reteach. Describing the purpose of her formative assessments in general, she notes that they help her to determine “which students are already showing mastery or starting to get it or the students need the reteaching” (P35, I1). She does not articulate how solution strategies can be connected to her instruction or how she can use student information to move all learners forward, not just those that struggle.

**Providing feedback that moves learners forward.** Victoria continues to recognize the importance of providing students with specific feedback that connects to students’ strategies as opposed to general praises like “good job!”. She articulates that this kind of feedback in math helps students think about their problem solving process as well as develop growth mindsets regarding math.

I think the one thing that I remember... [was] praising the way that they're thinking or how they're using a strategy instead of just saying that they're so smart I can just remember that example of saying I loved how you used your number line to solve that problem rather than saying you're a genius! Because I think it shows that student the importance of using a number line and it helps them to understand that they're using a strategy and they're not just coming up with an answer in their brain. When you’re using an example where you're so smart and they do get it wrong they feel like they’re not smart. (P35, I1)

Giving students specific feedback is also seen as an opportunity for her to help students recognize where and how they can improve—just like she saw her mentor do when she would meet with them and give them opportunities to improve their work based on her feedback.

In practice, she still finds it difficult to provide this kind of feedback on a daily basis. When she does provide feedback now, it generally is done verbally because of the younger age of her students. Written feedback will often be in the form of symbols,
like smiley faces, since many of her students struggle to read. Because she is the only teacher in the classroom now, she generally strives to give feedback during small-group instruction time instead of the one-on-one conferences she was able to do during her internship.

Activating students as instructional resources for one another. Having students become instructional resources for one another remains a challenge for Victoria in her current classroom. Conceptually, she defines this aspect as students being “able to learn from one another” (P35, I1). She is unsure how to expand on this definition and articulate how this aspect relates to improving student learning. She identifies this as a weakness for her in math instruction and she wants to learn how to better structure classroom activities, like discussions and group time, to make sure that students are learning from one another.

She does still continue to use small groups in her classroom similar to how she did in her internship. Students are split into small groups so that she can meet and reteach to a small group of students identified as struggling. Often, this is either based loosely on their performance in class the day before or focused on her ESOL students to support their language barriers. She describes students as “coaching” one another in these groups, but admits that she doesn’t circulate during these math stations so she is not sure how effective they are. She does not emphasize specific structuring of student collaboration or selection of group-worthy tasks to ensure this is leading to moving students towards their learning goals.

Activating students as owners of their own learning. Having students take ownership of their learning in mathematics is another aspect of Victoria’s formative
assessment knowledge and practice that has remained very similar to her internship. She understands ownership of learning as students having both choice and motivation in directing their own learning.

When we get to this point in the year how at this point they've learned so many different strategies and when it comes to adding or subtracting there's not a right or wrong way to solve it as long as you get that answer to see some of them wanting to use their number lines to see some of them counting in their head I think was definitely it's nice as a teacher to see that they have ownership and they have that choice of which one do you like using and which one do you think would be easiest to solve this problem so I love when I see them choosing which strategy they want to use. (P35, I2)

She continues to value students using multiple strategies and by giving students different ways to solve she is leading her students to take an active role in their mathematics learning.

While in the course, she was introduced to involving students in assessment by reviewing their own work, identifying areas for improvement, and selecting steps to move towards their learning goal. She still recognizes that this is an important process for students to engage in, but it has been a challenge to implement as a first grade teacher without the support of a mentor teacher. As she describes, "I don't know if at six or seven years old they're really able to understand that I got this wrong, let's fix it … I don't know if that's effective" (P35, I1). When asked about getting students involved in identifying ways to improve, she states that this is something she no longer uses. She is concerned about the ability of her students to genuinely be engaged in assessing their learning the way she applied it in her third grade internship classroom. However, when observing her students using whiteboards in the classroom, there is a small element of assessing their understanding as they keep track of how many questions they get right with stars in the corner of their whiteboard. This is not a
practice she explicitly taught, but she notes that students caught on to her use of stars as feedback during small group instruction and have continued this practice as a way to gage how well they are performing.

At my small group table when they're working both in math and reading and they are participating and giving good answers and explaining their answers I'll just do a little star on the table in front of them … they're just I guess a reinforcement like that was a great answer thank you … and one day when we were doing the whiteboards and we were solving this [challenge problem] I said if you got that one right give yourself a star and they're like oh it's just like you give a star so it just kind of naturally started and then from there whenever they would get their whiteboards if we got it right can we give yourself a star? so they almost kind of prompted it from a few weeks ago so now usually whenever we're solving a problem…well it's also I think it works for a lot of them and they enjoy it. I think they feel like they're the teacher. (P35, I1)

**Understanding the Impact of Setting and Individual Characteristics on the Appropriation of Formative Assessment**

Victoria makes some gains in her formative assessment knowledge and practice during the course and is able to sustain her levels of appropriation when taking a full-time position at the same school she interned in. The formative assessment course, consistency in teaching environments, and gaining teaching experience was the major themes for her. Constraints in her development included the characteristics of her students, knowledge and beliefs about mathematics, and the loss of mentor support. Each theme regarding supports and constraints will be presented in this section.

**Supporting Factors**

For Victoria, the formative assessment course did help her to build conceptual understanding of formative assessment and try some practices that were not previously a part of her mentor’s practice. Remaining in the same school setting supported her continued use of those practices. At an individual level, gaining overall teaching experience, including development of student-centered practices, was also a substantial
support in her sustained development of formative assessment knowledge and practice.

The hierarchy map in Figure 7-1 provides a summary of the support coding applied to Victoria’s data. In the map, the relative size of the rectangles demonstrates that teaching practices, UF program, instructional resources, and the formative assessment course were the parent codes applied to Victoria’s data with similar frequency. Within those domains, gaining teaching experience, UF support system, and school-based resources were all frequently applied child codes that aligned with the themes developed in this section.

**Formative assessment course**

Overall, Victoria believes that the course introduced her to seeing assessment in a different light—from a summative to formative perspective. As she puts it,

> I can remember is just understanding that assessment is not just something that's at the very end and I think going in to education that's just what I assumed you teach, you teach, you teach, and then you give a test at the end. And I think it helped me to see that you need to take little moments throughout your teaching to see who is ready for the next step and who needs to be retaught. (P35, I2)

Realizing that formative assessment could be very informal and easily implemented within existing teaching practices was important in her envisioning it in her future instruction and continuing to use the strategies she learned in the class. She does recognize that the practices she adopted were also largely influenced by her mentor teacher and aligning assignments with existing structures in her classroom.

Like the other participants, she described the importance of being able to implement ideas from the course while she was in a long-term, teaching intensive environment versus a part-time practicum experience. Not just being able to try out formative assessment ideas in the classroom, but she identifies the course as a critical
moment for understanding the theory behind her mentor teacher’s practices and build on her conceptual understanding of formative assessment.

There were so many things my mentor teacher was already doing and I didn’t necessarily know why she was doing it and I think the course reading, the textbooks probably helped me to see oh this is why she teaches this way…I think it was definitely more impactful to have it during the internship. (P35, I2)

In addition, sharing her experiences with her peers and seeing how others implemented formative assessment in similar grade levels with similar math concepts was a great resource for envisioning how she could implement those approaches in her own classroom.

Consistency between school environments

In Victoria’s case, being able to continue her first years of teaching in the same school in which she interned enabled her to at least maintain, if not increase, her levels of appropriation for all five aspects of formative assessment. One continuous theme in her discussion of formative assessment in her current classroom is a language barrier with the students. While this may have inhibited growth in her appropriation of formative assessment tools, her previous experience with ESOL students during her internship helped her to continue navigating the use of formative assessment with the significant number of ESOL students in her current classroom.

Remaining in the same school has made it easier for her to continue practicing the same teaching practices that her mentor teacher and other teachers in her school use. A prime example of this is the use of small group instruction. Victoria has used this setting both in her internship and current setting as an opportunity to elicit student thinking and provide feedback to move learners forward. Consistently meeting with her fellow teachers and collaborating on teaching practices and sharing lessons has made it
easier to continue using formative assessment in the same ways as the teachers in her community.

**Gaining experience in a supportive environment**

Multiple times throughout her interviews, Victoria discusses her use of new practices or reintroducing ones she used in the course over time. In the first year or two of teaching, she was simply learning to manage a class and learn new math content and did not necessarily have the time to “sift through” resources or previous coursework to implement formative assessment. As she felt more in control of her students and math content, she had a supportive school community of educators that did not mandate what she may or may not use in the classroom. Instead, she has felt comfortable to introduce ideas with her students and pull from resources outside the curriculum to support her use of formative assessment in mathematics. One example is her use of exit tickets. She notes that this is a new practice but she feels the freedom include this practice at the end of her math block and confidence in her teaching to find appropriate resources and questions that will elicit the information she needs to guide the next lesson.

**Constraining Factors**

When it came to implementing formative assessment, the greatest constraints Victoria describes are related to the characteristics of her students. Particularly, challenges with the language and age of her students have challenged her growth. An additional theme related to her current classroom setting is the loss of her mentor’s support. On an individual level, she also describes challenges with implementing certain aspects of formative assessment due to personal struggles in teaching mathematics. Figure 7-2 provides a hierarchy map summarizing the constraint coding.
of Victoria’s data. Student characteristics was the most frequently applied parent code with language and age being the most common child codes within the data. At a lesser rate, mathematical knowledge and beliefs and the loss of the mentor teacher were also commonly applied to Victoria’s data. The relative weights of constraint codes aligned with the themes of student characteristics, math knowledge and beliefs, and loss of the mentor teacher that will be described in the following sections.

**Student characteristics**

Victoria consistently identifies two student characteristics of her current classroom that impact her continued use of formative assessment: their age and their language comprehension. Even though she has remained at the same school, Victoria went from teaching third grade during her internship to first grade as a novice teacher. In terms of how she can assess her students, she notes that the age difference makes engaging in some of the same approaches she used difficult. For example, she made some substantial advances in understanding how to involve students in assessment during the course and looked forward to engaging students in these practices in the future. Yet, she has avoided engaging students in assessing their own progress over concerns about their ability to accurately describe their own levels of understanding.

Working in a school known for its work with ESOL students also has presented its challenges for Victoria. In terms of formative assessment, she often finds it challenging to find approaches to formative assessment that her ESOL students can engage in. She notes how she would love to be able to have discussions or group work where students can learn from one another, but she is afraid to use these assessments because she worries that her ESOL students may not understand and may feel left out. Even when ESOL students do engage with something like an exit ticket, there continues
to be the challenge of deciphering what a student really knows when they may not have understood what the assessment was asking.

Mathematics knowledge and beliefs

Much like Megan, Victoria makes multiple distinctions made between math and language arts in terms of formative assessment that demonstrate some of the constraints of her knowledge and beliefs about teaching mathematics. The best example from her experience is related to facilitating discussions around mathematics. First of all, she finds it challenging to think of open-ended questions and tasks in mathematics.

When I'm able to see them having those discussions and I think that all really stems from having the right questions. I think its harder in math to intentionally have those higher order thinking questions, those discussion type questions. I think in reading it just comes naturally and in math it takes more intentionality and its easy to go a whole lesson and just ask very basic right there questions but to really have the discussion [is challenging]. (P35, I1)

This may stem from limited background knowledge in mathematics content and pedagogy and a lack of experience with such reformed teaching practices. Not only is it a challenge to create open-ended questions, but at times she does not feel comfortable facilitating those conversations because she “doesn’t know where it’s going to go” (P35, I1). She describes it as a “weakness” and that she would like to work on in the future—again demonstrating her continued commitment to improving her own practice.

Losing mentor teacher support

When participating in the formative assessment course, Victoria notes the trust she has in her mentor teacher's classroom teaching and the strong bond she has built with her. This is a tremendous support to her in learning to teach and implement assignments for the course. It also impacted how she chose to implement different
formative assessment practices—tending to use existing teaching practices as a base to intertwine approaches from the course. When transitioning to her role as a sole classroom teacher, she finds some of the ideas from the course difficult to continue using without the support of another teacher in the room. During the course she had more opportunities to elicit student thinking through conversation, as she was able to pull students for one-on-one conferences while her mentor teacher was leading the rest of the class. As the only teacher in the room now, she feels restricted to whole-group instruction or working with only one small group which she recognizes as limiting her understanding of how individual students are understanding a topic and what strategies they are using.

Conclusion

Victoria made some conceptual progress during the formative assessment course and remaining in the same school from her internship through novice teaching years did shape what practices she did or did not continue using. Gaining teaching experience was an important part of her development and she frequently notes how she is working on putting new concepts into practice as she builds confidence in the classroom. Of all the participants, she was the most reliant on her mentor teacher and has continued many of the practices used by her mentor teacher and struggled to use some of the formative assessment practices without that relied on her additional support. Teaching a younger grade level in a school with a large concentration of ESOL students has shaped the kinds of formative assessments she has used since language is consistently a challenge to student engagement.
### Table 7-1. Summary of Victoria’s levels of appropriation as preservice teacher

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<th>FA2</th>
<th>FA3</th>
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<th>FA5</th>
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</thead>
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<td>Appropriating a Label</td>
<td>Appropriating Surface Features</td>
<td>Appropriating a Label</td>
<td>Appropriating a Label</td>
</tr>
<tr>
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<td>Appropriating Surface Features</td>
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<td>Appropriating Surface Features</td>
<td>Appropriating Surface Features</td>
<td>Appropriating Surface Features</td>
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### Table 7-2. Summary of Victoria’s levels of appropriation as novice teacher

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<th>FA2</th>
<th>FA3</th>
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<tr>
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<td>Appropriating Conceptual Underpinnings</td>
<td>Appropriating Surface Features</td>
<td>Appropriating Conceptual Underpinnings</td>
<td>Appropriating a Label</td>
<td>Appropriating Surface Features</td>
</tr>
</tbody>
</table>

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**Figure 7-1.** Hierarchy map of Victoria’s RQ2 support coding

**Figure 7-2.** Hierarchy map of Victoria’s RQ2 constraint coding
CHAPTER 8  
CROSS-CASE RESULTS

In the initial phase of analysis, descriptions of the appropriation of formative assessment and themes were developed at the individual case level. These themes aimed to answer each research question with respect to the particular settings in which each participant was appropriating formative assessment knowledge and practices. In the second phase of analysis, the similarities and differences between each of the four cases were explored in order to identify larger themes across participants. In this chapter, the results of those comparisons will be presented as they relate to the research questions for this study.

Comparing Levels of Appropriation across Participants

Cross-case analysis for the first research question first began with the comparison of levels of appropriation for all participants. These levels were summarized in a table and comparisons were made across aspects, participants, and aspects by participants. Formative assessment aspects will be used to organize the results of this analysis and potential reasons for the similarities and differences in novice teacher developments will be discussed.

Clarifying Learning Intentions and Criteria for Success

All participants experienced growth in their conceptual understanding and practice with learning intentions and criteria during the course. However, only two of the participants continued to grow in this aspect in their current teaching setting. Ashley and Victoria both felt challenged during their internship to integrate learning goals and criteria into their instruction beyond posting the learning targets established by the book. When transitioning to their own classroom, they gained more independence and
experience teaching math and understanding the importance of sharing goals and exemplars with their students. Megan and Nicole did not experience growth in this particular aspect but for seemingly different reasons. For Megan, working in the same setting from her internship to novice teaching appears to play the biggest role in her constant level of appropriation. Her setting both contributes to her use of “I Can” statements in her classroom but also the level of removal she feels from the development of these statements may contribute to her lack of conceptual growth and practice. Nicole, on the other hand, made significant strides during the course and developed a high level of conceptual understanding but not enough evidence from practice to be described as attaining mastery.

**Engineering Effective Classroom Discussions and Learning Tasks**

This aspect of formative assessment was another area where all participants experienced growth. During the course, all participants built conceptual understanding regarding the importance of eliciting evidence of learning and benefited from multiple implementation opportunities to make connections between theory and practice. For the participants who remained in the same setting as their internship, Megan and Victoria, there was no development beyond the course and their knowledge and practice largely remained the same. One explanation may be that teaching within the same context develops a level of comfort with practices adopted in the internship phase. In both cases, they have continued working from the same math curriculum, which they follow closely. These participants may not have encountered opportunities or challenges that pushed them to seek new knowledge or try new ideas related to eliciting tasks and discussions because of the continuity between contexts. Both cases also revealed levels of discomfort in teaching math and being open to student conversations.
and its possible that these individual factors also played a role in their plateau. The math methods courses and the formative assessment course contributed to their use of eliciting-activities, but both focus primarily on the implementation of those tasks and discussion and less on specific examples of student understanding or instructional adaptations.

On the other hand, both Ashley and Nicole made significant shifts in teaching environments and were able to appropriate to a level of mastery after three years in the classroom. Shifting teaching environments may have provided critical moments where they sought new knowledge and practice. In both cases, the participants acknowledged supportive administration and professional development opportunities particular to mathematics. Developing a level of mastery requires a certain degree of knowledge related to mathematics content and pedagogical content knowledge, and course assignment data also reflected participants’ affinity for mathematics and knowledge gained in the mathematics methods courses in the university program. While the university and school settings may have supported this development, it may be just as likely that their knowledge and beliefs for teaching math combined with reflective dispositions were just as pivotal in their ongoing development.

**Providing Feedback that Moves Learners Forward**

Not all participants grew in their use of feedback to move learning forward. Of all the aspects, this is one that participants began at a higher level of appropriation. One participant, Nicole, showed no growth while two, Ashley and Victoria, progressed one level after entering the teaching field. Unlike some of the aspects, it was difficult to determine any relationships between those who progressed and those that did not. One conclusion that may be drawn from this is that the course did not successfully...
address feedback beyond the prior knowledge participants brought from other UF coursework. Each participant came to the course with some conceptual development and while the readings may have addressed the role of feedback in formative assessment, the course did not provide substantial opportunities to implement those concepts in their internships. The two who did progress after the course may have encountered more opportunities to develop this skill in practice, but there is limited insight drawn from the data on why this may be. Across all cases, the challenge of finding time to provide feedback was shared and certainly a factor to consider in the lack of progression towards mastery.

**Activating Students as Instructional Resources for One Another**

All but one participant experienced growth in activating students as instructional resources. However, in most cases minimal growth was made in this aspect overall. Only one participant moved up a level during the course reflecting, as with feedback, that the course provided limited opportunities to develop knowledge and practice of how collaborative group structures could developed in ways that moved learning forward. In most cases, participants described using the grouping structures of their mentor teachers or traditional tiered structures within the internship setting. Even when transitioning to their own classrooms, the routine of using small, homogenous groups to meet with struggling students was constant across participants and most struggled to make conceptual distinctions between doing work in groups and using groups as collaborative learning opportunities. Participants all described some level of challenge with the age of students or classroom management and it is likely that this remained a barrier to continuing to develop truly collaborative mathematics structures. Nicole was one exception and she attributed her growth to gaining professional freedom to use
collaboration in ways that differed from her mentor and the administrative push in school for student-centered mathematics classrooms. Activating students as instructional resources for one another is arguably challenging to implement well and without the learning opportunities and administrative support that Nicole experienced, it may not be surprising that it was difficult for most of the participants to appropriate this aspect at higher levels as novice teachers.

**Activating Students as Owners of their Own Learning**

Activating students as owners of their own learning was a significant component of the formative assessment course and another aspect that participants demonstrated meaningful growth. Because several implementation assignments focused on involving students in the assessment process, it is not surprising that all the participants made progress in their understanding. Levels of appropriation were sustained as novice teachers, but participants did not demonstrate continued growth after completing the formative assessment course. Maintaining levels of appropriation was attributed mainly to the conceptual understanding of involving students in assessment rather than continuing the practices they engaged in during their internship. The age of the students was of particular concern across participants in this aspect. All participants expressed understanding of the importance of engaging students in assessment and the role it played in helping students own their learning and move forward, but in most cases did not involve students because of the concern that they would not be able to adequately assess and monitor their own progression.

**Comparing Supports and Constraints across Participants**

For the second research question, the data was reanalyzed to look at similarities and differences in the support and constraint codes applied across all four participants.
Analyzing constraints that were applied across most or all of the participants resulted in two primary themes: time and student characteristics. When the same process was repeated for supports, the practice-embedded course design and instructional resources were identified as two primary themes. Finally, when looking at differences in the support and constraint codes applied for participants the relationship between content and formative assessment knowledge and practice was a significant theme relevant to the preparation of novice teachers. Each of these themes will be presented in the following sections.

**Shared Constraints for Appropriation of Formative Assessment**

**The ever-present challenge of time**

One constraint was consistent across all four participants at some level, and that was time. Some participants described the challenge of time more than others, but it was present in all four cases. The challenge of time took two particular forms: time to implement formative assessment practices and time to review evidence and provide feedback. When it came to implementing formative assessment, the time allotted by the school for mathematics instruction was a common barrier for all participants. Engaging their students in discussions and collaborative tasks were especially seen as difficult to include when they had less than an hour for math instruction. When appropriating at the surface level, they were often selecting practices for each aspect that took minimal time to implement—like an exit ticket out the door. It often required a deeper level of conceptual understanding to recognize that the time investment in meaningful formative assessment practices was worth it for greater insight into student thinking and stronger outcomes in student learning.
When implementing formative assessment in mathematics, the concern over time to review the information being elicited was also a barrier. Ashley and Nicole both collected a significant amount of data from students, sometimes using technology, and described issues in finding the time to really look over all the student work they were collecting in meaningful ways. Victoria and Megan also described that when they collected exit tickets or student work from class, they knew it would be best to give students feedback immediately but found there was not enough time to meaningfully read through their work and give that depth of feedback in a timely way. Just like so many approaches to improving teacher practice and student learning, the concern of time was no different for these participants.

Variations in student characteristics

For all four cases, the characteristics of the students in the classroom presented some barriers to their development of formative assessment practices. Each participant conveyed some level of concern about the age and behavior of their students as it related to being able to implement the aspects of formative assessment. Victoria was one participant in particular that struggled with using formative assessment in the ways she had learned about or used in the course because she had a larger number of ESOL students in her classroom. Creating tasks that all students could engage in presented a challenge as many students had trouble communicating their ideas to one another. Nicole had shifted from a classroom of high-achieving students with strongly involved parents to a Title I school that struggled to meet high-stakes assessment goals and parents who wanted to be involved but often worked multiple jobs. This shift in student dynamics meant that some of the formative assessment practices that worked well in her internship needed to be changed to meet the needs of her new students. As a
whole, all the participants in this study also taught very young students. In some cases, this was different from their internship and that shift was a challenge in itself. At some level, they all described issues in managing classroom behavior or lack of maturity to effectively engage in collaborative work or self-assessment. In all of the cases, participants could understand the value in student-centered approaches to collecting evidence and activating students, but even participants with the highest levels of appropriation still struggled to use them as frequently as they would have liked. This was also a concern during the course as one of the primary texts was geared towards older students. There may be a need for a broader range of readings to better prepare those implementing with younger students.

**Shared Supports for Appropriation of Formative Assessment**

**Practice-embedded design supports development**

Throughout the course and into their first years of teaching, all four participants were able to show overall growth in their formative assessment knowledge and practice. In some capacity, they all attributed their current levels of appropriation to the practice-embedded design of the course. All participants were able to identify a few concepts or activities from the course that stood out to them, but one participant notes that she did not remember the course well before conversing with the researcher. The most commonly cited assignment was the second project, the tiered lesson plan. This was significant to the participants for two shared reasons: 1) it was used for another course assignment and observed by their university supervisors; 2) it required them to plan multiple instructional responses based on formative assessment data—a first time experience for all of them. While a similar tiered lesson plan format was not a part of their current practice, some of the formative assessment practices used within that
lesson were still a part of their math instruction. And although they did not remember other assignments by name, the interviews and observations showed strong relationships between current practices and those implemented and discussed during the course.

When asked if taking the course during their internship made a difference in how they understand and use formative assessment now, the answer was a resounding yes. In addition to growth in each of the aspects described earlier, participants noted a general shift in how they viewed the purpose of formative assessment from engaging in the readings and online discussions in the course. Megan and Victoria noted how they used to believe assessment in math was equivalent to a test, and the course helped them to discover that assessment can take many different forms and impact your teaching, not just provide grades. They felt that this continued into their first years of teaching and making themselves more open to assessing in formative ways. Ashley and Nicole began the course with more robust definitions of formative assessment, but they noted the importance of being exposed to the many types of approaches that could be considered formative. In their current classrooms, they espouse strong beliefs that anything can be considered formative assessment and it is much more than a list of strategies or benchmark assessments. The course was a stepping stone in forming participants’ views of formative assessment and what it looked like in their current classrooms.

For each participant, what made the impact of the course unique from others they had taken from the university was the purposeful design connecting course assignments to their internship teaching experiences. Every participant remarked how
having this course while they were in a long-term teaching position, unlike other practicum experiences, gave them the opportunity to practice assessment concepts they read about or learned in other courses with students. It was especially important that these were students they saw daily over a long period of time as they could experience the outcomes of each formative assessment practice they implemented. It also gave them a lens through which to critically analyze the practices of their mentor teachers. Ashley and Victoria also noted the difference they discovered with their current colleagues—describing a better understanding of what formative assessment is and a comfort level with implementation. In contrast, they see their colleagues struggle to use formative assessment even when it is mandated by administration. They believed one difference was their opportunities to see what formative assessment looked like in the classroom as they were learning about the theory, instead of being handed instructions on how and when to assess students.

Instructional resources

Across all participants, the importance of having instructional resources available to implement formative assessment was critical to their continued development. These resources took many forms, including: curriculum, technology, and supportive faculty and staff. First, curriculum and curriculum-related resources were cited across all participants as being a place to draw eliciting tasks and discussion questions from. Victoria described pulling tasks for her exit tickets from their math curriculum while Nicole noted the usefulness of assessment question banks developed to support her students’ textbooks. In the case of Megan and Victoria, the math curriculum largely defined their development of learning targets and deciding when to implement eliciting tasks and discussions.
Technology was another shared resource by Ashley and Nicole. In both cases, they found that using technology allowed them to easily collect student data and provide feedback to students, parents, and administrators with a goal to improve student learning. Of course, they also recognized the challenge of finding the time to review that evidence as frequently and timely as they knew would be most beneficial. The level of comfort they and their students demonstrated using the technology supported the frequency with which technology is utilized for formative purposes in the classroom.

All participants also identified supportive faculty and staff as important instructional resources. A collaborative teaching community that shared plans and instructional activities and feedback was described by Ashley and Megan, while Nicole and Victoria noted some sharing of assessment ideas and assessment resources provided by their administration. In most of the classrooms, support staff was available and came regularly to the classroom where they could help facilitate formative assessment practices that required more than one instructor.

**Primary Difference in Supports and Constraints**

**Formative assessment and content: A critical pair.** When it came to the development of formative assessment for math instruction, all four participants demonstrated the importance of having both content and pedagogical content knowledge for reaching higher levels of appropriation. Ashley and Nicole made significant progress in developing formative assessment knowledge and practice, and they also described strong, positive beliefs about mathematics and teaching mathematics conceptually. Knowledge of mathematics content and pedagogy supported their design and understanding of learning goals and criteria. It also allowed them to select tasks and facilitate conversations that provided space for multiple
solutions and strategies. While they still had some concerns over managing student-centered approaches to mathematics, those apprehensions were overpowered by their belief in the importance of teaching mathematics conceptually. Ashley and Nicole also were more likely to make more detailed interpretations of student thinking and not rely on vague instructional responses like re-teaching. While the connections to instructional adaptations were not perfect, their knowledge of math content and pedagogy was useful in making more specific responses that went beyond re-teaching or providing additional practice problems.

On the other hand, Megan and Victoria described concerns about teaching mathematics because they felt it was not their personal strength. In both cases, they made strong distinctions between using formative assessment in math as opposed to other subjects like reading and writing. When discussing those distinctions in their interviews, they revealed underlying beliefs about mathematics being a more straightforward subject with less room for interpretation than language arts. They acknowledged that students could use multiple strategies to find a solution, but they did not always feel comfortable facilitating conversations where students used multiple approaches. When describing how they monitored student progress using formative assessment, the focus was primarily a “get it or don’t” (Otero, 2006) approach and they looked at final answers to assess student understanding over dissecting student thinking. In both cases, it demonstrated that appropriation of formative assessments is not only impacted by setting but also individual factors like beliefs and knowledge.

**Conclusion**

When looking across all four cases, this study found that all participants experienced growth in their appropriation of formative assessment knowledge and
practices. Results across cases also showed that certain aspects of formative assessment were better emphasized by the course than others. The formative assessment course was found to be a support in the growth participants experienced, but the supports and constraints in the novice teachers’ schools played critical roles in how their knowledge and practices continued to develop. Instructional resources provided in the school setting were another shared support that participants described. On the other hand, student characteristics and time to implement and review formative assessment data were challenges to implementing formative assessment practices. When contrasting participants, the knowledge and beliefs about teaching mathematics emerged as a critical individual factor that impacted participants’ levels of appropriation. The findings from this cross-analysis and individual analyses will be discussed in the next chapter regarding their significance and connections to other research in the field.
Preparing Novice Teachers to Implement Formative Assessment

Formative assessment has been identified as having a significant impact on student performance when implemented in the mathematics classroom (Black & Wiliam, 1998; Crooks, 1988; Kingston & Nash, 2011; Natriello, 1987). This impact is amplified when teachers have developed the knowledge and skills to implement formative assessment effectively (Gotwals, et al., 2015; Phelan et al., 2011; Wilson, 2008).

However, research has found that formative assessment is often implemented ineffectively (Kohler et al., 2008; Schoenfeld, 2015; Shepard et al., 2005). This can be related to contextual factors related to the settings in which teachers are implementing formative assessments, including administrative support, school climate, student characteristics, and availability of resources. Teachers must also be given the opportunity to learn about formative assessment in ways that translate theory to practice. No matter the extent of evidence in favor of formative assessment, teachers are unlikely to take up ideas that they cannot envision in practice (Black & Wiliam, 1998; Schoenfield, 2015). One way to prepare teachers to use formative assessment effectively has been through teacher preparation courses. Practice-embedded courses aimed at connecting formative assessment theory to practice may be an ideal way to impact teacher practice prior to entering the field, but little is known about how and why knowledge and practices developed in these courses are sustained when entering the teaching field.

The purpose of this study was to understand how the formative assessment knowledge and practices of four previous participants in a practice-embedded formative...
assessment course evolved as they transitioned from preservice to novice teacher. The knowledge and practices were understood through the lens of activity theory, where the participants were seen as engaging in the activity of learning to use formative assessment during mathematics instruction. The formative assessment knowledge and practices were theorized as the conceptual and practical tools for learning to use formative assessment, with a focus on the five primary aspects of formative assessment defined by Wiliam and Thompson (2007). For each aspect, levels of appropriation descriptors were developed and used to describe the changes in participants’ formative assessment knowledge and practices from the course to their fourth year of classroom teaching.

In addition to understanding the evolution of their formative assessment knowledge and practices, the impact of the settings in which the participants learned to use formative assessment were analyzed to identify the ways in which it supported and constrained their current use of formative assessment in mathematics instruction. Activity theory recognizes that learning to teach does not occur in a vacuum, but the settings in which teaching tools are appropriated are critical. For these participants, two primary settings where they learned to use formative assessment were in the formative assessment course, their internship classroom, and their current classroom. An inductive analysis approach (Hatch, 2002) was used to identify the ways in which these settings supported and constrained the evolution of each participant’s formative assessment knowledge and practice.

Findings and Relevant Literature

Analysis of each participant resulted in a detailed description of the formative assessment knowledge and practice of each participant, as well as the impact of the
course, internship, and current classroom settings on that knowledge and practice. To understand the larger impact of these previously reported results, this discussion will focus on findings from individual cases as well as implications drawn from themes across all four cases. These findings will be presented in conjunction with related findings in the literature in the following sections.

**Understanding How Teacher Preparation Transfers to the Classroom**

Results of the study found that all participants experienced growth in the formative assessment knowledge and practices during the course, but not all continued this growth when entering the field. Participants appropriated some aspects of formative assessment better than others, such as activating learners as owners of their own learning, reflecting strengths and weaknesses in the course design. The growth participants experienced during the course support similar findings by Buck et al. (2010) and Wallace and White (2014) that teacher preparation courses can prove beneficial in developing preservice teachers’ assessment literacy. Buck et al. (2010) also found that preservice teachers encountered limits to their growth. Even after considerable conceptual growth in their understanding of formative assessment, preservice teachers often focused on content mastery over student thinking and struggled identify instructional adaptations—a finding echoed by Gotwals and Birmingham (2016). In this study, all of the participants faced similar limitations in their appropriation of formative assessment during the course. While two of the participants showed strengths in understanding the importance of multiple solutions and discussing student strategies, it was not a part of any participant’s regular practice during their internship. All of the participants struggled to make instructional adaptations that specifically addressed misconceptions identified during eliciting activities, and often relied on reteaching and
extra practice as solutions. When determining student progress towards learning goals and providing feedback, there remained an emphasis on mastery of the content as measured by final products over process.

Another important finding from this study was that the participants were able to sustain or improve their levels of appropriation as novice teachers and attributed their growth, in part, to the practice-embedded design of the course. This is of particular interest as recent experts in classroom assessment and teacher preparation research have described the need for studies that follow preservice teachers into the field to better understand the impact of professional knowledge and practice gained in coursework (DeLuca et al., 2013; Kohler et al., 2008; Sabel et al., 2015). Because of heightened expectations for student learning in recent years, teacher preparation programs have looked to include more opportunities to engage novice teachers in “practice-based” coursework that might support “ambitious” teaching practices needed in today’s classrooms (Forzani, 2014). The results of this study found that the opportunity to implement ideas in practice during the teacher preparation program led to gains in preservice teachers knowledge and practice around formative assessment, considered an element of “ambitious” teaching. Gainsburg (2012) also found that concepts that students were provided opportunities to implement in practice, including elements of formative assessment, were much more likely to be used by novice teachers of mathematics.

At the same time, there were limits to participants’ growth—especially during their internships. Many participants did not move past the level of appropriating surface features while in the internship, a finding similar to Luttenegger (2009). When tracing
teachers’ appropriation of formative assessment, she found that preservice teachers were unable to move past appropriation of surface features because they were unable to develop conceptual understanding in the span of one course. Similarly in this study, if the participants did not enter the course with existing conceptual understanding of the aspects of formative assessment it was rare for them to move past appropriating surface features.

Factors Impacting Appropriation of Formative Assessment

Initially, this study aimed to look at how the formative assessment course and current school settings impacted novice teachers’ appropriation of formative assessment knowledge and practice. After collecting and analyzing the data, however, it was evident that individual characteristics were an important dimension to discuss as it was pertinent to each participant’s growth. This outcome in the data is supported by activity theory, as Grossman et al., (1999) states that change in appropriation “depends on the social context of learning and the individual characteristics of the learner” (p.17). Other research on teacher development using activity theory as a framework found both learning contexts and individual characteristics to be important influences on levels of appropriation (Leko & Brownell, 2011; Longhurst, Jones, & Campbell, 2017; Luttenegger, 2009; 2012). The findings of this study add to this existing knowledge on how activity settings and individual factors impact teacher knowledge and practice. Each of the supports and constraints, related to context and individuals, will be presented below with their connection to relevant literature.

Supportive structures in school settings

The cultures and teaching practices that are emphasized in teacher preparation coursework, like the formative assessment course in this study, and in-the-field teaching
experiences are often at odds (Grossman et al., 1999; Vick, 2006; Zeichner, 2010) facing students with a choice between what they learned at the university versus what is happening in the schools they teach in. However, support structures like the participants in this study described may play a role in helping novice teachers continue practices that may not be common in the field. In fact, lack of support structures has been identified as a primary barrier in novice teachers’ continuing practices from their teacher preparation programs (Gainsburg, 2012; Liston et al., 2006). Supporting contextual factors in the participants’ current teaching settings included administrative support, curriculum, and instructional resources.

For several teachers in the study, support from their administration was beneficial to their use of formative assessment. In some cases this took the form of simply providing teachers with professional freedom to make instructional decisions and not feeling forced to stick to curricula or pacing guides. Fantilli and McDougal (2009) also found that a supportive administrator was cited as “one of the most effective supports in [the] first years of teaching” (p.823) by novice teachers. They found that novice teachers identified principals that supported collaborative teaching communities and built planning time into the schedules as critical supports. For several of the participants, particularly Megan and Ashley, strong collaborative colleagues were identified as important supports to their use of formative assessment and reflected the emphasis their administration placed on teacher collaboration.

Curriculum and instructional resources were also noted by several participants as beneficial to their use of formative assessment in mathematics. Having curricular resources that aligned with the theory and practices emphasized in the course was
helpful to some in implementing formative assessment, but most still needed the knowledge to identify those resources and implement them effectively. This supports the theory that conceptual development may need to proceed practical knowledge when appropriating teaching concepts (Grossman et al., 1999). Of particular interest was the case of Megan who was working from a strong, research-based curriculum that supported the aspects of formative assessment addressed in this study. Working from this curriculum provided her the opportunity to easily adopt the surface features of formative assessment, but she struggled to develop conceptual understanding that would help her to reach higher levels of appropriation. Although some have also argued that implementing practices before theory can eventually lead to the development of conceptual understanding (Liston et al., 2006), she demonstrated that the lack of conceptual understanding can lead to a more superficial adoption of teaching practices emphasized in reform-based curricula (Windschitl, 2002). In some ways this was unexpected, as novice teachers are often anticipated to be more likely to adopt the practices of reform-based curricula (Remillard & Bryans, 2004).

**Constraining factors in school settings**

Constraining factors across participants included themes of time and student characteristics. Time was recognized by all as an issue for planning, implementing, and responding to formative assessment in mathematics instruction. For some, this was an issue of not enough time provided for math instruction to include eliciting discussions and task. Gainsburg (2012) also found time to be an overwhelming barrier for novice teachers implementing the practices taught in their teacher preparation program—particularly the challenge of limited class time. It is also possible that their lack of
experience implementing discussions and collaboration in mathematics led to a perceived lack of time.

Even when participants found the time to implement formative assessment practices, the all described dimensions of student characteristics that made implementation challenging. Facilitating formative conversations in mathematics was not easily accomplished by any of the participants, but Victoria had an additional barrier of multiple ESOL students who struggled to engage in any level of conversation—a challenge that has been well documented (Moschkovich, 2007). Another commonly cited characteristic was students’ age as it related to their ability to appropriately engage in formative assessment practices and the behavior challenges of that engagement. Engaging students in the student-centered teaching required for good formative assessment practice is often at odds with the traditional classroom management techniques found in schools (Garrett, 2008) and this study found that participants also encountered that struggle—particularly Ashley. Both student characteristics and time could also be considered derivatives of what Liston et al. (2006) describe as the emotional stressors of the first years of teaching.

**Mathematics knowledge and beliefs**

Another finding from this study is that mathematical knowledge and beliefs played an important role in the appropriation of formative assessment. Many researchers have found similar results over the years, noting that knowledge and beliefs about mathematics play a significant role in the adoption of mathematics teaching practices (Ernest, 1989; Gainsburg, 2012). Ashley and Nicole demonstrated greater knowledge of and positive beliefs about teaching mathematics and were able to attain much higher levels of appropriation than their peers. This supports the findings of Falk
(2012) and his description of the reciprocal relationship between the use of formative assessment and pedagogical content knowledge. While implementing formative assessment practices, teachers are gathering critical information about student learning and building their knowledge about student strategies, misconceptions, and appropriate instructional adaptations.

**Implications**

These findings imply that similar online, practice-embedded courses may be able to support novice teacher use of formative assessment, but there is a continued need for support during the first years of teaching to overcome obstacles in comparable classroom contexts in the form of professional development, planning time, technology, and reform-oriented curricular resources. Other teacher preparation programs might consider developing similar online courses that focus on having students both develop conceptual understanding through readings as well as creating assignments that ask students to implement practices based on theory and be given the opportunity to reflect on those experiences. Because this was an online course, it also demonstrates that face-to-face instruction is not a mandatory component to building teacher practice in teacher preparation programs. The online format might be considered for those wanting to make more connections between coursework and practicum experiences when time is limited.

The limits that teachers experienced in their development also imply that teacher preparation programs may not be sufficient in developing teacher knowledge and practice. For all the novice teachers in this study, school-based supports were important to their success in continuing to use what was learned in the formative assessment course. In order to support teacher practice, schools with similar
characteristics should consider ways to support teacher learning with professional learning experiences and instructional resources as described in the cases presented here. Professional learning experiences might include professional development opportunities, well-developed mentoring and induction experiences, and support for continuing education with local universities. Instructional resources such as educative, reform-based math curriculum, technology, and support staff could support teachers in their formative assessment practices. Providing the time and collaborative teacher structures to plan for formative assessment should be considered, as this study revealed that time to develop formative assessment opportunities in their teaching and review the data in meaningful ways was limited across varied school contexts.

Results of the study also revealed an important relationship between knowledge and beliefs for teaching mathematics and appropriation of formative assessment. Those who demonstrated greater knowledge and positive beliefs experienced greater levels of conceptual understanding and use. In order to prepare novice teachers to use high-leverage practices like formative assessment, their content knowledge, pedagogical content knowledge, and beliefs about mathematics and teaching mathematics must also be addressed within their teaching programs. Mathematics content and pedagogy courses would be advised to address knowledge and beliefs and continue to revisit those knowledge and beliefs throughout practicum experiences. Reform-based curriculum that lend themselves to formative assessment did provide support in one teachers’ practice and adopting educative curriculum materials might be another potential avenue of addressing teacher knowledge about mathematics when faced with opposing beliefs from their own learning experiences.
Although the results provided a much-needed look at the practices of novice teachers, only four specific individuals and schools were included for this multi-case study. Results may translate to similar courses, schools, and individuals as those captured in study, but there is a continued need for larger, long-term studies on novice teacher use of formative assessment to make broader claims about the impact of teacher preparation courses and school contexts. Looking at the long term impacts for larger sets of students completing similar formative assessment courses and teacher preparation programs would give greater insight into the sustainability across varied contexts. Participants in the study may represent teachers who were already predisposed to improving their practice and following larger sections of students is needed to understand how practice-embedded courses impact novice teachers in less favorable conditions for sustaining formative assessment practices.

Limitations and Future Directions

Limitations of the research study presented include: time, self-report, and participant selection. First, the data collected from participants was limited due to time and, as a result, only represent a segment of each participants’ larger teaching practice. Triangulation of multiple data sources, including the collection of observations and artifacts, was included in attempt to compensate for the limited time window in which the data was collected. Another limitation is the reliance on teachers’ self-report of their teaching practices. Again, classroom observations and artifacts were collected to add more objective measures of teachers’ practice. The researcher was also intentional about building report with the participants and emphasizing the importance of understanding actual practice and not assessing teacher performance. Future studies might consider a longitudinal approach to novice teacher practice to develop a more
comprehensive look at how formative assessment knowledge and practice evolves. Additional research including multiple classroom observations would also help to overcome the challenge of inflated reports and provide more objective reports of daily formative assessment practice.

Finally, participants in this study represented a convenience sample due to the difficulty in finding teachers willing and available to volunteer. Each participant was a young, white female and this limits the application of the results to all novice teachers. Like many universities, the majority of students enrolled in the college of education are white females and their experiences may not mirror those from varied backgrounds. Those willing to participate also limited the school contextual variables included in the study. Ideally, more volunteers would have provided the opportunity to select participants that varied across school context variables to present distinct and compelling cases. Although the four participant contexts did vary in several ways, the degree to which they differed was constrained by the limited number of volunteers. Future studies would benefit from contacting students from multiple semesters to include other compelling cases that were not included in this study.

**Conclusion**

This study aimed to provide insight into the impact of novice teachers’ settings and individual characteristics on their development of formative assessment knowledge and practices gained during their teacher preparation program. In particular, it looked at a teacher preparation course on formative assessment that was designed to make explicit connections between formative assessment theory and practice by embedding the course in the participants’ student teaching internship. The results found that novice teachers were able to sustain or increase their appropriation of formative assessment
knowledge and practices after their first three years of teaching. All participants cited the practice-embedded design as an important support in their ability to continue using their knowledge and practice. This result supports calls for stronger connections between theories learned in teacher preparation programs and the opportunities to implement those practices during field experiences. It may also provide a potential online, practice-embedded model for similar universities looking to find ways to develop novice teachers with the knowledge and skills to implement what they learned in their programs when faced with potential cultural mismatches encountered in future school environments.

In addition, this study found that elements of school settings did impact practice. Critical contextual factors included administrative support, availability of instructional resources, time to implement assessment practices, and variations in student characteristics. This result supports the need for schools and universities to ensure continued professional supports that can help teachers maintain teaching practices, like formative assessment, once they enter their novice teaching years. The results also found that individual factors like knowledge and beliefs for teaching mathematics, professional drive, and teaching experience played a role in continued development of formative assessment knowledge and practice. Only providing multiple support structures for teachers may not be enough for all teachers to continue using formative assessment as novice teachers and there is a need to address teachers’ knowledge and beliefs with respect to teaching mathematics.

As a whole, the results of this study add to the field in several ways. First, this study provides a framework for analyzing teacher development of formative assessment
knowledge and practices with the articulation of the Formative Assessment Levels of Appropriation Framework. Second, it provides insight into how and why formative assessment knowledge and practices evolve as preservice teachers transition to new teaching environments as novice teachers. Third, it identified supportive and constraining factors of both school settings and individual characteristics that need to be addressed by comparable school and universities contexts. The results highlight a need for larger, longitudinal studies that can better inform how novice teachers might be best prepared to use formative assessment in today’s complex classroom environments on a greater scale.
APPENDIX A
INFORMED CONSENT

Informed Consent

Protocol Title: Understanding the Impact of a Practice-Embedded Teacher Preparation Course on Novice Teacher Formative Assessment Knowledge and Practices

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

Purpose of the research study:

The purpose of this study is to identify the formative assessment knowledge and practices of teachers who recently graduated from the College of Education at the University of Florida. The collection of data on formative assessment knowledge and practices will help to understand the impact of a practice-embedded formative assessment course (MAE5396/EDG6931) on the current teaching practices of full-time teachers in Florida who completed the course. Understanding the current practices of teachers and their connections to the formative assessment coursework will help evaluate the current practice-embedded model used in the course.

What you will be asked to do in the study:

You will be asked to complete two interviews and one classroom visit regarding your knowledge and utilization of formative assessment. The classroom visit will occur during a mathematics instruction block of your choice, lasting approximately 40-60 minutes. Both interviews will take approximately 30-45 minutes and will reference assignments you submitted on Moodle/Canvas when you were enrolled in the formative assessment course (MAE5396/EDG6931).

Time required:

2 - 3 ½ hours

Risks and benefits:

There are no known risks of participating in this study. There are no direct benefits to you for participating in the study.

Compensation:

There is no compensation/course credit offered for participating in this study.
Confidentiality:
Any identifiers will be removed from all data collected and replaced with pseudonyms to protect your privacy. Your identity will be kept confidential to the extent provided by law and will not be revealed in the final manuscript.

Voluntary participation:
Your participation in this study is completely voluntary. There is no penalty for not participating.

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

Whom to contact if you have questions about the study:
Carolyn E. Mitten, Graduate Student, School of Teaching and Learning, P.O. Box 117048, phone 352-273-4185.
Tim Jacobbe, Associate Professor, College of Education, P.O. Box 117048, phone 352-273-4232.

Whom to contact about your rights as a research participant in the study:
IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250, phone 392-0433.

Agreement:
I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: ___________________________ Date: ________________
Principal Investigator: ____________________ Date: ________________
## APPENDIX B
### FORMATIVE ASSESSMENT COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Reading</th>
<th>Due Wednesday</th>
<th>Due Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Why is assessment important?</td>
<td>Syllabus&lt;br&gt;Ahead of the Curve, Intro&lt;br&gt;Ahead of the Curve, Ch. 1&lt;br&gt;Laud, Ch. 1</td>
<td>&gt;Self-introduction&lt;br&gt;Read and post R1A</td>
<td>&gt;Try It -- Teacher Self Assessment and post T1A&lt;br&gt;Reading response post R1B</td>
</tr>
<tr>
<td>2</td>
<td>What is the student's role in math assessment?</td>
<td>Ahead of the Curve, Ch. 2&lt;br&gt;Laud, Ch. 2</td>
<td>&gt;Read and post R2A&lt;br&gt;Try It response post T1B&lt;br&gt;Work on the Involving Students in Assessment Project</td>
<td>&gt;Try It -- In Depth Analysis and post T2A&lt;br&gt;Reading response post R2B&lt;br&gt;Work on the Involving Students in Assessment Project</td>
</tr>
<tr>
<td>3</td>
<td>What will I do with my formative math assessment data?</td>
<td>Laud, Ch. 3</td>
<td>&gt;Read and post R3A&lt;br&gt;Try It response post T2B&lt;br&gt;Complete the Involving Students in Assessment Project and submit post P2A</td>
<td>&gt;Try It – Open Ended Questions and post T3A&lt;br&gt;Reading response post R3B&lt;br&gt;Involving Students in Assessment Project response post P2B</td>
</tr>
</tbody>
</table>
| 4 | How will I differentiate instruction to support students who are low achieving in mathematics? | Laud, Ch. 4 | >Read and post R4A  
>Try It response post T3B  
>Work on the Tiered Lesson Plan Project | >Try It – Plan to Improve and post T4A  
>Reading response post R4B  
>Work on the Tiered Lesson Plan Project |
|---|---|---|---|---|
| 5 | How will I differentiate math instruction to support students who are high achieving in mathematics? | Laud, Ch. 5 | >Read and post R5A  
>Try It response post T4B  
>Work on the Tiered Lesson Plan Project | >Try It – Enrichment Activity and post T5A  
>Reading response post R5B  
>Work on the Tiered Lesson Plan Project |
| 6 | How will I have time to implement this process on a regular basis in my math class? | Laud, Ch. 6 | >Read and post R6A  
>Try It response post T5B  
>Complete Tiered Lesson Plan Proj. and submit post P5A | >Reading response post R6B  
>Tiered Lesson Plan Proj. response post P5B |
| 7 | How can I make formative assessment a sustainable practice in my teaching of mathematics? | Ahead of the Curve, Ch. 9  
Ahead of the Curve, Epilogue | >Read and post R7A | >Try It – Strategy Choice and post T7A  
>Reading response post R7B |
| 8 | What are my views on the use of formative assessment in my math classroom? | None | >Try It response post T7B >Try It -- Teacher Self Assessment and post T8A | >Final Exam |
# Weekly Prompts for Reading Posts.

<table>
<thead>
<tr>
<th>Week</th>
<th>Reading Prompt</th>
<th>Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On pages 5-6 of her book, Leslie Laud compares a traditional classroom to a differentiated one. Which one of these best describes your most recent mathematics classroom? In your reading discussion group (automatically listed here) give examples that support your claim.</td>
<td>FA1, FA2</td>
</tr>
<tr>
<td>2</td>
<td>How do you feel about students being involved in the assessment process? Is this something that you can see working in your classroom? Can you think of any instances in your own classroom where you have used one or more of the cornerstones talked about in <em>Ahead of the Curve</em> reading this week? If not, how might you go about working one or more of these cornerstones into your teaching?</td>
<td>FA1, FA2, FA5</td>
</tr>
<tr>
<td>3</td>
<td>Please record your overall thoughts and impressions about this week's reading.</td>
<td>FA2, FA3</td>
</tr>
<tr>
<td>4</td>
<td>In what ways have you supported low achieving students in the past? Go to <a href="http://www.eduplace.com/kids/hmm">http://www.eduplace.com/kids/hmm</a> (Links to an external site.) (link found on p. 96 of the Laud reading) and explore the website. Would review games like these be helpful for your low achieving students? Explain how you envision using this site (or one similar), or explain why you believe these types of sites to not be helpful.</td>
<td>FA2, FA4, FA5</td>
</tr>
<tr>
<td>5</td>
<td>What are some positive and negative aspects you foresee with exempting high achieving students from completing all on-level work? The author talks about two strategies to avoid. Do you feel these should be avoided? Are there other strategies to be avoided that were not mentioned?</td>
<td>FA2, FA4, FA5</td>
</tr>
<tr>
<td>6</td>
<td>Comment on one of the timesaving strategies in this week’s reading. Then write a paragraph describing whether or not (and why) you have found implementing the activities asked of you by this course to be problematic in terms of time.</td>
<td>All</td>
</tr>
<tr>
<td>7</td>
<td>As described in the reading, peer community has the potential to be a powerful support for teachers. In your post respond to the following questions. 1) Why do you think the teacher collaboration systems described in the articles had such a big impact? 2) What is the structure of the teaching community where you are (e.g., are there teams, mentors, co-teaching, formal teaching meetings, or does everyone just do his/her own thing) and how has the structure impacted your experience? In particular, describe how you and your mentor teacher (if applicable) have learned from each other while implementing the formative assessment and differentiated instruction assignments for this class.</td>
<td>All</td>
</tr>
</tbody>
</table>
## Weekly Prompts for Implementation Posts

<table>
<thead>
<tr>
<th>Week</th>
<th>Implementation Prompt</th>
<th>Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complete the survey entitled &quot;Teacher Self Assessment,&quot; which can be found in the Laud book on p. 3 or online (link provided). You may answer these questions on the basis of any one math classroom where you have spent time recently. If you use the online version of the survey you should print your completed survey for reference now and at the end of the course.</td>
<td>FA1, FA2</td>
</tr>
<tr>
<td>2</td>
<td>As a form of involving students in the assessment process, have students complete the in-depth analysis of mistakes for an assignment of your choice. Younger students are likely to need a modified form and you may wish to implement this with just a small group of younger students so as to be able to scaffold them. Read through the responses you get from your students and reflect on at least one way you could alter or differentiate your teaching to accommodate a common mistake students seem to be making. If your students suggested ideas for going forward, share these in your post too.</td>
<td>FA1, FA4, FA5</td>
</tr>
<tr>
<td>3</td>
<td>As informed by the reading on p. 52 of the Laud book, identify three questions in your existing lesson plans you'll use this week that would be classified as &quot;single answer questions&quot;. For each one, rewrite the question in an open-ended form and use it in your teaching. In your forum post, share one question you rewrote and reflect on how your class responded to the open-ended format.</td>
<td>FA2, FA3</td>
</tr>
<tr>
<td>4</td>
<td>Customize the “Plan to Improve” on p. 83 of the Laud book to fit what your class is currently working on, and have one or more students who are struggling with that topic complete a Plan to Improve. Look over the results and comment on the following in your forum post: Based on the readings and discussions so far, how do you plan to follow up with the Plan to Improve? How will this follow-up help your low achieving students to improve their understanding? Please attach the &quot;Plan to Improve&quot; that you used to your post.</td>
<td>FA2, FA4, FA5</td>
</tr>
<tr>
<td>5</td>
<td>Design one enrichment activity for the current topic you are teaching and implement it. This can take any form you choose, but its purpose should be to provide a higher level challenge within the current topic for those students who need it. So although you may decide to open it up to all students, or provide a modified version to some students, the main enrichment activity should be targeted to the group who has mastered the basics already. It may be helpful for you to consider the guidelines presented in the middle of p. 115 in the Laud text. For your forum post, write a paragraph discussing the manner in which you gave the enrichment (e.g., which students participated and what other students did while they were taking it (or maybe it was homework)), and reflect on how it impacted your students. Please attach the enrichment activity with your post.</td>
<td>FA2, FA4, FA5</td>
</tr>
</tbody>
</table>
No post this week due to class project.

For this final implementation, you may choose any one of the following to try in your math classroom.
1) Feedback Forms—In last week’s reading the Laud book suggests structured feedback forms as a way to save time by having students direct their own learning based on their individual difficulties. Using the feedback form on pp. 122-123 as a guideline, tailor a feedback form of your own that fits the current topic you are teaching. Administer this form to students who make two or more mistakes on a homework assignment given this week. Meet with your students individually or in small groups to discuss their mistakes and how they were able to (or not able to) correct them on the form. In the forum for your group, detail how these meetings went and how your students responded to the individualized assignment and attention. What was your overall impression?
2) William’s Suggested Strategies—From this week’s reading in Ahead of the Curve, choose one of William’s five recommended strategies on pp. 193-194 and implement it during a lesson that you are teaching this week. You may use an exact strategy seen in the reading or you may modify it as you see fit. In the forum for your group, share the strategy that you used as well as the positive and negative aspects of the implementation. Be sure to tell why you would or would not use this strategy again.
3) Flex (your choice!): This is your chance to focus on a technique of your choosing inspired by this course that you haven’t yet written about, e.g. something inspired by the reading, by something else you tried, or by something a peer suggested. You may write about something you tried in a prior week of the course or something you have decided to try this week in time for you to write about how it went. It can be something very small—it should just be new to you and should relate to the mathematics formative assessment—lesson differentiation themes of this course. If you need ideas you might go back in to look at the postings of your peers. In the forum for your group, report on what you chose to do and reflect on how the experiment went.

Now that you’ve reached the end of the course, again complete the online survey entitled “Teacher Self Assessment”, which can be found on p. 133 of Laud or at http://goo.gl/forms/ap0ss8b2jD. Take a few minutes to read over your responses and reflect on the type of profile you’ve just created. Compare your responses to those from Week 1 and describe any differences. How has your view of formative assessment and its use in your classroom evolved as a result of this course?
## Course Descriptions of Formative Assessment Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Description</th>
<th>Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Involving Students in Assessment Project</strong></td>
<td>In this project you will identify possible misunderstandings your students may possess for a current mathematics topic, provide a pre-assessment to help your students evaluate their own understanding, and provide a flexible homework assignment that will allow individual students to choose their problems based on their individually-identified needs. (For younger students who don’t have homework this can be an in-class assignment instead.) Your work on this project will be evaluated on the basis of how well your class pre-assessment tool and flexible assignment reflect the varying levels of understanding you seek to address in your students and on the depth of reflection in your post-project discussion post.</td>
<td>FA1, FA2, FA5</td>
</tr>
<tr>
<td><strong>Tiered Lesson Plan Project</strong></td>
<td>In this project you will tier part of an upcoming lesson plan for three levels of students and implement it. You will be evaluated on the basis of how well your lesson plan identifies and addresses different levels of understanding and on the depth of reflection in your post-project discussion post. Please refer to the website for more details on this project.</td>
<td>FA1, FA2</td>
</tr>
</tbody>
</table>
WEEK 2 READING PROMPT: How do you feel about students being involved in the assessment process? Is this something that you can see working in your classroom? Can you think of any instances in your own classroom where you have used one or more of the cornerstones talked about in Ahead of the Curve reading this week? If not, how might you go about working one or more of these cornerstones into your teaching?

STUDENT READING POST: I definitely think that students should be involved in the assessment process and that it can work in my own classroom, but I think it is something that must be introduced gradually in order to make the students feel comfortable doing it all of the time. I think that it would be easy to help students "develop the habit of self-assessing work themselves with error-detection strategies as well as with answer keys and rubrics" (Reeves, 2007). After becoming familiar with the routine, I think that students can definitely be coached to start finding similarities and patterns in their errors.

Luckily, we already use samples to strengthen learning by allowing students to display their math journals on our projector during our math warm-ups, which is a good first step towards independent self-assessment. As Laud (2011) says, by displaying some student work we are showing "different ways to show or represent learning", and we emphasize the "attributes of quality the teacher expects to find as evidence that learning occurred". Whenever we display student work samples, we definitely make a point to emphasize how the student displayed their work and showed their thought process, rather than the answer they got. I think this allows children to not only see what we, the teachers, are looking for from them (which is important because it should be explicitly stated), but it also allows them to get into the mindset of an educator themselves. If they know how to systematically recognize quality work, it will hopefully help them become better at self-evaluating their own work. We also compare the work in our student's math journals against a rubric that all students are graded upon. As a group, the students review each other's work and give it a score based on our rubric. This process gives students "specific, descriptive feedback" (Laud, 2011) and emphasizes things students have succeed with and points out areas that need improvement, which is part of the second Cornerstone in the Ahead of the Curve reading this week. We also use Evaluative Feedback (also Cornerstone 2) in our classroom, but I think most classrooms use it since it is summative evaluation is a very traditional practice. In order to work the motivation Cornerstone into my teaching, I think I could allow students to see more of their graded work and give more specific feedback. It is very tempting to save time and grade/return papers myself, but it really does not give students much opportunity to be motivated to change. We have a very tight schedule, though, so perhaps I could try giving only some detailed feedback and then increasing the amount as students become more skilled at adapting my feedback into their own work.

PEER RESPONSE: You bring up a really good point in your response. I also think that including students in assessment is highly important, but is not something that can be done instantaneously. It seems to be a very gradual process, one that students need to
continually practice in order to master. I believe that self-assessment is extremely hard for adults, let alone students. It is a metacognitive strategy that students can only attain with practice, as you suggest. In addition, detecting errors and patterns in those errors might be difficult for students who are not used to that type of work in class. For example, my students do not do a lot of self-assessment. We do not have them go back and look over their assessments or tests thoroughly. We do go over their assessments, but that is only scratching the surface. Again, I think this is a strategy that would certainly take a while for students to master, but would be worthwhile for students.

I also like the idea of projecting student work for others to see. I think that our student’s peers serve as good motivators. If they see that their peers can do it, they will probably believe that they can produce quality work as well. In my classroom, we also have rubrics that students have copies of in order to reference. However, over time, we stopped emphasizing the rubrics. This is definitely something that I think I can bring up again to my students as a way for them to become more aware of the work that they are doing in their math journals.
WEEK 2 IMPLEMENTATION POST PROMPT: As a form of involving students in the assessment process, have students complete the in-depth analysis of mistakes for an assignment of your choice (you will find this on p. 18 of the Laud reading, or you can create your own). Read through the responses you get from students and reflect on at least one way you could alter or differentiate your teaching to accommodate a common mistake students seem to be making.

STUDENT IMPLEMENTATION POST: We have been working on representing two-digit numbers with amounts of tens and ones. Students completed a four-question assessment. Students were to represent a given number by writing down how many tens and ones there were. Then students were given a picture of a number represented with snap cubes and they had to write down what number it was. We used this half way through the week to see if students were gaining an understanding of the standard. I began by having the students check their work. I then explained to the class that we were going to all look at the problems that they answered incorrectly so that we were able to see what they needed help with.

I was very hesitant about completing this analysis because I thought first graders would have a very hard time correcting their own work. For this reason we went through it together. I gave them a piece of paper. At the top was a box for them to copy down the problem they answered incorrectly. I demonstrated how they would do this using the projector so students could see what I was doing. Then I had all the students write down the first question they got wrong. I then had students circle the part they answered correctly. I showed an example where I said I wrote 4 tens and 3 ones for the number 45. I circled 4 tens because I answered it correctly and then I had students do this with their problem. Then I had students circle with a different color what part of the question they answered incorrectly. Finally I had students figure out the correct answer. I was then going to have students analyze their work on their own but as I walked around I noticed students were having a hard time identifying the parts they got right or wrong and also how to fix it. For this reason I met with small groups and we worked on answering the questions together. With younger students do you think it is common that they are not able to fix their mistakes on their own? Should I have students write down the correct answer to the problem on the test so they having a starting point to fix their answer?

I used snap cubes when explaining tens and ones however the students were having a tough time understanding how many tens were in a number. Many students who answered questions incorrectly did not understand that when they made sticks of tens that they were a group of ten and that there could only be ten in one group of tens. During the next lesson I want to use tens frames to represent tens and ones. I think that with tens frames they would be able to see the ten empty boxes and when they are full they might better understand that it is a group of ten. Also I think this will help the students who had trouble realizing that once you get to ten you have to start a new group. They will be able to visually see that there are no more boxes so they have to
start a new group. I think that I need to show students how to solve problems in a variety of ways. I was so focused on explaining the information the way my mentor teacher and I discussed, using the snap cubes, that I wasn’t thinking of other ways to represent the information. However, all students do not comprehend information in the same manner, which means I need to remember to present information in many different ways.

PEER RESPONSE: It sounds like we are teaching much of the same math information. I am also teaching place value, specifically the tens and ones place. My students also struggled with conducting an in-depth analysis of mistakes individually; therefore, I met in individual conferences with them and guided them through it. I can relate to how your students struggled to know what part of their answer was right and what part of their answer was wrong. Even though I did not conduct my analysis this way, I could see my students struggling with the same concept. I believe it is very common for younger students to struggling fixing their own mistakes. I think it can be done but students need a lot of training and modeling of how to do it. I believe it would be a very time consuming process, but that it would be worth it in the end. It is hard reading examples from the Laude book because it is meant for grades 4-10. However, I believe we can still apply many of these concepts in a first grade class. It will just take more time, training, guiding, and modeling. One sentenced that stuck out to me in our Laude book on page 25 is “spending time investigating conceptually misunderstandings has far more value and impact ultimately on student achievement.” Even though it will take more time teaching our students to grade their own work and to conduct mistake analysis, it will teach our students an important skill and will give them a better chance to succeed. I also believe it is important to present information in many different ways. I had the exact opposite experience of you in my classroom. I used more base ten blocks to try to explain the concept of tens and ones to my students. However, I believe I should of used more cubes to explain the concept. I am sometimes hesitant to use manipulatives in my classroom because some of my students are not responsible with them. However, after reflecting on their tests, I realized it would have been more effective to have all of my students use manipulatives instead of just having a couple of students demonstrate in front of the whole class. I am going to implement your way of using snap cubes and see if that helps my class. It is great that you are willing to try new ways to present information and I hope it works well for your students!
APPENDIX F
SAMPLE INVOLVING STUDENTS IN ASSESSMENT PROJECT

Students Levels of Understanding

Students self evaluated themselves at the end of their pre-assessment to let both themselves and I know how the feel about addition regrouping. The students are to rate themselves on a scale of one to four to explain their understanding. The scale goes as follows:

**Level 1: I am having a hard time with three-digit addition regrouping.**  
Student does not how or when to regroup correctly.

**Level 2: I need some extra practice**  
Student can regroup correctly but does not know when it is appropriate to use it.

**Level 3: I feel like I understand three-digit regrouping.**  
Student knows how to regroup and when it is appropriate to use it most of the time.

**Level 4: I really understand three-digit regrouping.**  
Student knows how to regroup and when it use it all of the time.

________________________

**Pre-assessment**

Students completed pre-assessment as an in class assignment after we had learned five lessons from the chapter on three digit addition. When the students were finished we went over the answers all together while the students self graded/corrected their work. The questions on the pre-assessment corresponded to a specific lesson from the chapter. After grading, the students were able to find out what areas they need extra practice on. I also had students rate themselves on how they felt that they did on the pre-assessment. This allowed me to find out how they were feeling about addition with regrouping.

________________________

**Pre-Assessment Worksheet**

**Break apart the addends to find the sum.**

1. \[ 567 \rightarrow \underline{5} + \underline{6} + \underline{7} + 324 \rightarrow \underline{3} + \underline{2} + \underline{4} \]
   \[ = \underline{8} + \underline{8} + \underline{1} \]

2. \[ 425 \rightarrow \underline{4} + \underline{2} + \underline{5} + 232 \rightarrow \underline{2} + \underline{3} + \underline{2} \]
   \[ = \underline{6} + \underline{5} + \underline{7} \]
Write the sum.

3. 248
   +346
   594

4. 753
   +152
   905

5. 652
   +264
   916

6. 147
   +125
   272

7. 391
   +537
   928

Fill in the correct response.

8. There are 148 small sand dollars and 119 large sand dollars at the store. How many sand dollars are at the store?
   a. 257
   b. 267
   c. 357
   d. 367

After grading tell me how you feel about three-digit addition problems with regrouping by rating yourself on a scale from 1-4. Circle the number that best describes you.

1  2  3  4

1- I missed 5 or more questions on my worksheet. I am having a hard time with three-digit addition regrouping.
2- I missed 3-5 questions on my worksheet. I need some extra practice.
3- I missed 1-2 questions on my worksheet. I feel like I understand three-digit regrouping.
4- I answered all of the questions correctly. I really understand three-digit regrouping.
Homework

After the pre-assessment, I allowed each student to choose their own homework assignment based on his or her results. There were five homework choices and each one focused on an area of addition regrouping. The students looked at their pre-assessment to find out what they missed and then chose a homework assignment that best suit their needs.

Homework Choices

**Choice #1:** I missed question 1 or 2 on my pre-assessment. I need extra practice in breaking apart addends to find the sum. I may be able to add the hundreds, tens, and ones but I have difficult writing the sum.


**Choice #2:** I missed question 3, 4, 8 or all. I need extra practice on regrouping ones. I may have forgotten to add the regrouped ten.

Complete “3-Digit Addition: Regroup Ones” P137-138 in math workbook.

**Choice #3:** I missed questions 5, 6,7, or both. I need extra practice regrouping tens. I may have forgotten to add the regrouped hundred.

Complete “3-Digit Addition: Regroup Tens” P139-140 in math workbook.

**Choice #4:** I missed multiple questions in different areas of my worksheet. (For example: I missed 1,4,8,5, and 7). It would help me if I had a little practice on everything. OR

Complete “Addition: Regroup Ones and Tens” P 141 and 142 in math workbook

**Homework choice #5:** I did not miss any questions on the pre-assessment and I feel confident in addition with regrouping.

Free choice: Complete any of the homework choices #1-4
Grade: 1st  Subject: Math  Topic: Addition Story Problems

Learning Objectives

Standards (National or State):

- **CCSS.Math.Content.1.NBT.C.4** Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten.

- **CCSS.Math.Content.1.OA.A.1** Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.

Objectives for student learning:

- When asked certain questions, students will use the “turn to your partner” strategy to respond to the questions, take turns listening to others, and share their partners’ response.

- Given a story problem, students will use addition within 20 to find a solution.

Pre-assessment:

- Students will master story problems involving addition and subtraction within 10.

- Levels based on pre-assessment:
  - **Struggling:** Students cannot complete addition and subtraction equations involving numbers under 10 and/or they experience difficulty comprehending story problems and creating a number sentence to represent the story problem. These students struggle to complete work independently and within given time limits.
  - **Intermediate:** Students can complete story problems with numbers under 20 and record a representation on their paper to show how they arrived at their solution to the story problem with minimal support.
  - **Advanced:** Students use number relationships to solve addition and subtraction problems showing a deep understanding of the concept. These students can solve story problems with numbers over 20 and record representations of their thinking to prove how they arrived at an answer.

Motivation/Introduction

- Students gather on the carpet with a partner assigned prior to the lesson. Using a PowerPoint presentation, students will answer questions in a think-pair-share format about addition and subtraction. Two story problems will be shown and students will be asked *how* they could find a solution. The ways for
solving addition and subtraction problems will be discussed: counting all, counting on, counting down, number relationships, drawing a model, using cubes, etc. Students will then review the open-ended crayon problems (There are 5 crayons. Some are red, some are blue. How many of each could you have?) they worked on the week prior to activate their background knowledge and forge a connection to the main activity of the lesson.

Pre-Assessment

- Students were assessed prior to the lesson based on addition and subtraction story problems with numbers under 10 and numbers over 10 as well as addition and subtraction drills with numbers 10 and under.

Lesson Steps:

1. After the introduction, students will be divided into their three groups to answer the question for the main activity of the lesson “Mrs. Lewis’ class is getting ready to go to the farm. At Green Meadows Farm they will see 13 animals. Some will be pigs and some will be horses. How many pigs and how many horses could they see?” The students will be given a handout with the question on it and a large box to write the answers and record how they were able to get those answers. The question was altered slightly for two students in my struggling group. They will work with the number 6 rather than 13. Students in the struggling group are sent to the teacher table where they will have manipulatives and one on one support. The students in the intermediate group will be sent to their seats with the resources of counters and cubes at their desks. Students in the advanced group will be sent to their seats with the added challenge of finding all the possible combinations of pigs and horses and proving they found all the ways.

2. After providing the struggling group assistance, I will circle the room to monitor student learning, provide assistance, and informally assess students’ understanding.

3. Students who finish the activity early will have two options displayed on a PowerPoint slide. They can turn their paper over and find ways to get to 13 using subtraction, numbers over 13, and more than two addends. The other option is completing the challenge problem “Mrs. Lewis’ class is getting ready to go to the farm. At Green Meadows Farm they will see 13 animals. Some will be pigs, some will be goats, and some will be horses. How many pigs, goats, and horses could they see?” where they will work with three addends to get to 13.

4. After the main activity is done, students will be called back to the carpet to discuss their methods and solutions

Support:

- Students in the struggling group will be pulled to work one on one with me. Two of the four students will be given the same question used for the main activity, but with a smaller number (6) because they have not demonstrated understanding of addition and subtraction over 6. I will also have different
manipulatives that all four students can use to help them represent the problem. These students will all have the problem read for them multiple times.

Extension:
- Students in the advanced group will have the challenge of finding all the possible solutions to the answer and then proving they found them.
- Students in the other groups may do this as well but it is not required.

All class discussion:
- The students will be called back to the carpet to discuss how they found a solution, what methods they used. We will discuss the additional choices students could complete and those that think they found all solutions to the main question can share their findings with the class.

Assessment:
- During the introduction, I will be formatively assessing students based on their responses to the questions involving subtraction and addition. After I work one on one with the small group, I will also circulate the classroom to observe students’ work and informally assess their understanding. I will ask them questions that allow them to explain how they are finding the answer.
- The handout will also provide me with an assessment piece to review after the lesson. I will be able to see how well the students comprehended the question and were able to decompose and build up to the number 13 based on their solutions.
APPENDIX H
PRE-OBSERVATION INTERVIEW PROTOCOL

First, I want to ask you a few questions about your understanding of formative assessment and how you use it in the classroom.

- How do you define formative assessment? [Conceptual]
- In what ways does formative assessment differ from other forms of assessment used in your classroom or school? [Conceptual]
- What are some of the ways that formative assessment can be implemented in the classroom? [Practical]
- Describe several examples of how you typically use formative assessment in your classroom. [Practical]
- Please describe your understanding of the following aspects of formative assessment: [Conceptual]
  - Clarifying & sharing learning goals
  - Engineering effective classroom discussions and tasks to elicit evidence of learning
  - Providing feedback that moves learners forward
  - Activating learners as instruction resources for one another
  - Activating learners as owners of their own learning.
  [Provide a list for reference]
- Describe any connections you see between these five aspects. [Conceptual]
- Which of these aspects have you implemented in your classroom? Describe how you have used them. [Practical]
- Are there any of these aspects that you have not implemented? Why? [Practical]
- If I observed your class during a typical week, how frequently would I observe you using formative assessment? Each of the five aspects? [Practical]
- Do you use any resources (for example, other teachers, books, websites, etc.) when deciding how to use formative assessment or making instructional decisions based on the information you gather from the formative assessment? [Setting]

Let’s discuss the lesson I will observe next time.

- Summarize your goals for this math lesson.
- How do you plan to use formative assessment in meeting those goals? [Practical]
- How will formative assessment inform your teaching? Improve student learning? [Conceptual]
- Do you have any concerns about implementing formative assessment? [Setting]
- How will you determine if formative assessment has been implemented effectively in your classroom? [Conceptual]
- Are there any components of the lesson that you believe I should pay particular attention to? (Ex. Questions being asked, discussions, student reactions, etc.)
APPENDIX I
POST-OBSERVATION INTERVIEW PROTOCOL

Today we are going to start by discussing the lesson I observed.
- Summarize how you used formative assessment during this lesson.
- Tell me about how you planned this lesson and some of the decisions you made for using formative assessment.
- In what ways did you learn about your students and their mathematical thinking during the lesson?
- How will you adapt your plans based on the outcomes of this lesson?
- Here are some of the formative assessment practices I observed you using in the lesson today. Do you agree with my observation? Why or why not?
- [Have notes/rubric from observation available for teacher to see]
- I noticed you did not use the following formative assessment practices during this lesson. Please describe why. Would you say this is typical or could you describe other times when you have used those practices?
- I noticed you did/said __________________. Please explain why you thought this was important and how it impacted your instruction and/or student learning. [Tailor this prompt based on observations made]
- Would you say that today’s lesson is representative of how you use formative assessment? Explain.

During your internship at the University of Florida, you took a course on formative assessment for mathematics instruction.
- What did you learn about formative assessment through this course? [Conceptual]
- Are there any assignments or experiences that stand out to you? Explain. (Provide list of assignments & descriptions) [Conceptual and/or Practical]
- What did you learn from implementing those assignments? [Conceptual and/or Practical]
- How did taking the course at the same time as your internship impact your understanding of formative assessment and how it is practiced in the classroom? [Setting]
- Do you think your understanding and use of formative assessment would be the same or different if the course were separate from your internship? [Setting]
- How did this course differ from learning experiences in other courses you took during your program? [Setting]
- During the course, you said ________________. Do you still think this is true in your current teaching setting? Why or why not? [Setting]
- During the course, you did ________________. Is this a practice that you continue in your current teaching setting? Why or why not? [Setting]
## Formative Assessment Observation Report

### A. Learning Targets: Clarifying Learning Intentions and Sharing Criteria for Success

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<tbody>
<tr>
<td>1.</td>
<td>Does the teacher make certain that students understand the learning intentions for the class session?</td>
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<tr>
<td>2.</td>
<td>Does the teacher make certain that students understand the learning intentions for each activity?</td>
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<td>3.</td>
<td>Does the teacher provide examples of high and low quality work?</td>
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<td>4.</td>
<td>Does the teacher address potential misunderstandings regarding the criteria for success?</td>
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### B. Monitoring: Engineering Effective Classroom Discussions, Questions, and Learning Tasks That Elicit Evidence of Learning

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<tbody>
<tr>
<td>1.</td>
<td>Does the teacher make efforts to monitor student learning on an ongoing basis (i.e., minute-to-minute &amp; day-to-day)?</td>
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<td>2.</td>
<td>Does the teacher give students a variety of opportunities and methods (e.g., verbal, written, electronic, &amp; visual) to respond to questions?</td>
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<td>3.</td>
<td>Does the teacher use effective questioning strategies (e.g., adequate wait time, open-ended questions) to elicit evidence of learning?</td>
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<td>4.</td>
<td>Does teacher monitoring seek to elicit evidence from students of both factual/procedural knowledge and of deeper conceptual knowledge?</td>
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<td>5.</td>
<td>Does teacher monitoring seek to elicit evidence of whether students can transfer knowledge within and between disciplines/subjects?</td>
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### C. Feedback: Providing Feedback That Moves Learners Forward

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<tbody>
<tr>
<td>1.</td>
<td>Does the teacher provide meaningful feedback (i.e., information with which a learner can confirm, add to, overwrite, tune, or restructure understanding) immediately following formal and/or informal evaluations of student progress?</td>
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<td>2.</td>
<td>Does the teacher provide accurate feedback that assists learning?</td>
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<td>3.</td>
<td>Does the teacher provide feedback in reference to a criterion-based standard, avoiding feedback based in comparison to other students?</td>
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<td>4.</td>
<td>Does feedback describe specific areas of needed improvement and suggest alternative strategies for making that improvement?</td>
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<td>5.</td>
<td>Does feedback describe specific student strengths and suggest strategies for continued learning in those areas?</td>
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### D. Self-Assessment: Activating Students as the Owners of Their Own Learning

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<tbody>
<tr>
<td>1. Does the teacher give students opportunities to use self-regulatory competencies, such as the ability to accurately assess their own knowledge?</td>
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<td>2. Does the teacher make efforts to develop self-monitoring competencies in students (i.e., meta-cognitive skills)?</td>
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<td>3. Are students making decisions related to their own improvement on the basis of ongoing assessment data (i.e., ownership of learning)?</td>
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### E. Peer Assessment: Activating Students as Instructional Resources for One Another

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<tbody>
<tr>
<td>1. Does the teacher give students opportunities (e.g., discussions, questions, learning tasks) to engage in peer-monitoring?</td>
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<td>2. Does the teacher utilize the results of peer activities to strengthen ongoing assessment of student learning?</td>
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<td>3. Does the teacher utilize peer activities to help students deepen their understanding of common errors and alternative strategies?</td>
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### FA1: Clarifying learning intentions & criteria for success

<table>
<thead>
<tr>
<th>Level of Appropriation</th>
<th>Description</th>
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<tbody>
<tr>
<td>L1: Lack of appropriation</td>
<td>No conceptual understanding and/or not used in classroom.</td>
</tr>
<tr>
<td>L2: Appropriating a label</td>
<td>Identifies learning goals/criteria by name, but does not understand purpose of learning goals/criteria (e.g., equates with standards) and does not engage students with them.</td>
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<tr>
<td>L3: Appropriating surface features</td>
<td>Understands that learning goals/criteria as targets for performance and may share them with students, but does not impact student learning and instructional decisions.</td>
</tr>
<tr>
<td>L4: Appropriating conceptual underpinnings</td>
<td>Understands learning goals/criteria and their relationship to student learning progressions. Makes connections to instructional decisions but may have limited experience applying to practice.</td>
</tr>
<tr>
<td>L5: Achieving mastery</td>
<td>Understands the purpose of learning goals/criteria in shaping student learning and frequently makes instructional adaptations based on student progression towards learning goals. Evidence of student engagement with goals/criteria.</td>
</tr>
</tbody>
</table>

### FA2: Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding

<table>
<thead>
<tr>
<th>Level of Appropriation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1: Lack of appropriation</td>
<td>No conceptual understanding and/or not used in classroom.</td>
</tr>
<tr>
<td>L2: Appropriating a label</td>
<td>Describes the importance of discussion and learning tasks broadly but cannot articulate what it means to elicit evidence of students’ mathematical understanding. Describes discussion/task approaches in the classroom that are primarily driven by the teacher and no connections made to student thinking.</td>
</tr>
<tr>
<td>L3: Appropriating surface features</td>
<td>Articulates importance of discussion and learning tasks and describes approaches that can elicit student information, but primarily focuses on how to implement discussions/tasks and makes little to no connections to student thinking or instructional decisions from those discussions/tasks.</td>
</tr>
<tr>
<td>L4: Appropriating conceptual underpinnings</td>
<td>Understands and clearly communicates connections between discussions/tasks and evidence of student learning, as well as how that evidence can impact future instruction. Gives some examples of eliciting evidence from students, but struggles to identify instructional adaptations based on evidence.</td>
</tr>
<tr>
<td>L5: Achieving mastery</td>
<td>Frequently and effectively implements classroom activities and discussions that provide substantial evidence of students’ mathematical thinking and make clear connections to how instruction will be adapted based on evidence to improve student learning and correct misconceptions.</td>
</tr>
</tbody>
</table>
### FA3: Providing feedback that moves learners forward

<table>
<thead>
<tr>
<th>Level of Appropriation</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>L1: Lack of appropriation</strong></td>
<td>No conceptual understanding and/or not used in classroom.</td>
</tr>
<tr>
<td><strong>L2: Appropriating a label</strong></td>
<td>Broadly discusses the importance of feedback but describes an evaluative approach (e.g., equates with grades) and cannot articulate how feedback can improve student learning.</td>
</tr>
<tr>
<td><strong>L3: Appropriating surface features</strong></td>
<td>Understands the importance of feedback in the learning process and describes how they go beyond grades, but connections to improving student learning are limited.</td>
</tr>
<tr>
<td><strong>L4: Appropriating conceptual underpinnings</strong></td>
<td>Understands the role of detailed, quality feedback in student learning and makes connections to how feedback can be used to move student learning forward. Provides limited evidence of regular implementation.</td>
</tr>
<tr>
<td><strong>L5: Achieving mastery</strong></td>
<td>Frequently provides students with detailed, quality feedback that clearly connects to student learning. Can articulate specific examples of how feedback moves students forward in their learning.</td>
</tr>
</tbody>
</table>

### FA4: Activating students as instructional resources for one another

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>L1: Lack of appropriation</strong></td>
<td>No conceptual understanding and/or not used in classroom.</td>
</tr>
<tr>
<td><strong>L2: Appropriating a label</strong></td>
<td>Talks broadly about student collaboration, but focuses mostly on grouping of students with no connection to how it improves student learning.</td>
</tr>
<tr>
<td><strong>L3: Appropriating surface features</strong></td>
<td>Describes how group work and collaboration can improve student learning but focuses on specific strategies and their implementation with little description of how students improve from engaging in those tasks.</td>
</tr>
<tr>
<td><strong>L4: Appropriating conceptual underpinnings</strong></td>
<td>Understands how well structured group tasks can improve student learning and motivation and recognizes the importance of setting goals, individual accountability, and well-structure tasks. Examples from practice are limited.</td>
</tr>
<tr>
<td><strong>L5: Achieving mastery</strong></td>
<td>In addition to robust conceptual understanding, frequently engages students in collaborative group tasks and can specifically connect how the structure of those tasks led to student growth.</td>
</tr>
<tr>
<td>Level of Appropriation</td>
<td>Description</td>
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</tr>
<tr>
<td><strong>L1: Lack of appropriation</strong></td>
<td>No conceptual understanding and/or not used in classroom.</td>
</tr>
<tr>
<td><strong>L2: Appropriating a label</strong></td>
<td>Makes broad statements about the importance of involving students in assessment, but practices mainly teacher-centered and focuses on levels of performance versus skill acquisition.</td>
</tr>
<tr>
<td><strong>L3: Appropriating surface features</strong></td>
<td>Describes ways to involve students in the assessment process with a focus on implementation (e.g., how students are involved in scoring) but cannot articulate how self-assessment can motivate students and improve their learning.</td>
</tr>
<tr>
<td><strong>L4: Appropriating conceptual underpinnings</strong></td>
<td>Robust understanding of how students benefit from involvement in the assessment process, particularly in regards to motivation and monitoring their own learning. Examples from their practice are limited.</td>
</tr>
<tr>
<td><strong>L5: Achieving mastery</strong></td>
<td>In addition to robust conceptual understanding, frequently involves students in assessment in meaningful ways (i.e. not just grading their own work) and how that involvement supported their development of self-regulation skills and motivation for improvement.</td>
</tr>
<tr>
<td>School</td>
<td><strong>Instructional Resources</strong></td>
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<tr>
<td></td>
<td><strong>Technology</strong></td>
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<tr>
<td></td>
<td><strong>Assessment Resources</strong></td>
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<td></td>
<td><strong>Supportive Faculty &amp; Staff</strong></td>
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<tr>
<td>Administration</td>
<td><strong>Assessment Policies &amp; Initiatives</strong></td>
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<tr>
<td></td>
<td><strong>Support for Professional Decision-making</strong></td>
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<tr>
<td>Students</td>
<td><strong>Student engagement</strong></td>
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<td></td>
<td><strong>Parental engagement</strong></td>
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<tr>
<td>University</td>
<td><strong>Formative Assessment Course</strong></td>
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<tr>
<td></td>
<td><strong>Connecting theory to practice</strong></td>
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<tr>
<td><strong>Internship versus pre-internship</strong></td>
<td>This code is for when participants make explicit distinctions between taking courses, like FA course, during internship and coursework when they were at pre-internship sites.</td>
</tr>
<tr>
<td><strong>UF Program</strong></td>
<td><strong>Math Methods Course</strong></td>
</tr>
<tr>
<td><strong>UF Support System</strong></td>
<td>Different types of supports persons within the UF program that contributed to continued use of FA. This includes mentor teachers, supervisors, and course peers.</td>
</tr>
<tr>
<td><strong>Individual Knowledge, Beliefs, &amp; Dispositions</strong></td>
<td><strong>Supportive beliefs about math</strong></td>
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<tr>
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<td><strong>Supportive beliefs about FA</strong></td>
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<td></td>
<td><strong>Reflective Disposition</strong></td>
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<td></td>
<td><strong>Developing MKT</strong></td>
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<tr>
<td><strong>Teaching Practices</strong></td>
<td><strong>Gaining Teaching Experience</strong></td>
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<tr>
<td></td>
<td><strong>Student-centered Practices</strong></td>
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<tr>
<td>Level</td>
<td>Parent Code</td>
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<td>School</td>
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<td>Instruction</td>
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<td>interpret &amp;</td>
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<td>Curriculum</td>
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<td>Grouping</td>
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<tr>
<td>University UF Support System</td>
<td>Loss of Support Structures</td>
</tr>
<tr>
<td>-------------------------------</td>
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</tr>
<tr>
<td>Individual Knowledge, Beliefs, &amp; Dispositions</td>
<td>Closed beliefs about math</td>
</tr>
<tr>
<td>Limited MKT</td>
<td>Recognition of their struggle to be open to multiple solutions/strategies and concerns over not knowing what to do when encountering misconceptions identified with FA practices. This might also be demonstrated as reliance on reteaching as an instructional adaptation regardless of evidence collected.</td>
</tr>
</tbody>
</table>
LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Carolyn E. Mitten began her journey towards education while attending Messiah College, where she was a mathematics major. After serving as a camp counselor one summer, she discovered the joy of working with children and began working towards her teaching certification. After graduating with a B.A. in mathematics, she began teaching high school mathematics at a large, Pennsylvania public school. She particularly enjoyed the challenge of finding new ways to teach mathematics in conceptual ways to students that typically struggled in mathematics.

While teaching full time, Carolyn earned her Masters degree in Teaching and Curriculum from Penn State Harrisburg. She greatly valued the teacher educators she worked with during this time and enjoyed the opportunity to conduct her own research on mathematics anxiety. These positive experiences in higher education prompted her to pursue her PhD in Mathematics Education at the University of Florida.

In her time at the University of Florida, Carolyn engaged in many research projects for her Fellowship as well as taught mathematics education courses. One course in particular, Formative Assessment for Mathematics Instruction, peaked her interest for its unique practice-embedded design and the positive outcomes she was seeing in her students. Combined with her own experiences with implementing formative assessment, she identified the future direction of her dissertation and research. After graduation, she will be starting her new position as Assistant Professor of Mathematics Education at Moravian College in Bethlehem, PA.