A TENSION BETWEEN DIALOGIC AND DIRECT INSTRUCTION:
ONE COMMUNITY’S MATHEMATICS TEACHING CULTURE

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This study uses ethnographic methodology to describe and interpret one community’s mathematics teaching practices. Sociocultural theory is used as a theoretical framing to justify the study of the community’s educational stakeholders’ beliefs, values, and opinions regarding the mathematics teaching practices observed in their local elementary school. The study was conducted in two phases within a single school district. The first phase was focused on identifying and characterizing prominent mathematics teaching practices used in three fourth and fifth grade classrooms. The second phase was focused on eliciting and describing how stakeholders in the community (parents, teacher colleagues, principals, and professional development leaders) make sense of the identified mathematics teaching practices from the first phase of the study. Two prominent teaching practices were identified across the three observed fourth and fifth grade teachers’ mathematics lessons. One was similar to a direct instruction model of teaching, and the other was similar to a dialogic instruction model of teaching. Both teaching practices were represented in storyboards and used to elicit the beliefs, values, and opinions of stakeholders regarding mathematics teaching and learning.

Findings describe the two prominent mathematics teaching practices observed in the three teachers’ classrooms, and outline stakeholders’ beliefs, values, and opinions about mathematics teaching and learning. Discussion and implications explore how the findings illustrate the importance of examining values held by an educational community before attempting to improve aspects, such as teaching practices, within the community. Implications also explore the usefulness in using the concept of ritual as a tool for better understanding educational culture, rather than using educational rituals to rationalize unproductive teaching practices.
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Chapter 1 Introduction and Rationale

Research has demonstrated that many mathematics teaching practices persist within the American educational system, despite various attempts at change. Studies have revealed that, as a collective group, U.S. teachers continue to use the same mathematical teaching practices that they have for many years (e.g., Gainsburg, 2012; Jacobs et al., 2006). Furthermore, findings from additional research studies indicate that mathematics teaching practices in the United States tend to focus on procedural competency rather than on understanding concepts and mathematical relationships (e.g., Malzahn, 2002; National Council of Teachers of Mathematics [NCTM], 2014; Oakes, 1985; Stigler & Hiebert, 2004; Whittington, 2002). This finding is in contrast to standards documents that call for a focus on conceptual learning, problem solving, and development of mathematical reasoning (The Conference Board of the Mathematical Sciences [CBMS], 2010; Council of Chief State School Officers (CCSSO), 2010; NCTM, 2007, 2014; National Research Council [NRC], 2012).

Mathematics education researchers have made great strides in trying to address the discrepancy between observed mathematics teaching practices and desired mathematics teaching practices within the United States. There are multiple studies regarding what types of mathematics teaching practices that researchers consider to be best teaching practices for the type of student learning described above. Identified teaching practices include raising the level of the cognitive demand of mathematical tasks (Stein, Smith, Henningsen, & Silver, 2000), encouraging students to justify their reasoning and make connections with other students’ reasoning (McClain, 2002), and leading discussions that are student oriented as well as directed towards specific mathematical learning objectives (Stein, Engle, Smith, & Hughes, 2008). In addition, there are teaching standards documents that outline best practices according to these and similar research studies (NCTM, 2007, 2014). For example, NCTM (2014) suggests eight productive mathematics
teaching practices: establish mathematics goals to focus learning, implement tasks that promote reasoning and problem solving, use and connect mathematical representations, facilitate meaningful mathematical discourse, pose purposeful questions, build procedural fluency from conceptual understanding, support productive struggle in learning mathematics, elicit and use evidence of student thinking.

Drawing on the findings about best practices, researchers have made attempts to support and improve mathematics teaching practices across the country (e.g., Ball, Hill, Rowan, & Schilling, 2002; Stein, Smith, Henningsen, & Silver, 2000). There have been multiple large-scale studies regarding professional development attempts to improve mathematics teaching practices (e.g., Bell, Wilson, Higgins, & McCoach, 2010; Borko, 2004; Carpenter, Fennema, & Franke, 1996; Stein, Grover, & Henningsen, 1996). Despite attempts at improving mathematics teaching practices, studies on school policy highlight a scarcity of professional development programs working with a large amount of teachers and school districts proving successful at creating permanent changes in the teaching practices of participating teachers (Cobb & Jackson, 2011; Elmore, 2004; Gamoran et al., 2003; McLaughlin, 2006).

Current research tends to focus on how to improve mathematics teaching practices by working directly with the teacher; for example, trying to improve his or her knowledge of mathematical content or mathematical teaching pedagogy. Cobb and Jackson (2011), as well as others outside of mathematics education (e.g., Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010; Elmore, 2004; Sebring, Allensworth, Bryk, Easton, & Luppescu, 2006), call for improving teaching practices through “supporting schools’ and broader educational jurisdictions’ development of the capacity to scaffold teachers’ (and others’) ongoing learning” (Cobb & Jackson, 2011, p. 7). Following in the spirit of this call for research, the intent of this study is to focus attention on potential influences on teacher practice outside of the classroom teacher. This
study explores the culture surrounding mathematics teaching practices that have endured within elementary mathematics classrooms to the point that they have become ritualized.

The research presented in this study is founded on the perspective that mathematics teaching both influences and is influenced by the culture of the educational community of which the teacher is a member. A definition of culture is adopted from Bohannan (1995) and Nuthall (2005) as “the customary ways of acting, thinking, and feeling that are common to the members of a society and sustain their relationships (Nuthall, 2005, p. 896). The perspective that an educational culture is entwined with mathematics teaching practices provides a basis for this study, which explores one educational community’s beliefs, interpretations, and values regarding mathematics teaching practices. I choose to focus on ritualized mathematics teaching practices because of the notion that “within a culture, the ritualized routines that structure social interactions are unlikely to survive without a web of supporting beliefs or myths that explain and justify the way these routines are played out” (Nuthall, 2005, p. 920). Therefore, this research reveals insights into an educational culture regarding the use of a ritualized mathematics teaching practice. Specifically, the research question guiding this study is: How do educational stakeholders make sense of mathematics teaching practices observed in their local elementary school? The phrase “make sense of” is further explored through the following research sub–questions:

A. What are stakeholders' beliefs, values, and opinions regarding mathematics teaching and learning, and how do those beliefs, values, and opinions relate to the mathematics teaching practices observed in their local elementary school?

B. What are stakeholders' experiences in mathematics classes, and how do those experiences relate to the mathematics teaching practices observed in their local elementary school?
C. *How do stakeholders’ beliefs, values, and opinions about mathematics teaching practices relate to the state mathematics assessment administered to students in their local elementary school?*

The main research question is intentionally broad so as to allow for conversations and data collection to be extended by the participating members of the educational community. For the practical purposes of the research study, this question is examined through the three sub–questions listed above. While the main research question, and the ethnographic methodology, stood as a reminder to remain open to whatever topic of conversation the participants introduced during interviews, the sub–questions helped to direct interviews with stakeholders towards specific conversational topics that may provide insight into how they make sense of mathematics teaching and learning that was observed in their local elementary school.

The first sub–question allows for an examination of the beliefs, values, and opinions of the participating stakeholders, specifically how stakeholders’ beliefs, values, and opinions regarding mathematics teaching and learning relate to observed mathematics teaching practices in their local elementary school. The definitions of *belief* and *value* are adopted from Phillip (2007) who uses a combination of published literature and dictionary definitions to succinctly capture the meaning of each term. He defines belief as “psychologically held understandings, premises, or propositions about the world that are thought to be true,” and value as “the worth of something” (p. 259). Furthermore, Phillip (2007) clarifies the distinction between the two meanings as he writes, “Whereas beliefs are associated with a true/false dichotomy, values are associated with a desirable/undesirable dichotomy. Values are less context-specific than beliefs” (p. 259). The definition of *opinion* is adopted from The New Oxford American Dictionary as “A view or judgment formed about something, not necessarily based on fact or knowledge” (Opinion, 2015). Discussion with stakeholders about their beliefs, values, and opinions is one way to provide insight into the beliefs and values of the educational community. These discussions can help to
illustrate the aspects of education that the community values as well as the statements about education in which the community believes.

The second sub–question allows examination of how the experiences of stakeholders relate to their interpretations of the observed teaching practices. This question is motivated by research findings that demonstrate teachers’ experiences with mathematics teaching and learning may influence their teaching practices (e.g., Raymond, 1993). As teachers are among the group of stakeholders for this research study, it makes sense to examine their past experiences, as well as extend the notion that past experiences may influence any stakeholder’s interpretations of mathematics teaching practices. Conversations with stakeholders about their experiences in mathematics classes may provide insight into why they interpret mathematics teaching practices in a certain way.

The third sub–question allows for insights into how the stakeholders in the local community relates to the larger, national community. Many of the stakeholders are directly influenced by the state standards, which are adopted from the Common Core State Standards for Mathematics (CCSSO, 2010), because they either work directly with students in the state, or they work with teachers in the state. The implementation of standards and corresponding assessments across multiple states in the country may have an influence on how the community interprets the mathematics teaching practices in their local community.

**Rationale for the study**

The theoretical perspective for this study is a sociocultural theory of teaching and learning. Sociocultural theory originated with Vygotsky (1978) as a way of understanding how people learn. Distinguishing this theory from previously defined theories of learning is the interpretation that learning is a process that involves more than just a child and a teacher. As
Cobb (2007) states, “sociocultural theory characterizes the individual as a participant in established, historically evolving cultural practices” (p. 25). Explored in more detail in the subsequent chapter, sociocultural theory describes multiple ways in which culture impacts the teacher and the learner. For the purpose of this study, learning (whether learning to do teaching or learning to do mathematics) is regarded as an induction of a person into an educational community, rather than solely a generation of new individual knowledge.

It follows from sociocultural theory that learning is influenced by cultural practices and norms. As Wenger (1998) writes, “learning is an issue of engaging in and contributing to the practices of their communities” (p. 7). For mathematics education, this means students are engaging in established practices of a few different, yet related communities, as seen in Figure 1-1. These communities are: the community within the particular classroom (peers and teacher within a student’s current mathematics class), the community of the school site and school district (other mathematics teachers, other subject teachers, the entire grade level of students, possibly students in other grade levels, and administrators), the community of family (parents, siblings, other relatives), and the community of the general society surrounding the learner (members of the town, county, state, and nation).
Figure 1-1. Communities in which a learner is engaging in established practices.

Sociocultural theory is used in two ways to illuminate potential influences of the opinions of the relevant educational cultures on the mathematics teaching practices used by teachers within that community. First, as teachers engage students in the learning of mathematics, their mathematics teaching practices are influenced by mathematical learning goals that are deemed important by the relevant educational community. Second, as teachers assume the role of learner throughout various aspects of their careers, their teaching practices also have the potential to be influenced by the relevant educational community’s opinions regarding advantageous mathematics teaching practices. When teachers are engaged in learning about mathematics teaching practices, either before the start of their career (through 12 years observing the act of teaching from a student perspective, or engagement in university courses as college students), at the start of their career (through interactions with teachers and administration at their local school district), or during the extent of their career (through formal or informal professional development or conversations with other educators), they are potentially influenced by the relevant educational community. In summary, the relevant educational community can potentially influence both a teacher’s decisions regarding what mathematics content to include in lessons as well as the teacher’s mathematics teaching practices used during lessons.
Development of key terms

The focus of this study is on the members of each community depicted in Figure 1-1, who are considered educational stakeholders in the learning of the students within that community. A characterization of stakeholder for this study originates from Krainer (2014), who writes that educational stakeholders “have effects on students’ knowledge and at the same time [stakeholders] are affected by [students’] knowledge or lack of knowledge” (p. 54). Whereas Krainer (2014) refers to the effects between stakeholders and students, the term stakeholders will be utilized in this study to describe all people within a community who potentially influence or are influenced by mathematics teaching practices. If the mathematical knowledge of students is of consequence to educational stakeholders, then the ways in which students are engaged in learning is also of consequence, which implies that mathematics teaching practices matter to stakeholders as well. In addition, because teachers can be a specialized type of learner as they engage in learning about the practice of teaching, educational stakeholders have the potential to effect teachers’ mathematical teaching knowledge and have the potential to be affected by teachers’ mathematical teaching knowledge or lack of that knowledge in a similar way to how Krainer describes the relationship between students and stakeholders.

Krainer (2014) lists possible stakeholders in education as “parents, principals, superintendents, mathematicians, teacher educators, educational publishers, test developers, companies, (education) policy–makers, and even the whole society can be regarded as ‘stakeholders’” (p. 54). This list serves as the source for potential categories of educational stakeholders included in this study. Figure 1-1 includes four categories of educational stakeholders who may potentially influence the learning of a group of students within the community. The outermost layer of Figure 1-1 lists the more general society as educational stakeholders, including local, state, and national communities. This study concentrates on local
educational stakeholders, within a single school district, with some connection to the larger society through the statewide mathematics standards used within the district. As can be seen in Figure 1-2, there are five main groups of educational stakeholders included in this study. This list is specific to the participating school district, and each stakeholder group will be discussed more thoroughly in the methods section of this dissertation.

Figure 1-2. Groups of stakeholders who may have an influence on teaching practices.

One way to study the culture surrounding mathematics teaching practices is to examine a ritualized mathematics teaching practice within a single community. A ritualized teaching practice is an action, or a collection of actions, in which a teacher engages within a classroom setting that is directed towards student learning, and “that aspect of action that is formalized, traditionalized, symbolic performance” (McCloskey, 2013, p. 25). A ritualized teaching practice has endured in a particular culture for at least multiple years and therefore should be familiar to educational stakeholders within the local community. As such, it has potential to provide information about stakeholders' beliefs, interpretations, and values about not only the particular ritualized mathematics teaching practice, but also about mathematics teaching and learning in a more general sense. The goal of this study is to understand the culture surrounding a ritualized
mathematics teaching practice by examining how educational stakeholders make sense of that practice.

The phrase *teaching practice* is used frequently in this dissertation, rather than the phrase *teacher practice* so as to focus on the actions of teachers, rather than the teachers themselves; however, the two phrases are often used interchangeably and therefore any mention of teacher practice in relevant research literature will be assumed to have a similar understanding. Both terms are often assumed to be in the common vernacular of readers of educational research literature, but it is an elusive phrase that does not necessarily hold the same meaning for all. For example, some studies focus more on knowledge and skills (e.g., National Research Council, 2001) and others focus more on beliefs and relationships (e.g., Lampert, 2001; Simon & Tzur, 1999). For the purposes of this study, *teaching practice* is defined using the works of a combination of education researchers (Gainsburg, 2012; Grossman et al., 2009; Simon, 2000; Simon & Tzur, 1999) to mean the typically consistent actions of a teacher within a classroom, and the multitude of influences on these actions. This definition has two dimensions; the first dimension is the observable actions of the teacher within the classroom. These actions must be fairly consistently observed within the classroom to be considered a practice. In other words, the action is not something the teacher does only once or twice, but rather something that is done repeatedly throughout the school year. The second dimension, as described by Simon and Tzur (1999), is “everything teachers think about, know, and believe about what they do. In addition, teachers’ intuition, skills, values, and feelings about what they do are part of their practice” (p. 254). Both dimensions of teaching practice will be explored through this study. The first dimension is useful in identifying a ritualized mathematics teaching practice, and the second dimension is useful in accessing the culture in which the ritualized mathematics teaching practice resides.
Chapter 2 Literature Review

This literature review is structured in three parts: the “object” of study, the context in which it is being studied, and the lens through which it is viewed. The first part is a review of research regarding mathematics teaching practices, in order to present the ways in which education researchers have studied teaching practices in an effort to improve student learning when working with teachers. Research findings that relate to both “traditional” and “reform” oriented mathematics teaching practices are presented. The second part of the chapter is an examination of the theoretical perspective for this study, sociocultural theory, and how that theory has been developed and used within the field of mathematics education. This part will also include literature regarding educational stakeholders. The third part of the chapter is an examination of the concept of ritual, which provides a basis for the rationale and analytical framework for the study. The usefulness of the concept of ritual as a lens to view mathematics teaching practices is explored.

Mathematics teaching practice

At its core, this dissertation study explores mathematics teaching practices. The concept of teaching practice tends to be assumed as a collectively understood concept within the field of education; however, research indicates that this can be an elusive concept. Take, for instance, the dual phrasing of teacher practice and teaching practice, both of which generally refer to the same concept of what teachers do in their classrooms. As stated previously, this study refers to the concept as teaching practice so as place a focus on the teaching rather than the teacher; however, many use the phrase teacher practice, and therefore the phrase will be included in this dissertation as referring to the same concept as teaching practice. While most researchers seem to have an
implicit understanding of the definition of teaching practice, there are nuances about the definition that tend to be distinct. For example, a majority of researchers tend to agree that teaching practice encompasses the actions of the teacher as they relate to the process of teaching. However, some researchers believe teaching practice includes and focuses on the relationships that evolve as a consequence of the actions of teachers (Lampert, 2001), whereas others believe teaching practice is more about the influences on the actions of teachers in the classroom (Gainsburg, 2012; Simon & Tzur, 1999; Speer, Smith III, & Horvath, 2010). This study utilizes the latter depiction and, as described in the previous chapter, defines teaching practice as the typically consistent and observable actions of the teacher within the classroom, and the multitude of influences on these actions.

**Enduring mathematics teaching practices**

The rationale for this study is based on well-documented indications that mathematics teaching practices have resisted reform efforts despite a need for improved student learning outcomes in the United States (e.g., Hiebert et al., 2005; Hoetker & Ahlbrand, 1969; Stigler & Hiebert, 1999). This section of the literature review explores research findings regarding teaching practices, with a focus on mathematics teaching practices, that have endured for many years in the U.S. education system.

In 1975, the Conference Board of the Mathematical Sciences [CBMS] found that “Teachers are essentially teaching the same way they were taught in school” (CBMS, 1975, p. 77). This means that a 40–year–old 5th grade teacher in 1975 was teaching using methods from 1945, or a teacher of the same age in the present year is using teaching methods from 1975. The CBMS finding is consistent with other research findings that demonstrate that the average classroom continues to show little change in routines and practices, and in fact the same basic
method of teaching mathematics has been used for at least a century (e.g., Dixon et al., 1998; Fey, 1979; Hoetker & Ahlbrand, 1969; Stake & Easley, 1978; Stigler & Hiebert, 1997; Stodolsky, 1988; Weiss, 1978). Take, for example, Welch’s (1978) description of an observed mathematics lesson:

First, answers were given for the previous day’s assignment. A brief explanation, sometimes none at all, was given of the new material, and problems were assigned for the next day. The remainder of the class was devoted to students working independently on the homework while the teacher moved about the room to answer questions. The most noticeable thing about math classes was the repetition of this routine. (p. 6)

This observation could be used to describe many of the mathematics classes taught this year in the United States, and is probably familiar to readers from at least one mathematics course experience in their past. When eighth grade mathematics teaching practices in the U.S. were compared to Germany and Japan in the Third International Mathematics and Science Study (TIMSS), researchers found that 78% of the topics taught were stated rather than developed, and 96% of seatwork time was spent practicing procedures rather than applying concepts or inventing/thinking (Stigler & Hiebert, 1997). This implies that U.S. students are not heavily involved in thoughtful mathematical work during the school day, which is comparable to Welch’s (1978) description of a mathematics lesson that was observed at least twenty years prior to the findings described in TIMSS. More recent studies have continued to demonstrate a lack of rigorous intellectual development within K–12 schools (e.g., Weiss & Pasley, 2004). As a result, numerous studies attempt to characterize mathematics teaching practices observed in public schools.

One of the more prevalent types of mathematics teaching practices described through such research is the IRE pattern of discourse. As reported in the TIMSS video study, “most U.S. mathematics classrooms maintain an Initiation–Response–Evaluation (IRE) interactions pattern, where the evaluation move on the part of the teacher focuses on students’ answers rather than the
strategies they use to arrive at them” (Franke, Kazemi, & Battey, 2007, p. 229). The IRE pattern of discourse describes a three–step conversational pattern between teacher and students: a teacher presents an academic question to students, one or more student(s) responds to the question, and the teacher replies to the answer with some type of valuation. The prevalence of the IRE discourse pattern within mathematics classrooms is well documented (e.g., Cazden, 2001; Mehan, 1985; Pierson, 2008; Silver, Smith, & Nelson, 1995; Spillane & Zeuli, 1999), and students often expect this type of discourse pattern during a mathematics lesson.

In addition to studies on patterns of discourse in mathematics education across all grade levels, there has been extensive research on the mathematics teaching practices used by elementary and middle school teachers. Findings consistently indicate that elementary teaching practices tend to emphasize procedures, memorization, and correct answers to exercises (e.g., Epstein & MacIver, 1989; Gill & Boote, 2012; Goodlad, 1984; Oakes, 1985; Stodolsky, 1988). Stodolsky (1988), specifically, found that learning in fifth grade classes was almost entirely devoted to facts and skills, with 97% of lessons having low–level cognitive objectives, and an average of three–fourths of the mathematics class periods in the study were spent engaging students in recitation of mathematical content. Both elementary and middle school teachers tend to engage students in discourse that result in students providing correct answers to exercises that required procedures, memorization, and basic arithmetic (Spillane & Zeuli, 1999). Likewise, Boaler (2000) writes, “dominant school practices in the mathematics classroom are memorization, reproduction of procedures, and individualized work, all of which play a limited role in situations outside the mathematics classroom” (p. 391). Even after the Principles and Standards of School Mathematics (NCTM, 2000), which calls for mathematics teachers to focus more on conceptual learning, an emphasis on procedural learning has still been found to be prevalent in school classrooms (Hiebert et al., 2003; Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010). Hiebert et al. (2003) recorded that the U.S. was the only country in their study in
which teachers utilized each of following practices: low–level mathematical challenge (which included a prevalence of routine exercises, practicing familiar procedures, and an absence of mathematical reasoning), an emphasis on procedures and review, and lessons that were both mathematically and pedagogically fragmented. By fragmented, they mean lessons that addressed multiple mathematical topics within a single lesson and a higher level of non–mathematical discussion during lessons.

As a result of such research findings, Cobb and Jackson (2011) call for large change in practice through creating a support system for teachers. Findings presented in their article indicate that changes in teaching practices need to be supported by multiple types of educational leaders within the school system. This indication supports the rationale for the current study, as it acknowledges that more than just the teacher has an influence on teaching practices. Furthermore, prevailing cultural beliefs tend to be an impediment to changing teaching practices. Teachers’ beliefs (e.g., Handal, 2003; NCTM, 2014; Phillip, 2007) as well as parents’ beliefs (e.g., Herbel–Eisenmann, Lubienski, & Id–Deen, 2006; NCTM, 2014; Sam & Ernest, 2000) about education continue to influence the ability for educators to create lasting change in teaching practices.

**Mathematics teachers’ beliefs and their influence on practice**

As described in the development of key terms, the second dimension of the definition of teaching practice involves teachers’ beliefs about the teaching and learning of mathematics. This section describes research that has demonstrated a connection between mathematics teachers’ beliefs and their teaching practices in order to reinforce the notion that the two are often interrelated.

There are various research studies that examine mathematics teachers’ beliefs about teaching and learning as well as their beliefs about the content they teach. Teachers’ beliefs have
been found to have an impact on student learning as well as teaching practices (e.g., Handal, 2003; McCombs & Whisler, 1997; Wilkins, 2008). In one instance, Carpenter and Fennema (1992) report a positive correlation between first grade teachers’ knowledge of their students’ mathematical abilities and those students’ achievement. They also report a positive correlation between a belief that teaching is building upon students’ existing knowledge in order to construct new knowledge and students’ abilities to engage in problem solving. Similarly, Thompson (1984) and Raymond (1993) reported findings that teachers’ beliefs about mathematics teaching and learning influence their mathematics teaching practices. Specifically, Thompson (1984) reported on a case study of three junior high school teachers that demonstrated how their beliefs on mathematics teaching and learning had a significant impact on their teaching practices. And, Raymond (1993) found that among six case studies, teachers’ beliefs about mathematics influenced their teaching practices. Raymond (1993) also demonstrated a connection between teachers’ past experiences and their beliefs about mathematics teaching and learning.

In a more recent study, Polly and colleagues (2013) found that teachers who believed that teaching requires the teacher to transfer a set amount of knowledge to students, engaged heavily in teacher–oriented practices. Furthermore, multiple researchers report a connection between student–centered teaching practices and student motivation, both in classwork and on assessments (Kelley, Heneman, & Milanowski, 2000; McCombs & Whisler, 1997; Ryan, Ryan, Arbuthnot, & Samuels, 2007). For example, findings indicate that teacher–oriented practices correlate with smaller gains on curriculum–based assessments than student–oriented practices, and that teachers who believe that mathematics teaching should promote the use of discovery learning and encourage students to make connections within the content, self–report a higher use of student–centered practices (Polly et al., 2013).

Teachers’ beliefs are examined in this study as a potential influence on the enduring quality of mathematics teaching practices. While most of the studies referenced in this section
discuss how teachers’ beliefs influence student–learning outcomes, this dissertation is one step removed from those outcomes because it focuses on teaching practices, rather than on student outcomes.

**Best mathematics teaching practices**

Often in the opposite direction of enduring teaching practices, research findings describe what researchers deem to be best teaching practices. The phrase *best teaching practices* can be misleading because it does not immediately address the desired learning outcome that is associated with those teaching practices. Teaching standards documents tend to lead teachers and researchers into certain directions about best teaching practices for mathematics. For example, NCTM (2014) presents eight research–informed teaching practices that “represent a core set of high–leverage practices and essential teaching skills necessary to promote deep learning of mathematics” (p. 9). Recent teaching standards documents tend to promote the belief that best teaching practices are those that support engaging students in problem solving and developing mathematical reasoning. Research on best teaching practices will be used to guide the data collection for this study.

Some researchers provide lists of findings from studies of teachers who are considered effective in increasing student achievement in their relative school locations. For example, according to student achievement levels on the Iowa Test of Basic Skills, Good and Grouws (1977) found that effective teachers in Iowa request more work and higher achievement from students, provide immediate, nonevaluative feedback that was relevant to the mathematical task, and have an ability to make clear presentations of content. In another study, Schoen, Cebulla, Finn and Fi (2003) report that student achievement on the Iowa Test of Educational Development seem to correspond to the following teaching practices: an increased use of pair and group work
among students along with a decreased use of teacher presentations and whole group discussions, limited use of class time for nonacademic activities, a use of multiple assessment strategies including student interviews, high expectations on homework, and grading that focused more on academic factors than on attitude or effort. In a related study, focused on teacher quality rather than on student achievement, Arbaugh, Lannin, Jones, and Park–Rogers (2006) report that teachers with high lesson quality tend to use high cognitive level tasks, encourage students to solve problems using their own methods, ask students to discuss their problem solving methods with each other, and encourage students to critique mathematical tools.

The lists of practices discussed here are considered best teaching practices because research has shown that they support student achievement and align with teaching standards documents (e.g., NCTM, 2014). The remainder of this section will focus on three of the more prominent categories of best practices: classroom discourse, the use of mathematical tasks, and establishing classroom norms. These three are the focus because of their importance and prominence in the literature base, and they are reasonable as categories of practice within which teachers can be expected to engage their students.

Classroom discourse is one of the more researched mathematics teaching practices, and includes several characterizations, which are included among the list of best teaching practices. When utilizing discourse with and among students as a deliberate teaching practice, mathematics teachers need to pay attention to the students if they are going to help them develop a productive disposition (NRC, 2001) towards the mathematical content. For example, teachers have to decide when they need to speed up or slow down a conversation (Rittenhouse, 1998), and they need to focus on what the students are saying so as to rephrase or ask further questions about the discourse (Lampert, 1990; Lampert, Rittenhouse, & Crumbaugh, 1996; Rittenhouse, 1998). Furthermore, Lubienski (2002) found that classroom discourse that included students made those students who came from families with a higher socio–economic status feel more confident and
empowered, but made students who came from families with a low socio-economic status feel frustrated in those same conversations. This indicates that discourse may need to be sensitive to individual students. Evertson, Anderson, Anderson, and Brophy (1980) found that among junior high and high school mathematics teachers, more effective math teachers were the ones who asked more questions of their students. These teachers tended to focus on whole class instruction with some individual mathematics work, and were also “active, well organized, and strongly academically oriented” (p. 58).

Franke, Kazemi, and Battey (2007) note three teaching practices that stem from discourse in the classroom that will be further developed here: revoicing, interrogated meaning, and the use of mathematical tasks. Revoicing is defined as “the reuttering of another person’s speech through repetition, expansion, rephrasing, and reporting” (Forman, McCormick, & Donato, 1998; O’Connor & Michaels, 1993, 1996). Revoicing students’ language within classroom discourse can allow a teacher to incorporate precise mathematical language into the conversation, and maintain students’ understandings and focus on a particular mathematical goal within the lesson (Franke, et al., 2007; Herbel–Eisenmann, Drake, & Cirillo, 2009). Researchers have reported that the teaching practice of revoicing has been found to support students’ mathematical ideas as well as their identities as math learners (Forman, Larreamendy–Joerns, Stein, & Brown, 1998; O’Connor & Michaels, 1993, 1996; Strom, Kemeny, Lehrer, & Forman, 2001). 

*Interrogated meaning* is a phrase introduced by Rosebery, Warren, and their colleagues (Rosebery, Warren, Ballenger, & Ogonowski, 2005; Rosebery, Warren, & Conant, 1992) to engage students in questioning the content being discussed. Through interrogated meaning, students are encouraged to make meaning out of intellectual activity that takes place in the classroom, and clarify any misunderstandings they may have about the content.

Choosing high level mathematical tasks is a teaching practice that involves understanding one’s students well enough to know which tasks will provide high–level cognitive problem
solving and engage students in using multiple strategies, connecting ideas across content areas, and provide tasks that are interesting to students (e.g., Franke et al., 2007; Stein, Grover, Henningsen, 1996). Parlady & Rumberger (2008) found that first grade teachers who spend more time engaging students in explaining how a mathematical problem is solved before allowing students to solve the problem saw an increase in test scores. Whole–class discussions around a mathematical problem tend to be at a higher cognitive level if the teacher introduces mathematical tasks in a manner that maintains high cognitive demand (Jackson, Garrison, Wilson, Gibbons, and Shahan, 2013). The same study found that the quality of whole–class discussion around a mathematical task was positively correlated to attention given to the mathematical relationships within a task during introduction of that task, even when the task was not a problem–solving task (Jackson et al., 2013).

In their research with the Mathematical Tasks Framework, Stein and Lane (1996) found that mathematics teaching practices that engaged students in doing mathematics tasks or procedures with connections tasks corresponded to higher achievement levels on assessments that tested students abilities to engage in high–level mathematical thinking and reasoning. These researchers also found that if teachers engaged students in mathematical tasks that “were both set up and implemented to encourage the use of multiple solutions strategies, multiple representations, and explanations,” their students tended to perform better than those who were engaged in tasks that did not do those things (Stein & Lane, 1996, p. 50). Similarly, the researchers on the Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) project found that engaging students in higher–level mathematical tasks resulted in higher student achievement (Silver & Stein, 1996).

Establishing classroom norms is an important aspect of teaching practice because the practice allows for productive mathematical discourse between students (Franke et al., 2007). Norms are not created solely by the teacher, but can be fostered by teachers through certain
activities and language that require students to work together. Teachers’ use of mathematical notation has been shown to help establish productive classroom norms (McClain & Cobb, 2001). According to some researchers (Franke et al., 2007; Yackel, Cobb, & Wood, 1991; Yackel, Cobb, Wood, Wheatley, & Merckel, 1990), there are four types of norms that are built in classrooms: how students and teachers work together, ways for students to think for themselves, what types of mathematical reasons are acceptable, and what explanations are acceptable. Additionally, Kazemi and Stipek (2001) recorded four social norms within fourth and fifth grade classrooms that they found to support conceptual learning among students: “(a) an explanation consists of a mathematical argument, not simply a procedural description or summary; (b) mathematical thinking involves understanding relations among multiple strategies; (c) errors provide opportunities to reconceptualize a problem, explore contradictions in solutions, or pursue alternative strategies; and (d) collaborative work involves individual accountability and reaching consensus through mathematical argumentation” (p. 64).

Kazemi and Stipek (2001) found that the teaching practice of establishing a norm specifically designed to increase opportunities for conceptual thinking led students to a deeper understanding of the mathematical content. As a part of the previously mentioned QUASAR project, Silver et al. (1995) reported that middle school teachers needed to create a classroom norm that included trust and mutual respect if they were going to develop communities that would engage in productive academic discourse. They also found that the teacher should model logical arguments and justifications in order to increase students’ abilities to engage in logical arguments and to successfully utilize mathematical justification as a strategy for communicating mathematical ideas to other students. Research on Cognitively Guided Instruction (CGI) demonstrated that teachers from first grade through third grade cultivated higher–achieving students if they engaged in the teaching practices of listening to their students’ mathematical reasoning and thinking, used that thinking to influence their lessons, engaged students in using
multiple strategies for problem solving, and engaged students in more problem solving and word
problems than exercises with number facts (Fennema et al., 1996; Franke, Carpenter, Levi, &
Fennema, 2000).

Another aspect of establishing classroom norms is the relationships that are formed
between teacher and students. Teaching practices should include building relationships among
students so that the students feel comfortable having open and honest conversations among each
other and can fully explore their own mathematical ideas within the context of the classroom
(Franke et al., 2007). In addition, teachers should build relationships with students so they can
attend to students’ individual mathematical needs within their lessons. This includes knowing the
ways students tend to think about mathematical topics and being informed about potential
mathematical trajectories (Simon, 1995; Simon, Tzur, Heinz, & Kinzel, 2004). When building
relationships, it is important for teachers to attend to students’ cultural identities and practices
(Franke et al., 2007).

As discussed, research studies have characterized multiple best practices in mathematics
education, but three commonly researched practices were used as guides for this study:
productive mathematical discourse in the classroom, the use of mathematical tasks, and
establishing classroom norms. These three categories of teaching practices are used to guide
classroom observations by providing a focus for the observations conducted for this dissertation
study. While not all ritualized teaching practices fall into the category of best practices (in fact,
many are considered not best practice), the focus on best practices allows for a positive
relationship between the observed teachers and me.
Direct instruction and dialogic instruction

While the previous three categories of best teaching practices were used to guide the observation focus during data collection, the each of the two prominent identified teaching practices were similar to either direct or dialogic instruction. One group of mathematics education researchers came together throughout the 2011/2012 academic year to characterize and discuss two opposing types of mathematics teaching practices, traditional and reform, which they characterize as direct and dialogic, respectively. The group of nationally recognized experts in mathematics, mathematics education, and education in general met for a series of discussions regarding mathematics teaching practices. The organizers of this collection of discussions, Munter, Stein and Smith (in press), make it clear that both practices are seen as valid forms of teaching among different groups of researchers, and the goal of their orchestrated discussion series was to clarify how each type of practice is characterized by the discussion participants. According to their discussion group, direct instruction is characterized as: a collection of activities that includes: presenting a lesson goal that is explained and connected to previous lessons, describing the necessary concepts and procedures through examples of problems, and allowing students time to practice on similar problem types, during which the teacher provides support as needed. Contrary to direct instruction, dialogic instruction is characterized as: a collection of lessons during which teachers provide students with opportunities to grapple with mathematical content, justify their own mathematical claims, analyze claims stated by their peers, and practice mathematical problems that were thoughtfully created by a teacher. Notably, the authors point out that while teachers use direct instruction, “lessons should be made engaging” (p. 17), but do not include the same caveat to the description of dialogic instruction. Rather, the dialogic instruction definition is supplemented by a description of two types of tasks in which teachers should engage their students: “tasks that initiate students to new ideas and deepen their
understanding of concepts, and tasks that help them become more competent with what they already know” (p. 17). The undertones of the two definitions are that there is a clear mathematical goal for both types of lessons, but direct teaching practices include more straight-forward presentation and practice of mathematical content, whereas dialogic teaching practices include more student-centered, exploration of mathematical content.

**Theoretical framework: Sociocultural theory**

Sociocultural theory provides the theoretical framework for this study because it is a general conception of how learning and teaching occurs and therefore guides my research questions. This part of the literature review provides an overview on what sociocultural theory is, as described by researchers, and provides background information on how the theory has been used in ways similar to this dissertation study.

**What is sociocultural theory?**

Sociocultural theory depicts learning as a cultural activity. In research regarding education, this implies that the focus is typically on children as learners; however, this study applies the theory of learning to adult teachers as a description of how the surrounding culture can influence teaching practices. According to the sociocultural theory of learning, students go through a process of enculturation into society by learning content through the process of social interactions (Kozulin, 1998; Wertsch, 1997). “For Vygotsky, psychological activity [such as learning] has sociocultural characteristics from the very beginning of development; children, therefore, are not lone discoverers of logical rules, but individuals who master their own psychological processes through tools offered by a given culture” (Kozulin, 1998, p. 39).
When this idea is translated from children learners to adult teachers, the implication is that teachers learn how to teach by using tools that are given to them via the school culture in which they have participated, as both student and teacher, and will participate in the future, as a teacher. The beginning of a teacher’s development occurs when that person is participating in an apprenticeship of observation (Lortie, 1975) through observing teaching from a student’s perspective. Therefore, many of the practices teachers use come from their individual observations of teaching from a student perspective. As Stigler and Hiebert (1999) write from their years of research experience on teaching practices, “Teachers learn to teach by growing up in a particular culture, by watching the methods their teachers used when they were students. The methods most teachers use are inherited from earlier generations of instructors, not invented when they read the classroom” (p. xiii). In this fashion, teachers are brought into the culture of teaching, and their own teaching practices are heavily influenced by the culture of teaching and learning surrounding their entrance into the profession, and their own experiences as students.

**Use of sociocultural theory to study mathematics teaching practices**

“The task of a sociocultural approach is to explicate the relationships between human action, on the one hand, and the cultural, institutional, and historical contexts in which this action occurs, on the other” (Wertsch, 1997, p. 24). This section of the literature review explores research that has used sociocultural theory to study mathematics teaching practices, and describes what the field of mathematics education already knows about teaching practices through a sociocultural lens.

It is well documented that cognitive and problem–solving abilities are often bound by the context in which they are utilized (Ceci & Roazzi, 1994; Nunes, Schliemann, & Carraher, 1993;
Rogoff & Lave, 1984). For instance, Lampert (1990) found that social norms between teacher and students dictate the interactions that occur in the context of the classroom. Lampert writes,

> When classroom culture is taken into consideration, it becomes clear that teaching is not only about teaching what is conventionally called *content*. It is also teaching students what a lesson is and how to participate in it (Florio, 1978; Jackson, 1968; Mehan, 1979). From the activities the teacher sets for them, students learn what counts as knowledge and what kind of activities constitute legitimate academic tasks (Cazden, 1988; Doyle, 1985, 1986; Leinhardt & Putnam, 1987; Lemke, 1982; Palincsar & Brown, 1984). Face-to-face interaction between students and their teacher follows context–specific rules, and cues within these contexts signal how and what anyone says is to be understood in relation to the task everyone is assembled to accomplish (Cazden, 1988; Mehan, 1979). (1990, pp. 34–35)

Lessons regarding knowledge, classroom lesson etiquette, and legitimate academic tasks are perpetuated as valid teaching practices when a small group of those grade school students choose to become teachers. As a teacher enters the profession, he or she brings along the lessons learned about the roles of the teacher and students from their own experience as a student.

Cobb and Yackel (1996) suggest combining a constructivist perspective of learning with a sociocultural perspective of learning as they examine two cultures’ impacts on learning opportunities. They acknowledge that most researchers take one stance or the other, but use their previous research to demonstrate that while individual learning might be a constructivist process, learning is impacted by and situated within a larger cultural context. The view that learning is situated within a context dictated by culture can be extended to teaching practices, as they are similarly situated in culturally dictated context.

Yang and Cobb (1995) report that the culture in which learning occurs can manifest through unique learning opportunities and experiences during educational activities. Specifically, their study compares the learning experiences among Asian cultures and U.S. cultures. Their study implies that the culture in which a school is situated is an important influence on how learning occurs within the school. Moreover, Yang and Cobb (1995) present “differences in cultural beliefs and values and in instructional approaches,” identified in prior studies (e.g.,
Stevenson & Lee, 1990) “as explanations of different levels of performance in mathematics” (Yang & Cobb, 1995, p. 2). A logical conclusion is that the differences observed in instructional approaches across the two cultures are influenced by the culture as much as they influence student performance. Yang and Cobb (1995) report that the sequence of the learning activities in which students were engaged was one difference between the educational experiences in the two examined cultures. Through interviews with teachers and parents, the authors gathered information on preferred “methods or procedures that all children should learn,” as well as important learning activities, expected developmental stages of understanding, and beliefs regarding the extent to which children need help to learn (Yang & Cobb, 1995, p. 7).

Given the findings that there are vast differences in learning outcomes between the two cultures, the culture must influence the teaching practices that are being used as well. For example, Yang and Cobb’s (1995) study demonstrates that American teachers and parents found place value to be a difficult concept, and that those beliefs were passed onto students through teaching practices. Yang and Cobb’s (1995) study demonstrates that if teachers use their own conceptions of how they learned a mathematical concept to influence the way they teach that concept to students, then their students will adopt analogous mathematical conceptions. This is one example of how culture influences mathematics teaching practices.

**Analytical framework: Ritualized teaching practices**

The lens of ritual provides an analytical framework for this study by informing what it means for an enduring teaching practice to be ritualized. The concept of ritual has mostly been developed outside the field of mathematics education. It has its roots in anthropological and religious studies as a way to understand the cultures of different groups of people. Understandings of ritual fall under two main categories – one described by Durkheim
(1912/1965) and one described by Turner (1969). Durkheimians believe ritual is more of a “social function” that helps to “maintain the status quo” (Quantz, 1999, p. 494). Turnerians believe ritual is more of a “social process” that helps to make social “transformation possible” (Quantz, 1999, p. 494). Quantz (1999) addressed the dispute by suggesting that research move forward from trying to define what ritual is, and instead focus on “how we might use the concept to make sense of our world” (p. 495).

For the purposes of this study, the definition of ritual is adopted from McCloskey (2013), which was adapted from Quantz (2011) and Bell (1997). Ritual is defined as “that aspect of action that is formalized, traditionalized, [and a] symbolic performance” (McCloskey, 2013, p. 25). For the purposes of clarifying the definition, each of the four parts (namely formalized, traditionalized, symbolic, and a performance) will be described individually. Formalized refers to the idea that there is an established routine surrounding the action; “that witnesses to a ritual bring certain expectations as to the appropriate and expected temporal and spatial organization of a ritual” (Quantz, 2011, p. 39). If an action is formalized, it would be apparent to an observer that the ritual participants clearly understand how the ritual should look as it is being played out. Traditionalized refers to the idea that “the action appeals to tradition or custom in some way” (McCloskey, 2013, p. 25). There should be an indication that the action is connected to the past in some way. Symbolic refers to the idea that the ritual includes symbols that “represent things indirectly through association” (Quantz, 2011, p. 28). For a ritual to be symbolic, it should be clear that the ritual stands for something more than a direct interpretation. Performance refers to the notion that a ritual “is not simply instrumental to achieving an overt end, but is acted in a matter to be seen or heard and ‘read’ by others” (Quantz, 2011, p. 36). This means that a ritual should seem fairly manufactured, or almost read off a script of some sort. As an analytical framework for this study, the definition will be dissected into four distinct parts and used to
identify a ritual when all four parts of the definition are satisfied within a single classroom action. This process will be discussed further in the methods chapter of the dissertation.

The following section of the literature review will first discuss how the concept of ritual has been used in general education and mathematics education research, followed by a description of other frameworks that are similar to that of ritual, and a discussion of why ritual will be used for this study. Throughout the review of ritual, it is important to note that the proposed study uses the term *ritualized teaching practice* to mean a teaching practice that has ritualistic aspects. The study will explore ritualized teaching practices, not rituals specifically; however, the reviewed literature will use the term ritual, which will help to depict how others have studied the concept in a way that informs this study of ritualized teaching practice.

**Use of ritual in research in education and mathematics education**

The concept of ritual as a topic of research in the educational field is fairly new. A popular focus in research on rituals within general education tends to be on rituals within a school or district that are an inherent source of power for the people who are in charge of education (e.g., Illich, 1970; Kapferer, 1981; McLaren, 1993, 1999; Quantz, 1999). For example, McLaren (1993) takes “a perspective of ritual which attempts to take seriously the concepts of power and domination and which addresses ritual as a cultural production constructed as a collective reference to the symbolic and situated experience of a group’s social class” (p. 4). This view of an outcome of rituals in education is to say that rituals are a way of controlling power within the education system. Rituals empower the dominant culture by integrating students into a specific class. For a mathematical example, Quantz (1999) describes lecturing as a mathematical ritual, saying, “lecturing may be all too effective in teaching the wrong thing – to be docile subordinates” (p. 512). However, research on rituals in mathematics education tend not to focus
so much on social inequalities, but rather on using rituals to understand how mathematical knowledge is transmitted to students.

In mathematics education, ritual has been used to compare teacher–student interactions in mathematics classes with other types of classes (Ensign, 1997), as well as describe cognitive and psychological aspects of learning mathematics (Sfard & Lavie, 2005). There are multiple studies that use the construct of ritual to characterize a learning that tends to be void of any type of sense making with regards to mathematical knowledge (e.g., Cobb & Yackel, 1996; Edwards & Mercer, 1987; Hull, 1985). Vinner (2007) calls for mathematics educators to change the practice of teaching by recognizing the rituals in mathematics and seeing those as meaningless. He claims that mathematics educators should strive to recognize meaninglessness in rituals in order to make education more meaningful for students.

In contrast, Solomon (1989, 1998) claims that “mathematics is a set of social practices which are constitutive of its meaning” (Solomon, 1998, p. 379). She critiques the notion that engagement in rituals is in strict contrast to understanding and building mathematical knowledge. She writes “the teacher’s task is not merely to point out what already exists in the real world, but to induct children into talking mathematically about it” (Solomon, 1998, p. 384). Thus, it follows that mathematical learning is more of an induction into the culture of mathematics, and that teachers and students must engage in the culture together in order for students to become a part of that society of knowledge.

There is also research that highlights miscommunication between teachers and students as a result of rituals in education. For example, Boaler (1999) found that students tend to engage in a more complex mathematical procedure rather than relying on their own mathematical reasoning because they have become conditioned to perform certain actions and felt that “school mathematics was incompatible with thought” (Boaler, 1999, p. 263). Similarly, Novotna and Sarrazy (2011) describe that if mathematics teachers always use the word share when they mean
divide, students will tend to respond to the directive of share by dividing without actually understanding what it means to divide. Both of these examples show that teaching practices that have become ritualized, and therefore likely to be meaningless to learners, can lead to disjointed learning.

**Why ritual?**

R ritual is used for this study because it can be influential on communities’ abilities to reflect and alter their ways of doing things, including educational communities’ abilities to change common teaching practices in order to improve student learning. While some rituals in education are negative influences on learning, there is the potential for rituals to be neutral or even a positive influence on student learning and the surrounding community. Using the definition of ritual as an action that has endured within a particular culture for years to study rituals within mathematics education is to study something that may be resistant to change. However, there is evidence that rituals can be used both as an agent of change as well as an agent of stability within a culture (Aldenderfer, 1993). There should be an examination of whether or not researchers actually want to change a practice or not. If practices have become ritualized, it is important to examine the potential roles they play for society and realize that education is more than just succeeding on standardized tests or increasing students’ grades. Education is about molding students in certain ways to prepare them for entrance into society so that they are able to be productive members of that society. While mathematical knowledge is important, it is also important to understand how society is trying to mold students for entrance into the culture. Maybe certain practices are useful in cultural ways that are outside of improving or increasing student knowledge. McLaren (1993) writes, “rituals may be perceived as carriers of cultural codes (cognitive and gestural information) that shape students’ perceptions and ways of
understanding” (p. 3). In this light, the concept of ritual can provide a powerful insight into the culture surrounding teaching practices.

Teaching practices are an important part of formal education because of their demonstrated influence on student learning. Sociocultural theory is a theoretical framing for the study because of cultures’ demonstrated impact on student learning as well as on teaching practices. Ritual provides a useful analytical framework in that it is clearly delineated into categories of characterizations that will be used to identify ritualized teaching practices, and in that it helps to identify teaching practices that have endured within the school culture.
Chapter 3 Research Methods

The purpose of this study is to explore the claim that certain mathematics teaching practices endure because they have become ritualized in an education culture. As ritualized practices in the educational culture, those mathematics teaching practices are likely to hold some meaning for educational stakeholders within the local school culture. The intent of this study is to identify common mathematics teaching practices within a school community, determine if there are any ritualized mathematics teaching practices, and examine how educational stakeholders make sense of those ritualized practices. More specifically, the research questions guiding this study are:

How do educational stakeholders make sense of mathematics teaching practices observed in their local elementary school?

(a) What are stakeholders' beliefs, values, and opinions regarding mathematics teaching and learning, and how do those beliefs, values, and opinions relate to the mathematics teaching practices observed in their local elementary school?

(b) What are stakeholders' experiences in mathematics classes, and how do those experiences relate to the mathematics teaching practices observed in their local elementary school?

(c) How do stakeholders' beliefs, values, and opinions about mathematics teaching practices relate to the state mathematics assessment administered to students in their local elementary school?

In order to study the educational culture surrounding the observed mathematics teaching practices, the study is designed from the interpretivist philosophical point of view, through which ethnographic research methods (Eisenhart, 1988; Erickson, 1973; Geertz, 1973) are used.
“Central to interpretivism is the idea that all human activity is fundamentally a social and meaning-making experience, that significant research about human life is an attempt to reconstruct that experience” (Eisenhart, 1988, p. 102). While this study is not a traditional ethnography, many of the underlying ethnographic philosophies guide the design of the study in order to reconstruct the meaning-making experience of observed teachers and stakeholders.

One of the most prominent assumptions underlying this research study is that human activity is inherently social in nature, and its complexities must be carefully examined and reconstructed through research. When this philosophy is extended from traditional ethnography to mathematics education research, it allows for complex human interactions in teaching and learning to be studied in a way that describes how people within the culture, such as stakeholders in formal education, are making sense of human interactivity, such as enduring mathematics teaching practices (e.g., Eisenhart, 1988).

In contrast to experimental or quantitative studies, ethnographies have traditionally been used as a way of describing the complexities of societies and attempting to shed light on unfamiliar cultures in a way that did not position those cultures as abnormal (Erickson, 1973). Ethnographers operate under the assumption that there is value in understanding and attempting to describe the complexities of a particular culture. Erickson describes two assumptions that ethnographers must make when they research a formal school setting. The first is that while researchers are examining what may seem familiar to them, they must remember that what is happening in that culture is noteworthy.

The next assumption is that what goes on in school is not only a matter of relations between individual teachers, and students and parents but of relations among students as groups, among teachers as groups, relations between the school as a whole interacting with other social units as wholes (community groups, the larger school system, political and economic entities), outside it. In short, it is assumed that the full significance of many events inside school can only be seen in the context of events throughout the whole school, of influences on the school from outside it, and of influences of the school on the larger society. (Erickson, 1973, p. 16)
Erickson’s assumptions demonstrate why ethnographies conducted in settings within which the researcher is familiar can be precarious because even though the researcher may be familiar with what she is observing, she must orient herself in a way that makes the observed practices novel in order to be successful with the research. The second assumption addresses a significant part of what this research study examines, and that is the complex nature of what happens in the formal grade school setting. Specifically, there is an assumption for this study that decisions made about mathematics teaching practices are not made by a single teacher or single school site, but rather that there is a more complex group of individuals who have some type of influence on practices that are used to teach mathematics, whether that influence is acknowledged or not.

Ethnographic methods will be used throughout the study in an attempt to better understand educational stakeholders’ sense making of mathematics teaching practices observed in their local elementary school. One such method is thick description (Geertz, 1973), which is used as a method for observing and describing classroom contexts. Thick description is important when studying a culture because there is meaning in the way in which members of that culture interact with one another that would not make sense outside of that culture. Therefore, when attempting to characterize a particular culture, it is important to fully describe the situation that is being studied so as to make clear to others a full picture of what is happening. Geertz (1973) writes:

There are three characteristics of ethnographic description: it is interpretive; what it is interpretive of is the flow of social discourse; and the interpreting involved consists in trying to rescue the “said” of such discourse from its perishing occasions and fix it in perusable terms. (p. 13)

This is to say that ethnographic description is the researcher’s interpretation of some particular aspect of the culture in which she has situated her study. Thick description is a tool that can be used to provide a clear depiction of the culture and clear interpretations of that culture to
people outside the study. A clear depiction is made possible and believable by spending considerable time within the cultural setting.

Finally, ethnographies stress a focus on empowering the research subjects, which is a theme that was utilized when designing and implementing this study. As described in subsequent sections of the chapter, the idea of empowering the teachers and stakeholders in the study infiltrates the data collection methods. For example, member checking was a regular part of analysis, and the observed teachers were asked and encouraged to provide support for the creation of the interviews for the second half of the study. Consideration of the teachers’ understandings of the enduring teaching practices is an important part of following ethnographic methods, because it is through their understandings that we can come to better understand that practice as it is utilized in that school.

In the following sections of this chapter, the context of the study, data collection methods, data analysis methods, and procedures to ensure the trustworthiness and validity of the study are described in detail.

**Context of the study**

The study is situated within a single school district in the northwest United States. The school district is a supportive and collaborative community with a focus on and a history of high achievement on state assessments. The primary focus for the study is one of three elementary schools in the district, which all feed into one middle and one high school in the district. There are about 450 students registered for the elementary school during the observed school year, and about 150 of those are in fourth and fifth grade. The school district is located in a small college town, with only 31 percent of students qualified for free and reduced lunches. There are 19 teachers and one administrator working at the school, the majority of whom hold Masters
degrees. All three elementary schools in the district have approximately the same number of students, teachers, and students who qualify for free and reduced lunch.

As the school is located in a small college town, there is a high level of parent involvement and teacher collaboration, both within the elementary school and across the school district. University collaboration is also encouraged, and has gained momentum in recent years. Teachers who work with students in the same grade levels frequently construct lesson plans with each other, and often engage in various types of co-teaching. The local community supports the schools in the district, and engages with groups of students through various field trips and town parades or celebratory events.

**Participating classrooms, teachers, and stakeholders**

Observed teachers were identified and approached using previously established relationships with faculty from the local university. One faculty member from the university suggested two elementary teachers, both of whom were currently involved in the faculty’s professional development program. The teachers met with the faculty member and me to discuss the dissertation project, and agreed to participate as observed teachers. The faculty member made it clear that this study was separate from their professional development program, but that the goals of the two research studies complemented each other. Another faculty member at the same university suggested a third teacher, who is a part time graduate student as well as an elementary teacher. The teacher was contacted via email, and agreed to an informal meeting where the project dimensions and requirements were discussed. She was excited about the project and agreed to participate as an observed teacher.
Three fourth and fifth grade teachers, from the elementary school previously described, agreed to participate in the observation portion of the study: Ana, Beth, and Fred\textsuperscript{1}. Each of the three classrooms includes between 25 and 30 students, but the exact number varies throughout the three months of data collection. Fifth grade students are primarily grouped according to performance on the previous year’s state assessment, with students who have similar scores in both Mathematics and Language Arts clustered together. Fourth grade students are re–grouped during mathematics class according to their state assessment scores in Mathematics from the previous year.

Ana has taught elementary school for 27 years, with three years at the current school. She has taught every grade from first through sixth, except for third, and teaches fifth grade this year. Ana is a part–time graduate student in Science and Mathematics Education at a local university, and is currently taking one or two courses per semester in the evenings. Her classroom this year contains mostly average–level students, and includes multiple students with special needs. Ana’s mathematics class is typically about 45 minutes with her usual students, and 45 minutes of an activity called Walk to Math. During the Walk to Math portion of class, Ana and another teacher sort their collective students according to pre–tests and student performance with certain skills, such as ability to multiply two–digit numbers. The Walk to Math class time is spent with students in small groups practicing basic mathematical skills, with direct instruction help from both teachers in the identified weak areas, specific for each student.

Beth teaches fourth grade during the data collection school year, which is her 28\textsuperscript{th} year of teaching elementary school. She has her administration credential, but has decided that she does not have interest in using it; she would rather focus on teaching. Beth has some experience teaching pedagogical courses at a local university and has worked with many pre–service teachers through the university, especially in relation to Special Education. Her classroom this year

\textsuperscript{1} All three names are pseudonyms.
\textsuperscript{2} Details about this professional development are provided in the next chapter.
includes many struggling fourth grade students. Beth’s mathematics class contains about half of her usual students, and half of students from other fourth grade classrooms. As a result of the structuring of fourth grade mathematics, she teaches at the same time every day for 90 minutes a day.

Fred teaches fifth grade during the data collection school year, which is his seventh year of teaching. His classroom is mainly comprised of mostly high–level fifth grade students. Because his students do not rotate classrooms, his mathematics teaching schedule varies each day. Typically, he spends about an hour on mathematics daily, but this is adjusted as needed to fit the rest of the schedule. Some days he spends more time on mathematics lessons, while other days he decides to spend less time. Educational stakeholders were identified during the first part of data collection as categories of people who have some form of interaction with grades four and five in the local elementary schools, as can be seen in Figure 3-1, and who were willing to talk about their opinions concerning local mathematics teaching practices. This diagram is an adaptation of Figure 1-2, which is adapted from research findings on categories of educational stakeholders to the incorporate the actual educational stakeholders participating in the current study. The adaptation is in the direction of the arrows, which are now bidirectional to indicate that the stakeholders are interpreting the mathematics teaching practices, whereas this figure was previously demonstrating potential influences on mathematics teaching practices.
Administrators from all three elementary schools in the district were contacted, parents from students in the observed classrooms were asked to provide their contact information if they were willing to be interviewed for the second portion of the study, university researchers who had been working with professional development at the elementary school site were contacted\(^2\), and the observed teachers provided names of some of their colleagues within the same school site who might be willing to participate in the second portion of the study. This search resulted in 16 stakeholder participants for the study, which include two elementary principals, six parents, four university researchers, and four teachers colleagues (different from the three teachers who were observed for the first part of the study), as depicted in Table 3-1.

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\(^2\) Details about this professional development are provided in the next chapter.
Table 3-1. Summary of all study participants, including observed teachers and interviewed stakeholders.

<table>
<thead>
<tr>
<th>Observed Teachers (3 total)</th>
<th>Interviewed Stakeholders (16 total)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elementary Principals (2 total)</td>
</tr>
<tr>
<td>Ana</td>
<td>Marie</td>
</tr>
<tr>
<td>Beth</td>
<td>Leo</td>
</tr>
<tr>
<td>Fred</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to preserve participant anonymity, stakeholders are described within each of the four groups rather than as individuals. For example, rather than a description of Marie and a description of Leo, they will be characterized together as the group of participating elementary principals.

The two participating principals are from two of the three elementary schools located in a single school district, which was previously described. Both schools are involved in a local university–led professional development, and one is the principal of the school where the three observed teachers work. One of the administrators was a kindergarten teacher for 16 years, and has recently taken on the role of principal in the district. This principal is now the leader of the same elementary school in which she was a kindergarten teacher. The other administrator was a high school mathematics teacher for many years before becoming an elementary principal. At the time of data collection, he had been in local administration for about 13 years.

Five of the six parents have one child enrolled in Ana, Beth, or Fred’s mathematics classes. The sixth parent has a fourth grade child, who is enrolled in another elementary school in the same school district. Four of the six parents have more than one child enrolled in the school district, while the other two parents have only one child. One of the parents is an undergraduate
student at a local university; three parents are faculty at a local university, working in departments outside of education; one parent is a local doctor, and one parent is a homemaker.

The four university researchers constitute all but one of the Principal Investigators, or PI’s, in the local professional development program previously mentioned. Three of them were middle and high school mathematics teachers before transferring into mathematics education as university professors. All four have experience teaching mathematics or mathematics education as tenured and tenure–tracked professors. The fifth PI on the project was heavily involved with the professional development at the start of the project, but no longer works with the professional development implementation. This person is an administrator in one of the schools that worked with the professional development at the start of the program, but is no longer involved in professional development work associated with the university.

The four teachers colleagues all work at the same elementary school as the observed teachers. One is a second grade teacher, who has taught multiple grade levels for 15 years. One is a first grade teacher who has taught for 13 years. Another is a fourth grade teacher who has been teaching for 14 years, and the last has been a third grade teacher for eight years.
Data collection and analysis methods

Data collection occurred in two phases over the course of two semesters, as is depicted in Table 3-2. Data collected in Phase I focused on classroom observations and teacher interviews, with the intent of identifying prevalent mathematics teaching practices in the elementary school. Data collected in Phase II focused on interviews with educational stakeholders with the intent of understanding how stakeholder made sense of the identified teaching practices from Phase I.

Table 3-2. Phases of data collection and data analysis.

<table>
<thead>
<tr>
<th>Phase I: Identifying mathematics teaching practices</th>
<th>Research Activity Type</th>
<th>Research Activity</th>
<th>Research Tool</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Collection</td>
<td>Classroom Observations</td>
<td>Video and audio recording, and field notes</td>
<td>Sept. – Dec. 2014</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase II: What meaning do stakeholders make from this practice?</th>
<th>Research Activity Type</th>
<th>Research Activity</th>
<th>Research Tool</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Collection</td>
<td>Interviews with stakeholders.</td>
<td>Video and audio recording</td>
<td>March – April 2015</td>
<td></td>
</tr>
</tbody>
</table>

The goal of data collection and analysis in Phase I was to better understand mathematics teaching practices that are common to all three of the participating classrooms, and the goal of data collection and analysis in Phase II is to better understand how educational stakeholders make sense of the identified mathematics teaching practices. Data collection methods follow from the underlying interpretivism philosophy that guides this study, as Eisenhart (1988) writes, “The purpose of doing interpretivist research, then, it to provide information that will allow the investigator to ‘make sense’ of the world from the perspective of the participants” (p. 103).
Throughout the duration of data collection, four methods for data collection common to ethnography (Eisenhart, 1988) will be utilized. They are: participant observation (Denzin, 1978; Eisenhart, 1988; Spradley, 1980), ethnographic interviewing (Eisenhart, 1988; LeCompte & Preissle, 1993; Spradley, 1979), a search for artifacts (Denzin, 1978; Eisenhart, 1988; LeCompte & Preissle, 1993), and researcher introspection (Denzin, 1978; Eisenhart, 1988; Pelto & Pelto, 1974). Together, these four ethnographic methods provide opportunity for data triangulation (Eisenhart, 1988) for the study. This means that the findings from this study came from multiple data types during analysis.

Table 3-3: Types of data collection, their use, and their phase of data collection.

<table>
<thead>
<tr>
<th>Type of Data Collection</th>
<th>Usefulness in the Study</th>
<th>Phase of Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Observation</td>
<td>Provides insight into the culture from an outsider’s perspective.</td>
<td>Phase I</td>
</tr>
<tr>
<td>Ethnographic Interviewing</td>
<td>Provides insight into the culture from different perspectives within the culture.</td>
<td>Phases I and II</td>
</tr>
<tr>
<td>Search for Artifacts</td>
<td>Describes and represents teaching practices to stakeholders in order to elicit their interpretations.</td>
<td>Phase I</td>
</tr>
<tr>
<td>Researcher Introspection</td>
<td>Assists with writing thick descriptions, allows for biases to be described, helps describe realistic interpretations of the observed culture.</td>
<td>Phases I and II</td>
</tr>
</tbody>
</table>

Data collection and analysis: Phase I

Phase I of the study focused on observing mathematics teaching practices from the three observed teachers. The goal of the observations was to identify and describe mathematics
teaching practices common among all three teachers. The result of Phase I was an interview protocol to be used with stakeholders in Phase II.

**Phase I: Data collection**

During Phase I of data collection, data was collected regarding a variety of mathematics teaching practices in an attempt to identify and characterize the most common mathematics teaching practices during a period of approximately three months across all three observed classrooms. The primary source of data for Phase I came from participant observation (Denzin, 1978; Spradley, 1980), in which the participants are the teachers and students in the observed classrooms. Throughout this process, I chose “to be primarily an observer and less of a participant” (Eisenhart, 1988, p. 105). I did not interfere with the teaching practices as enacted by each teacher; however, in order to build and maintain relationships with the students and teachers, I did walk around the classroom during some lessons and helped students with any of their mathematical questions. Occasionally teachers asked me about my opinions regarding student learning during the lesson, and I did respond to those inquiries. Data on classroom observations was collected through audio- and video- recordings, as well as fieldnotes taken during and just after the observations. During each classroom observation, a video camera was placed at the back of the room to capture both visual and audio interactions of teacher and students. Additionally, during most observations, both the teacher and I wore audio recording devices to capture individual conversations. While true ethnographic fieldnotes typically have a broad focus, this study differs in that fieldnotes were taken specifically about mathematics teaching practices in each classroom.

Observations started after two weeks of informal observations. For those first two weeks, there were two observations per classroom each week, but those interactions were not captured on
video– or audio– recordings. The goal for these informal observations was for me to establish a relationship with the students and each teacher before formally recording classroom lessons. By the second week, students in all three classrooms treated me as a typical classroom adult. They were not distracted when I walked into the classroom, and they asked me mathematical as well as logistical questions during the lesson. For example, during one classroom observation, students were working on a poster, and asked me for help on how to correctly indicate spacing on a number line. The following day, students asked me where the completed posters should be placed. These types of interactions between students in all three classrooms and me indicate comfort and acceptance among the students towards my presence in the classroom.

Additionally, by the second week, all three teachers were talking to me about their mathematics lesson plans. Some interactions were more focused on the teacher telling me what was going to happen, or explaining why certain activities happened; other interactions were more of a discussion between the teacher me regarding decision making for future lesson plans. For example, Beth asked my opinion regarding a completed lesson. Beth thought the students needed more time to grapple with the mathematical ideas from the lesson, and asked if my interactions with students indicated the same need for additional time during the next mathematics lesson.

Following the previously described indications that both the students and the three teachers felt reasonably comfortable with my presence in the classroom, formal observations started during the third week of interaction. In the following months, I visited each classroom for an average of twice a week. Each lesson lasted between 45 minutes and an hour and a half. Depending on the teachers’ schedules, some weeks contained more visits than others. By the end of three months, there were a total of 18 observations in Ana’s classroom, 19 observations in Beth’s classroom, and 20 observations in Fred’s classroom. Because of the varying lesson lengths, 16.5 hours were spent in Ana’s mathematics class, 22.5 hours were spent in Beth’s mathematics class, and 21 hours were spent in Fred’s mathematics class.
In addition to participant observation, ethnographic interviewing (LeCompte & Preissle, 1993; Spradley, 1979) was utilized during Phase I with teachers to describe their interpretations of the observed teaching practices. During the observation period, there were three formal interviews with each of the teachers, each lasting between 30 minutes and an hour. Formal interviews were audio recorded, and were designed in order to gain information regarding prevalent teaching practices used in each classroom. The specific questions asked during each interview can be seen in Appendix A. The first interview was used to better understand the philosophies and beliefs of each teacher regarding mathematics teaching and learning, as well as an attempt at identifying common mathematics teaching practices utilized within each mathematics lesson, according to each teacher. The subsequent interviews were directed at specific teaching practices, with the intent of characterizing previously identified common teaching practices. Additionally, there were many informal conversations during the observations that provided insight into each teacher’s decision-making process and details regarding their teaching practices. The content of these conversations were recorded in a combination of field notes, audio recordings, and video recordings. An additional goal during some teacher interviews was to member check by eliciting teachers’ feedback on interpretations of mathematics teaching practices to be utilized in Phase II of data collection, and to elicit suggestions about potential stakeholders in the classroom from the observed teachers. The details of this will be discussed further in the section about Phase II.

The data collection method of searching for artifacts (Denzin, 1978; LeCompte & Preissle, 1993) will be more relevant during the analysis of Phase I, which will be described later. However, searching for artifacts was a part of the data collection in Phase I to provide support for initial descriptions of common mathematics teaching practices. Such artifacts include pictures of work done on the board, handouts in class, and pictures of textbooks. These artifacts were used to describe the observed mathematics teaching practices during analysis, and also for Phase II of
data collection. In keeping with the ethical considerations of educational research, any artifacts used during Phase II were discussed with the observed teacher(s) before being utilized during stakeholder interviews.

The last method of data collection during Phase I is researcher introspection (Denzin, 1978; Pelto & Pelto, 1974), which was used to “account for sources of emergent interpretations, insights, feelings, and the reactive effects that occur as the work proceeds” (Eisenhart, 1988, p. 106). While I chose to remain more of an observer than a participant in the classrooms, it was important to record interpretations, thoughts, and feelings about what happened during each day of observation. This introspection was recorded in a daily journal and includes my written recordings and reflections regarding observed mathematics teaching practices, as well as interpretations of those practices. For instance, each journal entry includes a description of the classroom activities with specifics about the teacher’s actions and the students’ actions during the lesson. Throughout and following the descriptions, there are reflections such as “Note: Teacher asks students to generalize and justify their generalizations at the end of most tasks; this request does not seem to come when students are working from the textbook” (Journal Entry, November 12, 2014).

A decision to end data collection was made based on data saturation. Two primary teaching practices had been identified across all three classrooms. These practices occurred multiple times and multiple days for each observed teacher, and were clearly the focus for each teacher as he or she thought about lesson planning. In fact, at least one of these identified mathematics teaching practices was observed during almost every classroom observation throughout the entirety of data collection. By the end of the third month of data collection, there was enough video observation data to dissect and thickly describe the classroom activity, as well as enough interview data to support the descriptions. These teaching practices are considered findings of this study, and so they are presented and discussed in the next chapter.
**Phase I: Data analysis**

The second part of Phase I is analysis of the classroom observations, which were analyzed according to ethnographic methods (Eisenhart, 1988; Erickson, 1973; Geertz, 1973) as described in detail below, and utilizing the ritual framework outlined in McCloskey (2013). The goal of this data analysis was to identify and depict mathematics teaching practices common to all three teachers, and use those depictions to create an interview protocol for Phase II of the study. The ritual framework (McCloskey, 2013) was used to identify one of the mathematics teaching practices as a ritualized teaching practice.

As stated by Eisenhart (1988), ethnographic analysis methods begin during data collection through the data collection method of researcher introspection (Denzin, 1978; Pelto & Pelto, 1974). During the classroom observations and discussions with the observed teachers, two mathematics teaching practices became apparent as an important part of the conversation teachers were having regarding improving their own teaching practices. In a vast majority of the conversations and interviews with Ana, Beth, and Fred, the teachers discussed a tension between what they called a more traditional form of mathematics teaching and a more task–oriented form of mathematics teaching. Because of the prevalence of discussion surrounding these two practices, they were chosen as the focus for data analysis.

Once the mathematics teaching practices were identified, classroom observation videos were analyzed for evidence of each one being consistent across all three classrooms. A teaching practice was considered consistent if it was observed during multiple mathematics lessons and across multiple teachers’ classrooms. Utilizing both the field note descriptions and the teacher–identified lessons containing each type of teaching practice, I created categories of teacher and student activities that occurred during each type of teaching practice along with the order in which the categories of activities typically appeared within observed lessons, as seen in Figure
3-2. These ordered categories were used to code classroom lessons as either a task–oriented lesson or a traditional, textbook–based lesson.

Figure 3-2. Categories of classroom activities created in Studiocode.

During Phase 1 of analysis, the video analysis software, Studiocode was used to systematically categorize the observation data according to various classroom activities. The program was used to identify teacher and student activity within each observation as either a task–oriented activity or a textbook–oriented activity. As will be described in further detail in Chapter 4, all but a few of the classroom lessons could be categorized as either task–oriented or textbook–based. Many lessons contained elements of both task–oriented and textbook–oriented activities across the entire lesson; however, each instance of coded student or teacher activity fit completely into one category or the other. For example, a lesson might start with a textbook–oriented review, and then engage students in a mathematical task for the remainder of the class time, but students were either engaged in textbook–oriented activities or task–oriented activities, not both at the same time. Those lessons that could not be categorized as either type of lesson were testing days or holidays, during which teachers often engaged students in some type of fun, tangentially mathematical activity. During this phase of analysis, I also searched for confirming and disconfirming evidence (Eisenhart, 1988; Erickson, 1986) for the existence of an additional
teaching practice, but did not find one. Once the two practices were confirmed as consistent across all three classrooms and observed over multiple weeks, attention was turned to analysis of the two teaching practices for evidence of ritual.

The two practices were analyzed for evidence of ritual using McCloskey’s (2013) framework. The definition of ritual and the framework for analysis that McCloskey (2013) describes is not intended to characterize instances of practice as positive or negative, but rather intended to allow for a different focus in qualitative research than previous studies. Ethnographic methods are intended to do just that, as Erickson (1973) writes, “ethnography should be considered an inquiry process guided by a point of view” (p. 10). By using McCloskey’s ritual framework as a way to reorient the point of view, this study attempts to understand the way that stakeholders make sense of teaching practices within the local elementary school district community. McCloskey also claims that her framework is not intended to identify certain rituals; however, this study uses the parts of the definition to determine whether or not the two observed mathematics teaching practices are ritualistic.

McCloskey’s (2013) ritual framework is used to provide thick descriptions (Geertz, 1973) of each part of the definition of ritual used for this study, as seen in Table 3-4. As discussed earlier, for the purposes of this study, ritual is characterized from McCloskey’s (2013) adaptation of Quantz (2011) and Bell (1997) as “that aspect of action that is formalized, traditionalized, symbolic performance” (McCloskey, 2013, p. 25). Evidence of each of these three characteristics that was used to determine if each mathematics teaching practice can be considered ritualistic is described in Table 3-4.

The criteria used for coding teaching practices are from McCloskey’s (2013) ritual framework. This study adapts her definition of ritual as “that aspect of action that is formalized, traditionalized, symbolic performance” (McCloskey, 2013, p. 25), as described in the literature review section of this paper. Each of the four parts of the definition of ritual was used to identify
instances of the identified teaching practices so as to evaluate for ritual aspects. Table 3-4 outlines some descriptions and examples according to each of the four parts of the definition of ritual. These are developed mainly from McCloskey’ (2013) framework.

Table 3-4. Details of classroom evidence that corresponds with each part of the ritual framework.

| **Formalized** | a. There is a routinized way that the practice occurs each time.  
| | b. Classroom participants bring expectations to the practice.  
| | c. Students or teachers are attentive to how a practice looks or when it happens during the lesson. |
| **Traditionalized** | a. There is a connection to previous mathematics classes. For example, any mention about the way a practice has been done before.  
| | b. The practice has an aspect of tradition or custom. For example, students recalling their older siblings or parents having participated in a similar way with the practice. |
| **Symbolic** | a. There are messages or meanings about mathematics conveyed through the practice that are beyond the specific situation.  
| | b. It conveys something about what it means to be mathematically competent within the classroom. |
| **Performance** | a. Teacher and students each play a particular role throughout the duration of the practice.  
| | b. Classroom participants’ actions have some underlying meaning to the rest of the group. |

A constant comparative method of analysis (Glaser & Strauss, 1967) was used to compare instances of each of the teaching practices observed during Phase I of data collection with the descriptions and examples outlined by McCloskey (2013) for each part of the ritual definition. In addition, the ethnographic analysis method of searching for confirming and disconfirming evidence (Eisenhart, 1988; Erickson, 1986) of the ritual aspects of the teaching practices are used during this analysis to determine whether or not each practice can be considered a ritual within the local elementary school context. As was expected and will be discussed in Chapter 4, the textbook–oriented teaching practice showed evidence of being
ritualized; the task–oriented teaching practice showed some aspects of ritual, but did not demonstrate all the characteristics of being ritualized.

Once each teaching practice was analyzed for evidence of ritual, attention was turned towards creating interview protocols for stakeholder interviews in Phase II of the study. In order to protect the identity of Ana, Beth, Fred, and their students, I decided to examine the use of a static, visual representation of each of the teaching practices. Similar to a comic strip that tells a story across multiple snapshots in time, this representation came to be known as a storyboard, and was pilot tested through mock interviews. The phrase storyboard was decided on through conversations with other researchers, and is intended to characterize a cartoon-like set of images without the inherent comical meaning that the word cartoon generally infers. Both storyboards can be seen in Appendix B. The creation process of the storyboards for each teaching practice is described below.

First, I reviewed classroom observation videos, searching for a prototypical instance of each of the identified teaching practices. Discussed in detail in Chapter 4, each mathematics teaching practice was characterized as the collective engagement of teacher and students in a specific pattern of activity. For instance, one teaching practice was characterized as three chronological activities: a teacher introduction to content, student work time, and a mathematical activity unrelated to the day’s topic that students were asked to do in the remainder of the class time. Therefore, a prototypical instance was characterized as an episode of teaching that included all identified activities within the teaching practice. As a matter of coincidence, the two classroom episodes that most clearly demonstrate each part of the pattern of activity for both teaching practices were recorded during Fred’s classes. Using the pattern of activity as a guideline for describing each of the teaching practices, pertinent teacher and student discussions and activities were transcribed from the classroom episodes in Fred’s class. The transcriptions were narrowed down to create a more manageable amount of classroom data for use in the stakeholder
interviews. The process of narrowing down the transcription into useable quotations for the storyboards was heavily focused on including valid aspects of each of the pattern of activities for the teaching practices. Following the pilot data with mock interviews, the transcript data was narrowed further in an effort to change the conversational language into more formal written language. This decision was made as a result of pilot interviews with participants who reported that they felt distracted by the informal language, as it was written verbatim. One pilot participant admitted that seeing the word “gunna” written on paper made her question the intelligence of the teacher; whereas, if she heard the teacher speak the same words, it would probably not affect her view of the teacher. An example of the results of the process of narrowing the transcript data to a more suitable format for the storyboards can be seen in Table 3-5. Additionally, classroom artifacts such as copies of worksheets and mathematics tasks, as well as pictures from hand written problem examples during lessons were used to create a storyboard that presented an authentic view of the teaching practices as they were observed in the classroom.
Table 3-5. A comparison of a portion of a classroom transcript to the narrowed down version used in one of the storyboards.

<table>
<thead>
<tr>
<th>Verbatim transcript from a portion of a teaching episode</th>
<th>The pieces of transcript used for the storyboard to characterize the episode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green Teaching Practice:</strong></td>
<td><strong>Green Classroom:</strong></td>
</tr>
<tr>
<td>Fred: Today you’re just gunna do addition and subtraction of decimals. It’s a basic skill, you probably know how to do most of it. But then again, when I look at your pretest scores, you maybe don’t. So, I’m gunna show you some basics, I’m gunna give you the assignment, and then after you’re done with the assignment, then you can do some math games.</td>
<td>“Today you’re going to do addition and subtraction of decimals. I’m going to show you some basics, give you the assignment, and then after you are done with the assignment, you can do some math games.”</td>
</tr>
<tr>
<td><strong>Purple Teaching Practice:</strong></td>
<td><strong>Purple Classroom:</strong></td>
</tr>
<tr>
<td>Fred: So there’s four bags of numbers, okay? There’s a bag of seven, ten, thirteen, sixteen. You can use the paper that’s out in front of you. What I want you to do, choose any three numbers from the bags, and you can choose, you know, the same numbers, so you can choose a ten and a ten and a three, or a seven a ten and a sixteen. So choose any three numbers out of the four bags and add them together. So again, you can have all sevens, you could have one different ones, two of another. Choose any three numbers from the bags and add them together. So, for example, if I wanted to choose a seven, a ten, and a thirteen, I’d add those. Or if I wanted to do sixteen, sixteen, and sixteen, okay. Choose any three, add them together, and get your sum.</td>
<td>“For today’s task, there are four bags of numbers. Choose any three numbers out of the four bags and add them together.”</td>
</tr>
</tbody>
</table>

The storyboards were created to highlight the collection of teaching practices contained within each depiction. Therefore, the teacher and students were depicted as somewhat human–shaped, but genderless and faceless. Outside of the mathematical details of the lessons, the only classroom detail left in the depictions was how the student desks were oriented, because the observed teachers talked about this characteristic as an integral part of each teaching practice. The details of the differences in each classroom depiction are described in detail in Chapter 4.

Animations are receiving increased attention in mathematics education research, particularly with portrayals of teaching episodes for use with teachers. For instance, Chazan and
Herbst (2012) explore the use of animated videos with a teacher study group to determine how teachers engage with this method of lesson portrayal. They found that using animations to depict mathematics lessons were successful in that teachers viewed “the animations as representing the work that they do” (p. 114). However, their use of animations was not necessarily employed as a method for protecting the anonymity of teachers whose lessons are portrayed through the animation medium.

Reviewing the research questions, an interview protocol (as seen in Appendix C) was created to align with each of the classroom depictions and elicit stakeholders’ values and beliefs about mathematics learning, along with their interpretations of the green and purple classrooms. Additionally, mock state assessments were created in accordance with the Smarter Balanced practice test questions (Smarter Balanced Assessment Consortium [SBAC], n.d.) and the Partnership for Assessment of Readiness for College and Careers, or PARCC, practice test questions (PARCC, 2015). Smarter Balanced and PARCC are both services designed to create and implement mathematics and English assessments that align with the Common Core State Standards in schools across the country, including the state in which this study took place. Two mock assessments were created, one to align with each of the classroom storyboards. Each assessment contained five questions, starting with straightforward exercises and increasing in difficulty to finalize with a longer word problem as the fifth question. The five–question mock assessments were created with the intention of mimicking the type of question and frequency of teach question type as they appeared in the practice test question bank from each website. Another priority was to have the two mock assessments be similar to each other in length and difficulty. Interview questions were added to the protocol to inquire about stakeholders’ interpretations of state testing, and how well each type of teaching practice prepares students to succeed on those assessments. Both mock assessments can be seen in Appendix D.
Data collection and analysis: Phase II

The focus during Phase II was on interviewing educational stakeholders, using the interview protocols designed during Phase I. The goal of the interviews was to better understand stakeholders’ values, beliefs, and opinions regarding the two identified mathematics teaching practices from Phase I.

Phase II: Data collection

Once two mathematics teaching practices were identified and described, and stakeholder interview protocols were created, Phase II of data collection began with an attempt to identify the interpretations, values, and beliefs that a variety of educational stakeholders have about the two mathematics teaching practices. These interviews were an attempt to reconstruct stakeholder meaning behind the observed mathematics teaching practices. Phase II utilizes ethnographic interviewing and researcher introspection methods of data collection. Ethnographic interviewing is used “to inform the researcher about activities beyond his or her immediate experience, such as relevant historical events or events occurring in other places” (Eisenhart, 1988, p. 105). Each of the 16 interviews lasted approximately 45 – 60 minutes and was audio–recorded, as permitted by each participant.

As previously described in more detail, the interview protocol contains two classroom depictions, one depiction of each of the identified mathematics teaching practices that was observed during Phase I of data collection. Depictions of each teaching practice was created during Phase I of Data Analysis, and are in the form of storyboards. The stakeholder interview protocol, which can be seen in Appendix C, began with questions designed to elicit past experiences regarding mathematics classroom experiences, as well as identify current interactions
and relationships with the local elementary school district. Furthermore, questions were designed to gather information on stakeholders’ values and beliefs regarding mathematics teaching and learning. Following the information-gathering questions, stakeholders were shown one of the mathematics teaching practice depictions (the green classroom) and asked additional open-ended questions about their interpretations of what was happening in the classroom depiction, and whether or not he or she felt there was value in the mathematics teaching practice. Stakeholders were then presented with a mock assessment, seen in Appendix D. Details regarding the creation of the mock assessment are described in the previous section. Each stakeholder was then shown the purple classroom storyboard and asked the same questions about the different classroom depiction. A second mock assessment was shown, followed by the same questions. At the end of the interview, stakeholders were asked about their values regarding the state assessments and whether or not they felt one type of classroom teaching was more valuable than the other.

In addition to the interviews, researcher introspection (Denzin, 1978; Pelto & Pelto, 1974) was used to record my insights throughout the interview process. During each interview, I recorded notes about the responses to interview questions. Following each interview, the my journal was used to record insights and thoughts about the preceding interview and frequently informed the next interview. For example, one stakeholder responded to a question about expected teaching practices in the local elementary school lessons by discussing what he felt teachers should utilizing as practices in their mathematics lesson. After reflection on his response, I changed the interview question to ask stakeholders about their preferred method(s) of teaching mathematics.
Phase II: Data analysis

Phase II of analysis made use of an ethnographic analysis method described by Spradley (1979; 1980), which provides “a procedure for organizing material into domains or major categories of meaning” (Eisenhart, 1988, p. 107). The goal of data analysis in Phase II of the study is to determine how stakeholders make sense of each of the identified mathematics teaching practices. Each stakeholder interview was transcribed, and the transcriptions were used for the remainder of analysis. The process of indexing, coding, and recording emergent themes is described in this section, and outlined in Figure 3-3.

Figure 3-3. A visual representation of the data analysis process for Phase II.

Prior to reading the transcripts, I created a system of categories, to be “applied to the text in order to aid in the retrieval of material for further analysis” (DeWalt & DeWalt, 2011, p. 183), called indexing. Grounded in the research questions, each category is meant to represent topics of discussion from the interviews that specifically address a particular part of each research question, as can be seen in Table 3-6. During the indexing process, I sorted statements from each stakeholder interview transcript into different documents, one for each category seen in Table 3-6. The result of the indexing process was eight different groups of transcript data, each one a collection of stakeholder statements related to a specific data sorting category.
Table 3-6. Categories used for indexing.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Sorting Category (for indexing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do educational stakeholders make sense of mathematics teaching practices observed in their local elementary school?</td>
<td>• Interpretations of the green classroom&lt;br&gt;• Interpretations of the purple classroom&lt;br&gt;• Comparisons of the green and purple classrooms</td>
</tr>
<tr>
<td>A. What are stakeholders' beliefs, values, and opinions regarding mathematics teaching and learning, and how do those beliefs, values, and opinions relate to the mathematics teaching practices observed in their local elementary school?</td>
<td>• Values regarding mathematics teaching and learning&lt;br&gt;• Beliefs regarding mathematics teaching and learning&lt;br&gt;• Opinions regarding mathematics teaching and learning</td>
</tr>
<tr>
<td>B. What are stakeholders' experiences in mathematics classes, and how do those experiences relate to the mathematics teaching practices observed in their local elementary school?</td>
<td>• Experiences from grade school mathematics classes</td>
</tr>
<tr>
<td>C. How do stakeholders' beliefs, values, and opinions about mathematics teaching practices relate to the state mathematics assessment administered to students in their local elementary school?</td>
<td>• Opinions about the Smarter Balanced mathematics assessment</td>
</tr>
</tbody>
</table>

I then created summary paragraphs for each stakeholder, summarizing their statements into eight paragraphs, one per data sorting category. Specifically, each stakeholder had one summary paragraph for their interpretations of the green classroom, one summary paragraph of their interpretation of the purple classroom, and so on for each data–sorting category seen in Table 3-6. Thick descriptions were used to provide a clear portrayal of the culture surrounding the teaching practices by utilizing descriptive language and detailed explanations of the interview responses for the summary paragraphs. DeWalt and DeWalt (2011) “use the term coding to refer to the development of categories that emerge from the data (emic) as a result of reviewing the data for inherent concepts and patterns” (p. 183). Coding was used in this sense to review the summary paragraphs and identify common ideas and patterns of ideas among the collection of summary paragraphs for each data–sorting category. For instance, all 16 stakeholders’ summary
paragraphs for interpretations of the green classroom were reviewed to identify a common pattern among the interpretations of the green classroom across all 16 stakeholders. Through the coding process, I was “looking for understandings and interpretations that arose from the materials as a result of the interaction of the ideas and concerns of the participants and the researcher” (p. 189). The coding analysis process resulted in about seventy stakeholder statements, called stakeholder assertions, split among the eight data sorting categories seen in Table 3-6. For example, within the “interpretations of the green classroom” data sorting category, one stakeholder assertion was that the green classroom was similar to the stakeholders’ experiences with mathematics lessons during grade school.

Further analysis and review of the eight data sorting categories and the seventy stakeholder assertions resulted in themes. A theme is defined in this study as “an idea that characterizes and ties together materials from different people or people in different settings” (DeWalt & DeWalt, 2011, p. 189). Each theme is a collection of stakeholder assertions grouped together within each data–sorting category. I then used the summary paragraphs to tally stakeholders who made some indication of each of the stakeholder assertions. The assertions that were discussed by over half of the stakeholders were identified as prevalent assertions from the interview data. The collection of prevalent assertions among each data–sorting category were identified as refined themes. Additional assertions were added to a theme if there was prevalent agreement among particular groups of stakeholders that differed from other stakeholder groups. For example, if five out of six of the parents indicated a particular assertion, but none of the teachers, principals or researchers indicated the assertion, then it was considered prevalent among a particular stakeholder group, in this case: the parent stakeholder group.

Themes were further developed through another reading of each stakeholder interview transcript, during which I searched for confirming and disconfirming evidence (Eisenhart, 1988; Erickson, 1986) for each of the identified themes. While no disconfirming evidence was found,
nuances among themes were noticed and used to create more specific descriptions of each theme. For example, one theme started as “stakeholders’ values,” and became three different themes through the process of searching for confirming evidence: values regarding mathematical content, values regarding mathematics teaching actions, and values regarding student mathematical activity. Through a constant comparative analysis method (Glaser & Strauss, 1967), themes were then compared to each other and analyzed for further meaning, as described in chapter six of this study. The results of the data analysis process for this research study are collections of *stakeholder assertions*, which portray the ways in which the stakeholder participants made sense of mathematics teaching within their local community.

**Procedures to address trustworthiness and credibility**

My academic advisor periodically examined the raw data, the analysis, and the findings, with the purpose of asking questions, and critically examining the credibility of findings. In addition, methods of establishing trustworthiness of the study from Guba (1981) were used. These methods include findings presented in a clear and thorough manner so that readers can determine the reliability of the claims for themselves. Triangulation of collected data bolsters trustworthiness for the results because in order for a finding to be reported, it needed to appear in multiple data sources (data sources can be seen in Table 3-3). For example, one finding is a description of a direct teaching practice\(^3\) used within the community. This finding is reported based on my observation of the teaching practice on 24 out of 57 observation days (five times in Fred’s class, nine times in Beth’s class, and ten times in Ana’s class), and based on the Ana, Beth, and Fred’s discussions, via formal and informal interviews, about their use of the direct instruction teaching practice. Teachers were frequently asked to confirm interpretations of

\(^3\) Details and description of this teaching practice are in chapter 4.
information they provided during interviews. Teachers were asked for advice and input with the depiction of the teaching practices for the creation of the interviews for Phase II of data collection, but only Fred and Beth were interested in providing feedback. Examples of the type of advice elicited are teacher opinions on the portrayal of organization of student desks within the storyboard classrooms, and input on whether or not the storyboards were accurate portrayals of the teaching practices. For instance, Fred said he liked how students were grouped in the purple classroom (where students work together), but in rows in the green classroom (where students work individually). He elaborated that even though students are always grouped in his classroom, this differing depiction of student desks for each teaching practice helped to reinforce the illustration of how students worked during each type of teaching practice. Both Fred and Beth said the storyboards were clear depictions of the two types of teaching practices, and they were comfortable with the storyboards being used in stakeholder interviews. Additionally, Fred and Beth were asked if the storyboards should be presented to stakeholders as actual lessons that occurred in their school district, or if they should be presented as lessons from a more broad set of observations, in order to help protect Fred and Beth’s anonymity during the stakeholder interviews. This helped to empower the observation teachers, and followed the ethnographic principle of trying to explain the culture in a way that is as descriptive and true to actual events as possible. I was leaning towards not linking the storyboards to the specific school district, but both Fred and Beth said that the stakeholders might provide more meaningful insights about the teaching practices if they knew that it was teaching that occurred within their local school district. As a result, the interview protocol included mentioning that the teaching practices were observed in the mathematics classrooms in the local elementary schools. Additionally, prolonged time (about five months in total, and approximately 20 hours in each teacher’s classroom, for a total of approximately 60 hours) at the research site allowed for relationships to develop that were built on mutual trust and respect with the teachers, students, and administrators.
Evidence that the teachers trusted my experience as a fellow mathematics teacher was the fact that they would ask my advice during some of the observations. For example, on October 20, Beth had a mathematics task that involved students being able to know and use the factors of 30. She discussed how to find multiples of three with the class, and while they were working on finding all the multiples of three, Beth asked me if I thought the class should also talk about multiples of five before starting the task, or if the students seemed ready to start the mathematics task. I indicated my agreement with her, that multiples of five should be discussed first, and then students could start the task. After our conversation, she decided to talk with the class about multiples of five before engaging them in the task. Instances of conversations such as this one were prevalent during the data collection period. Especially with Beth and Fred, I was treated like a colleague: someone with knowledge about mathematics and teaching mathematics with whom the teacher could bounce ideas around and collaborate prior to, during, or after a lesson.

Another consideration for this study is the degree to which I was an insider or outsider for the community of participants for the study. In some ways, I am an insider because of my background in teaching middle school mathematics. Through that experience, I gained knowledge of common educational language and an understanding of some of the reasoning behind certain actions that may not make sense to someone who does not have experience with working in a mathematics classroom in a public school. On the other hand, I am also an outsider because each school and district has a unique system of inner workings with which I was not familiar. The school and community surrounding it are contained in a new geographical location, which included unique aspects as well. For the purposes of this study, a balance between being an insider and an outsider helped to provide trustworthiness for the results because any commonalities I had with the participants helped to build relationships with them. At the same time, a new perspective is brought to the data that can potentially provide insights that might be overlooked if I was a complete insider to the school culture.
Chapter 4 Findings from Classroom Observations: Mathematics Teaching Practices

Classroom observations occurred over a three–month timespan (September–November, 2014) and included approximately 20 hour–long observations for each of the three teachers. During the data collection period, each teacher participated in three formal interviews, the questions from which can be seen in Appendix A, and daily informal conversations during and following the observed mathematics lessons. This chapter will describe the findings from Phase I of data collection and analysis, specifically the elementary school and teachers’ connection to a local university professional development, findings that detail the two identified prominent mathematics teaching practices, and findings regarding the observed teachers’ beliefs, values, and opinions regarding mathematics teaching, learning, and state testing.

Connection to university–provided professional development

Two of the three observed teachers for this study are participants in a large professional development program provided through a local university. Through conversations with all three teachers, it became apparent that the professional development had a significant influence on the mathematics teaching practices used at the elementary school. As a result, the professional development has also had a significant influence on the current study. This portion of the paper will describe the professional development in its relation to the observed teachers. The professional development description is derived from information provided by the observed teachers as well as the four research Principal Investigators, or PI’s, who were interviewed for this study.
Professional development description

The professional development was designed through collaboration between two local universities with the goal of improving upper elementary, middle, and high school mathematics teachers’ ability to reason mathematically, and thereby improving their students’ abilities to successfully reason mathematically. The PI’s asked the school district participating in this study, among other districts, to identify one or two potential teacher leaders to participate in the professional development work over the course of three years. According to one of the PI’s, “we wanted people who the administration thought had the potential to be leaders. In other words we tried to make it quite clear that we didn’t want teachers who in some sense needed fixing. We wanted strong confident teachers who could step up and be leaders, and ultimately step up to doing PD with other teachers in their district” (researcher Rosa). Both Beth and Fred were considered teacher leaders in the professional development and were heavily involved in the professional development work throughout the three years. Ana, on the other hand, was involved indirectly in the professional development, through district-level professional development designed and implemented by Beth, Fred, and other teacher leaders in the school district. At the time of data collection for this study, Beth and Fred were in their third year of participation with the professional development work.

The first year of Beth and Fred’s involvement with the professional development began with a course that was implemented over the course of three weeks during the summer. According to information provided during interviews from all four participating PI’s, the professional development course focused on building the designated teacher leaders’ abilities to generalize and justify mathematical claims. The summer course included instruction on mathematical content as well as leadership skills, and engaged teacher leaders in solving, creating, and utilizing mathematically rich tasks. All three observed teachers and four interviewed
researchers indicated that a rich task should engage students in problem solving. Specifically, a rich mathematical task should have a “low entry point” and a “high ceiling” (Fred, Interview 2). According to interview discussions with the teachers and researchers, this means that any student should be able to start working on a rich task (low entry point), and students who succeed quickly should be able to solve it a second way or justify their reasoning (high ceiling).

During interviews, the researchers reported that they had reflected on the teachers’ use of rich tasks, and decided to adjust the professional development accordingly. Specifically, the researchers indicated that they felt they had focused too much on rich tasks, and not enough on rich implementation of tasks during the first part of the professional development. They conveyed that they were switching the focus during the professional development away from the idea that tasks were either rich or not rich and towards the idea that teacher implementation could make a task rich or not rich. As researcher Rosa says during her interview, “somewhere in this last year we realized that teachers were thinking that if you’re going to do [professional development program] type work, you have to have a really good rich task with which to do it. And we realized that wasn’t the case at all.” “We realized that it wasn’t the task that had to be rich but it was the implementation that had to be rich. So this past year in our regional meetings our focus has been on rich implementation of tasks,” specifically, “what we tried to get across to teachers is that you can take your regular curriculum, you can even take tasks that are in your curriculum, and you can implement them richly.”

Following the summer professional development course, teacher leaders were encouraged to start using the mathematical processes in their own mathematics instruction during the subsequent school year. During the first school year, teacher leaders were observed by researchers, and also attended a one–day professional development course follow–up to the summer course. In addition, teacher leaders were asked to attend five follow–up meetings
throughout the academic year, during which they discussed their progress on implementing the mathematical processes of generalizing and justifying in their classrooms.

During the second year of participation in the professional development, teacher leaders attended a second summer professional development program with a similar, but more advanced agenda. The three–week long professional development course included furthering the teacher leaders’ mathematical ability to generalize and justify, as well as information regarding how to lead their own professional development sessions. During the school year, the teacher leaders were asked to continue engaging their students in generalizing and justifying, and also to lead six small professional development sessions for a select group of teachers at their school. In addition, they were asked to attend a one–day professional development course follow–up to the summer course, and two additional follow–up meetings throughout the school year, which were used to discuss the progress of their students’ mathematical process as well as their small professional development sessions.

The third year of the professional development, which overlapped with data collection for the current study, was similar to the second year in terms of requirements for teacher leaders. However, the focus of the expected professional development led by the teacher leaders switched from a small group to a larger, perhaps district–wide professional development. According to conversations with each of them, Beth and Fred were largely in charge of those district–wide professional development sessions during the data collection for this study. They both helped to organize and implement the sessions for other teachers within the district. These professional development sessions included many of the activities from the summer professional development sessions, and focused on developing teachers’ abilities to engage in, and engage their students in, generalizing and justifying. Ana indicated her participation in the professional development during both the second and third years of the professional development, as she attended the district-wide professional development sessions.
The district-wide focus on engaging students in mathematically rich tasks, as well as generalizing and justifying was the main topic of conversation during most of my interactions with Ana, Beth, and Fred. As will be discussed in more detail in the next section, shortly after data collection began, it was evident that utilizing rich tasks in a mathematics lesson was important to all three teachers. They each expressed beliefs that rich tasks allow their students to participating in generalizing and justifying, and that those two types of mathematical activity were important to a student’s mathematical experience in elementary school. The teachers discussed both their apprehension and their excitement with implementing rich tasks in their classrooms.

**Observed teachers’ mathematics teaching practices**

As previously mentioned, there were two notable mathematics teaching practices used by all three observed teachers during the data collection period. Interview evidence suggests that the use of both teaching practices were influenced by the introduction of the professional development to the school district. This section will describe each mathematics teaching practice in detail, and describe the creation process of storyboards that were designed during the analysis of Phase I data. The observed teachers were aware of the two teaching practices in their own classrooms and, as will be explained at the end of this chapter, the teachers’ meaning–making of a tension between these two teaching practices constitute the findings of this first phase of analysis. Both teaching practices occurred multiple times across all three classrooms, although one teaching practice was observed more frequently than the other. A count of each observed teaching practice can be seen in Table 4-1.
Table 4-1. A count of each observed teaching practice.

<table>
<thead>
<tr>
<th>Green (Direct-like) Teaching Practice</th>
<th>Ana’s Class (18 total obs.)</th>
<th>Beth’s Class (19 total obs.)</th>
<th>Fred’s Class (20 total obs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green teaching practice</td>
<td>10</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Purple (Dialogic-like) Teaching Practice</td>
<td>15</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

**Green teaching practice**

The first mathematics teaching practice is a textbook–oriented type of mathematics teaching and came to be known as “The Green Classroom” during analysis of Phase I data. Therefore, the phrase *green teaching practice* refers to the mathematics teaching practice observed in all three teachers’ classrooms, and characterized as the green classroom for the stakeholder interviews in Phase II of the study. While teachers used different phrases to talk about this teaching practice during data collection, it is a collection of teacher and student actions familiar to most people who have taken mathematics courses in the U.S. This teaching practice was observed in all three classrooms multiple times over the course of data collection; however, it was frequently used for review lessons, warm up problems, or structured remediation. Specifically, the green teaching practice was observed in 10 of the 18 observation days in Ana’s classroom, 9 of the 19 observation days in Beth’s classroom, and 5 of the 20 observation days in Fred’s classroom, as seen in Table 4-1. The following section describes the characteristics of the teaching practice as a result of my analysis, how the observed teachers talked about this practice, the similarities between the identified teaching practice and a direct instruction model of teaching, and the results of analyzing the teaching practice for evidence of ritual.
**Characteristics of the teaching practice from my analysis**

Through analysis, it was evident that this teaching practice follows a similar pattern of three main activities in each occurrence, across all three classrooms, as seen in Figure 4-1. First, there is an introduction to the topic. This was typically the teacher stating the topic for the day, and then providing at least one, sometimes multiple, procedures for how to solve a particular mathematical exercise. Second, students work on practice problems similar to the examples provided by the teacher. Typically this work was individual and the students in the class worked in silence, but occasionally students might whisper to a close neighbor to ask for help or double check their answers. Third, there is some sort of filler activity for when students were done before the mathematics period was over. Depending on the specific teacher and class, the activity was either some type of purchased mathematics game, or returning to work on the day’s warm up/homework worksheet.

![Figure 4-1. Pattern of activity for the green teaching practice.](image)

As previously mentioned, many of the classroom episodes that contained the green teaching practice were lessons during which the teacher was reviewing for a test, engaging students in remediation of basic skills in which they were lacking, or asking students to do warm
up problems before the official lesson began. For example, one of Fred’s lessons was a review lesson for addition and subtraction of decimals. His introduction to the topic included a statement of the mathematics content that would be addressed, an overview of the class period, and explanations, with examples, of how to solve specific exercises. Transcription evidence of his topic introduction can be seen in Table 4-2. Following the second example, a student asks, “Why do you have to line them up?” Fred uses the previous example to demonstrate that students would not get the same answer if the decimal places were not in a straight line. Students seem to accept that the first answer was the correct answer, and the second answer is clearly different and therefore must be incorrect. Fred then distributes a worksheet of addition and subtraction problems to students, and tells them, “You get to choose eight addition and eight subtraction, so you only have to do sixteen.” He further explains, “I need you to show your work on notebook paper or graph paper. Because when I got and check your work, if you’re making errors, I need to see what the problem is to help you.” The remainder of the class time is dedicated to students working silently on the worksheet. Occasionally students will whisper to another student to double check an answer. As students complete their sixteen problems, they move to the front of the classroom and start playing previously purchased mathematics games from the front of the classroom.
Table 4-2. Evidence of Fred's topic introduction on October 15.

<table>
<thead>
<tr>
<th>Statement of topic and review of class activities for the lesson.</th>
<th>Fred: Today you’re just gunna do addition and subtraction of decimals. It’s a basic skill, you probably know how to do most of it. But then again, when I look at your pretest scores, you maybe don’t. So, I’m gunna show you some basics, I’m gunna give you the assignment, and then after you’re done with the assignment, then you can do some math games.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review of an algorithm</td>
<td>Fred: Alright, so, what’s the rule when you’re adding decimals? What’s the thing that you have to do, to make your addition or subtraction work? Student: Always move the decimal on the same. Fred: Yep, so you wanna always line up your decimal points.</td>
</tr>
<tr>
<td>Two example problems: One addition and one subtraction</td>
<td>Fred: So the problems that I’m gunna give you today, for example, [T writes “1.7 + 1.742” on the white board] are gunna be written like this. Because when I look at other problems and they stack it for you, there’s no skill there. Because, you’ve already stacked your decimals. So, you’re gunna get a sheet that looks kinda like this [A list of addition and subtraction problems written horizontally]. And they’re all written horizontally. So, the first thing you wanna do, is you’re gunna look at your decimals and you’re gunna set it up in an algorithm. So, I’m gunna line up my decimal spots [Fred writes “1.7” underneath his previous recording of “1.742”]. What numbers are here [Fred points to blank spaces next to the 7 from 1.7, and under the 4 and 2 from 1.742]? Student: Well, you could you put zeros. Fred: I could put zeros. [Fred writes 00 next to 1.7 to create 1.700]. If it was a subtraction problem, would I have to put my zeros? Multiple students at the same time: Yeah. No. Yes. No, you don’t have to. It depends on which side. Fred: Alright, well, we’ll look at it. So let’s do this. We’re gunna add these two together. And then you just do addition, right? It’s not rocket science, right? Okay. What if my number was this [Writes a second example vertically of 1.07 - .93, with the decimals lined up]? So, again, I’m gunna line up those decimal spots. And then you just do your subtraction, right? Student: Yep.</td>
</tr>
</tbody>
</table>

Many of the instances of this teaching practice occurred during warm up problems, and the topic introduction phase was often omitted from the teaching episode. One example of this is
Beth’s daily warm up worksheets, which the students routinely collected as they walked into her classroom and started working on once they took their seats. Beth did not introduce the mathematics content represented on the worksheets, nor did she do any examples of the problems before the students started working. As the mathematics content was review, it seemed like a common assumption that students knew how to do most of the problems without any instruction. However, there were often problems that students did not know how to solve. In these cases, Beth demonstrated either the solution or a similar example problem for the class. One instance of this was on October 16 when students did not seem to understand what was meant by the terms “addition sentence” and “multiplication sentence.” Transcript evidence of the direct instruction teaching practice in this instance can be seen in the following dialogue.

Beth: So, addition sentence and a multiplication sentence [Beth points to the problem on the screen, seen in Figure 4-2]. What they mean by sentence is this [She writes “2x10=20” on the board, as seen in Figure 4-3]. Yesterday, when we were doing this: two times ten equals twenty, that is a multiplication sentence [Beth points to the sentence on the board].

…

Beth: We don’t usually think about it as a sentence [She labels the symbolic sentence with the phrase “multiplication sentence” as seen in Figure 4-3].

…

Beth: So who can, <Student>, give me an addition sentence.

Student: Addition?

Beth: Yeah, just any old addition sentence. I don’t care, just pick one. [Beth writes the phrase “addition sentence” under the previous example, as seen in Figure 4-3].

Student: Six

Beth: Uuhh. [Beth records the equation “6+6=12” as seen in Figure 4-3] Student: Plus six equals twelve.

Beth: Yep. That’s an addition sentence. So, what they mean is they have addends and an equal sign and a sum. Alright? Then this has factors and a product. So that's a sentence. When they’re asking for that, that's what they want.
Figure 4-2. The warm up question Beth uses with her students to demonstrate a particular problem type for the lesson.

Figure 4-3. Example responses Beth records to demonstrate acceptable types of answers to questions asking for students to write multiplication and addition sentences.

The answers to each problem on the worksheet were posted at the start of class the following day, and students were expected to check their answers with those on the board. Often, time was devoted to solving any problems on which a majority of students reported struggling or arriving at an incorrect solution. This time was frequently conducted using the green teaching practice. Students did not frequently finish the warm up worksheet before the formal lesson began, but those who did were expected to find some other homework to work on while they waited. That other homework constitutes that filler activity for warm up episodes such as this one.
The observed teachers’ phrasings and depictions of the teaching practice

Throughout the three formal interviews and various conversations during lesson observations, each of the three teachers talked this teaching practice, and often it was mentioned in contrast to the promoted teaching practices of the professional development. As data collection progressed, I inquired more about the teachers’ specific descriptions of the teaching practice. The results of these conversations are described below.

During her first interview, Ana talked about this form of teaching practice as “the show and then let them practice” form of teaching. Her description was in response to the question if there were any teaching practices she was trying to change during this school year. During her third interview, Ana was asked to talk more about this teaching practice. She refers to it as “traditional” mathematics teaching and describes it as “Here’s an example, let’s do some together, then you practice.” This indicates three teacher actions during this type of lesson: a teacher presenting an example of a exercise to the students; the teacher and student practicing exercises together; and the teacher presenting students with some sort of worksheet or list of problems to practice on their own. As she talks more about this teaching practice, Ana says, “they aren’t creating their own knowledge, they don't understand the deeper meaning” (Ana, Interview 3). This indicates a very teacher–oriented lesson, during which students are gaining a surface level understanding of determined mathematical knowledge.

Similar to Ana, Beth refers to this teaching practice as a response to the question of whether there are any teaching practices she would like to change during the school year. She calls the practice “direct instruction” in Interview 1, and describes it as rote memorization and practice. During her third interview, she describes the teaching practice as, “you’re at the front of the room, you’re talking, and you’re explaining here’s the way to do it. And then students do the book assignment at their desks, and then they have a homework page for homework.” Her
description includes details about where the teacher is positioned in the classroom, and demonstrates a shift in focus from the teacher at the start of the lesson to individual student practice at the end of the lesson.

From the first interview, Fred expresses a tumultuous relationship with this teaching practice. He calls it “textbook work” and says it is used to teach content “they just have to know” when there is “nothing to uncover” (Fred, Interview 1). He talks about the teaching practice as being “boring” for both himself and his students, and voices a desire to use the teaching practice as infrequently as possible. During his third interview, he describes the location of students during a lesson like this, saying students are “at their desks.” Further, he describes his personal experience with teaching practice as: “Stand and deliver type of teaching. I’d spend 10 minutes talking at them, telling them how it was done, and they’d spend 45 minutes practicing, and my day was done” (Fred, Interview 3). Similar to Beth’s description, it highlights a small portion of teacher instruction followed by providing students with a large amount of time with exercise practice.

**Relationship of the green classroom to a direct instruction model**

While the observed teachers have varying terms to name the teaching practice depicted in the green classroom, this study will refer to the traditional teaching practice as a direct instruction model of teaching (Munter et al., in press). As described in the literature review, the direct instruction model contains five parts: “describing an objective;” providing “reasons for achieving the objective and connections to previous topics; presenting requisite concepts;” “demonstrating how to complete the target problem type; and providing scaffolded phases of guided and independent practice, accompanied by corrective feedback” (p. 16). When compared to the characteristics of the observed mathematics teaching practice, there are similarities between the
two classroom descriptions. The observed mathematics lessons did not always include the teacher describing an objective, but did start with connections to previous lessons and a demonstration of how to complete a specific type of problem. Observed lessons then included some type of scaffolded guided and then independent practice for students.

The similarities between the direct instruction model and the observed classroom lessons helped create an understandable and manageable depiction of the observed traditional teaching practice in the storyboard called the green classroom. Specifically, the characteristics identified during data analysis combined with the characteristics of the direct instructional model from Munter et al. (in press) helped create a meaningful depiction of the observed mathematics teaching practice by highlighting the pertinent aspects of each classroom episode to be included in the storyboard.

**Ritualized teaching practice**

From the first conversations with Ana, Beth, and Fred it seemed apparent that this teaching practice, as observed in their classrooms, had aspects of ritual. The practice is one with which I was familiar, is aligned with a typical description of a traditional mathematics lesson, and is discussed by all three teachers as something that is commonly understood. As previously characterized, the definition of ritual used for this study is “that aspect of action that is formalized, traditionalized, symbolic performance” (McCloskey, 2013, p. 25). The direct instruction teaching practice observed during Phase I of data collection conforms to each facet of this definition. The observed practice is formalized because the teachers and students all seemed to understand and expect the lesson to follow a specific pattern; specifically, the teacher demonstrating how to solve a specific type of mathematical exercise, and then the students working mostly independently on a list of similar exercises. The teaching practice showed
evidence of being traditionalized through conversations with each of the teachers. They each mention their own student experiences in mathematics classes following a similar pattern of activity, and indicate a history of experience teaching in this fashion. For instance, when Beth was asked about her mathematics experience as a student, she said, “it was all about memorizing, […] all boring skill and drill” (Beth, Interview 1). And during an interview with Ana, she indicates that she has used a similar teaching practice in the past when she says she is “trying not to [use the teaching practice of] show and then let them practice” (Ana, Interview 1). The symbolic nature of the teaching practice is evident in the implication that the teacher is the one with the mathematical knowledge, and students have limited opportunities to bring utilize their own mathematical knowledge during the lesson. Last, the teaching practice shows evidence of a performance because of the roles played by each teacher and student group. The teacher stands up at the front and performs a demonstration of how to solve some type of problem, while the students act out their role of watching and then mimicking the teacher’s mathematical actions.

**Purple teaching practice**

The second teaching practice is a task–based type of mathematics teaching that came to be known as “The Purple Classroom” during analysis of Phase I data. This teaching practice was observed frequently in all three classrooms over the course of data collection; however, the level of student engagement and mathematical rigor varied among each occurrence. Specifically, the purple teaching practice was observed in 15 of the 18 observation days in Ana’s classroom, 14 of the 19 observation days in Beth’s classroom, and 13 of the 20 observation days in Fred’s classroom, as seen in Table 4-1. This teaching practice was the preferred teaching practice promoted by the professional development. The following section will describe the characteristics of the teaching practice as a result of my analysis, how the observed teachers talked about this
practice, the similarities between the identified teaching practice and a dialogic instruction model of teaching, and the results of analyzing the teaching practice for evidence of ritual.

**Characteristics of the teaching practice from data analysis**

Through analysis of the classroom observations, this teaching practice seemed to include four major activities, as seen in Figure 4-4. First, the teacher would introduce the mathematical task. This would include the teacher reading the question aloud, asking for any clarifying questions from the student. Sometimes the teacher would also do a small example or talk about a strategy that could be used to solve the problem. Second, students would work on the mathematical task. Sometimes this was done individually, but more often students worked in partners or groups to solve the mathematical problem. During this time, the teacher would walk around the room and talk to individual students or groups about their work. Third, the teacher would select a few students from the class to talk about their strategy or solution. This student selection was purposeful, according to Beth and Fred. For example, it would often start with a student or group who had progressed the least in finding a solution or had the least sophisticated solution, and chronologically include students with more detailed solutions or who were further along in solving the problem. The fourth step only occurred if there was time at the end of the mathematics lesson. This step was the teacher discussing strategies that students had used to solve the mathematical tasks. Often, students were asked to reflect upon their use of the Common Core State Standards for Mathematical Practices (CCSSO, 2010) during the process.
One example of the purple teaching practice comes from a classroom episode in Ana on Nov 17 and continued into 18. She introduces the mathematical task by asking different students to read each sentence, resulting in the following word problem: *Alexia gave one fourth of the money in her pocket to Ambrose. Then she gave a third of what she had left to Lily. She then split the remainder of the money with you. Alexia gave you twenty dollars, how much money did she have when she started?* The second phase of the teaching practice starts with Ana telling students, “I want everyone to have a few minutes of individual work time. Figure out exactly what the question is asking, what you ultimately need to do” (Ana Observation, November 17). She also mentions that they are using the mathematical practices from the Common Core standards (CCSSO, 2010), which she has written on her white board. Specifically, she says, “So that's making sense of the problem. Go ahead and draw a picture, a visual representation, if that's helpful to you. Be prepared to tell all of the steps that you went through. And show visual representation of it.” As students work on the task, Ana walks around the classroom talking to
specific students. Ana spends this time reminding students to continue working on the task, and helping students who ask for help or appear to be struggling. During these interactions, Ana asks questions such as: “What does the one third represent?” and “Is this a third of the whole thing, or is this a third of this much?” and rephrases students thinking like, “So, you’re saying she started with that much money?” All of her interactions with students start with Ana asking them open-ended questions about their work, such as: “Okay, tell me about what you have.”

After about ten minutes of students working on their own, the second phase of the teaching practice continues, but in a more collaborative setting. Ana suggests, “Why don’t, you know, work as a table group. Listen to what one person says, and see if you can find the answer in what they said, and support them.” Again, she calls attention to the mathematical practices and says, “So you’re going to be critiquing what they said and comparing it to what you said, and seeing if maybe somewhere in between you guys have the right direction.” Ana makes it clear to students that she is expecting them to work collaboratively in an attempt to progress further in their solution to the task. She says, “So take turns sharing with your shoulder partners or your table mates, and see if you can get to the next level.”

Approximately fifteen minutes later, Ana calls on one student to present his solution to the class, and enters into the third phase of the teaching practice, student presentation of solutions. He says:

Okay, this is how I figured it out. If Alexia gave you eighty dollars, well this is what I did, I started going up. If she split the remainder of the money with you, and you had twenty dollars, that means there was forty dollars right here [The student gestures to the sentence “She then split the remainder of the money with you” on his paper.]. (Ana Observation, November 17)

Ana seemed to agree with the student’s solution and let him continue. He explains, “She gave a third of it to Lily. Okay, so this is what I figured out. Sixty divided by three is twenty. So you add the twenty again. Does that make sense?” At this point, Ana asks, “Well, where did you come up with the sixty?” The student continues to try to explain how he arrived at sixty, but his only
explanation is “sixty divided by three is twenty,” which Ana does not except as a permissible reason. At the request of Ana, a second student explains that he also arrived at forty for the last sentence, and then states that a forth of eighty is twenty, so he thinks twenty is the solution to the first part of the task (Alexia gave one fourth of the money in her pocket to Ambrose). However, this student did not have a solution to the second sentence (Then she gave a third of what she had left to Lily), so Ana asks a third student. The third student reports, “I don't think Lily got twenty, because a third is bigger than a forth.” Ana follows up on the statement by asking students, “Okay, can someone talk to us about how a third is bigger than a forth, but Lily got the same amount?” Another student responds, “Well, three thirds minus one third equals two thirds,” but he cannot successfully explain why his statement is relevant. Ana then calls attention to another student by saying that he “had a great visual, even though he didn’t get the answer all the way.” This student brings his visual representation to the front of the classroom, but he cannot fully explain what he has drawn. Ana explains, “Look at his bar diagram he has here. So you figured out what all the money she had was, and then you figured out what a forth was, and then you drew a third of what she had left.” Both the student and Ana agreed that the rest of his work was incorrect, and Ana said they would discuss the problem more during the next day.

Through this example, Ana engaged five different students in presenting their partial solutions in a way that built upon the previous student’s solution to move the collective class of students forward in a solution to the task. As described, this purposeful selection of students, and order in which each student presented, was a thoughtful part of the purple teaching practice. Ana even mentions this to a student who asks if he can present his solution to the class. She responds to his request by saying, “I’m gunna look for different ways that different people are solving it, so flip it over and let me see how you’ve done it.” According to informal interviews from Beth and Fred, it was a design introduced by the professional development, and allows a teacher to give credit to multiple students, who demonstrate various levels of interaction the mathematical task.
In this example from Ana, the forth phase of the teaching practice, a discussion of strategy, occurs throughout the lesson. Ana has previously discovered that her students require extra guidance throughout their engagement in a mathematical task. Therefore, she requires them to engage in a strategy of working alone first, and then comparing solutions with their peers. Additionally, she uses the mathematical practices to suggest strategies of first making sense of the problem, and using a visual representation to do so, as well as critiquing the reasoning of their peers as a strategy of productive collaboration. Another strategy that Ana provided for her students, but did not discuss with them was the way in which she presented the mathematical task. While the task was discussed as a single problem, it was presented to students on a piece of paper with the problem divided by each sentence, accompanied by some blank space to work. This strategy reinforced the idea that students should think about the problem in segments, which is exactly how each student who was called on presented their work to the class, as demonstrated in the previous paragraph.

The observed teachers’ phrasings and depictions of the teaching practice

Throughout the three formal interviews and various conversations during lesson observations, each of the three teachers talked about this teaching practice, and expressed a desire to use it frequently in their mathematics lessons. Their comments frequently included descriptions of the teaching practice as described from the professional development. For example, Fred says he thinks about the definition of teacher practice as “teacher moves, which [he] gets mainly from [the professional development]” (Fred, Interview 1). Additionally, Beth says, “so many things just came together and clicked through [the professional development], and that has been a huge influence [on her teaching practices]” (Beth, Interview 1). As data collection progressed, I
inquired more about the teachers’ specific descriptions of the teaching practice. The results of these conversations are described below.

During her first interview, Ana describes this teaching practice in response to the question that asks her to talk about a teaching practice of which she is proud, she responds, “task selection, open-ended tasks,” with a focus on “concept understanding instead of algorithms.” She says this is something she is trying to use more in her own teaching, and she is proud of her use of the teaching practice so far during the school year. During the second interview, she says that a class engaged in a rich task would include “kids talking in groups,” and “the teacher asking questions.” She further states that the teacher questions would be an attempt to get students to explain their reasoning and thinking with regard to the presented mathematical task.

During Beth’s first interview, she says she is most proud of her use of the teaching practices put forth by the professional development program, and her influence in creating district-wide professional development regarding those practices. She describes the practices as “a way to get students to access material in a meaning-based way” (Beth, Interview 1). During a later interview, Beth refers to the teaching practice as an engagement in “rich tasks” and characterizes it as discussion that is “sometimes whole class and sometimes among students” and “kids are thinking about it different ways than each other” (Beth, Interview 3).

Similar to Ana, Fred identifies “high-level tasks” as a teaching practice of which he is proud (Fred, Interview 1). Then during his second interview, he talks about the teaching practice as a “rich task” and characterizes it as “usually a word problem.” He says the classroom is characterized as “engaging,” with students “all over the place, lots of noise, using math tools.” He explains that the teacher is “listening to conversations” and asking questions such as “what are you finding,” while monitoring student learning (Fred, Interview 2). He talks about this teaching practice in stark contrast to the direct instruction teaching practice, mainly through comparisons of levels of student engagement and energy during the lesson. For example, during his first
interview he says the teaching practice of “I do, you do, we do [is] not the most effective, because of the level of engagement” (Fred, Interview 1). Fred also mentions this comparison to his students on October 14 as he tells them, “If you see how excited you are when I give you a math task like this, versus yesterday. Think about how you sat in here yesterday. Were you very excited?” His students respond with a collective “nOO” and Fred says, “No. Okay. That’s why I don’t teach that way anymore. I used to teach that way every day. It sucks. Its not a lot of fun.” Fred makes it clear that he prefers to use math tasks during his lessons because the students are so much more engaged and excited about those types of activities than they are when he uses the green teaching practice.

Relationship of the purple classroom to a dialogic instruction model

The focus of this teaching practice for all three teachers was on the introduction and implementation of a mathematical task. The teachers discussed it as the opposite type of teaching practice as the direct instruction teaching practice, and therefore seemed to relate to a dialogic instruction model (Munter et al., in press). As described in the literature review section of this paper, the characteristics of a dialogic model are more nuanced then the direct instruction model, and may occur over a series of lessons, rather than in just a single lesson. Students have opportunities to “wrestle with big ideas;” “put forth claims and justify them as well as listening to and critiquing claims of others;” and “engage in carefully designed, deliberate practice” (p. 17). Opportunities for students to engage in each of these lesson characteristics were seen in the observations, although each observation did not necessarily included evidence for all of the characteristics.

Additionally, a dialogic model describes the teacher’s role as that of helping students build “new ideas and deepen their understanding of concepts;” “help them become more
competent with what they already know;” coordinate classroom discussions to help lead all students in the direction of the lesson goal; “introduce tools and representations that have longevity;” and “sequence classroom activities in a way that consistently positions students as autonomous learners and users of mathematics” (Munter et al., in press, p. 17). The classroom observations of the purple teaching practice align with this description. For example, there is evidence that the teachers are helping students build new ideas and lead them towards a particular goal. For instance, when Ana works with her students on the money task described previously (Alexia gave one fourth of the money in her pocket to Ambrose. Then she gave a third of what she had left to Lily. She then split the remainder of the money with you. Alexia gave you twenty dollars, how much money did she have when she started?), she asks a student if a portion of his drawing represents “a third of the whole thing,” or only a third of part of the total (Ana Observation, November 17). While her question attempts to clarify the student’s representation of his solution, it also leads the student toward the notion that he should be focusing on a third of the remainder of Alexia’s money, and not a third of the total amount of money with which Alexia started. Additionally, the activity of deepening students’ understanding of concepts was frequently apparent in classroom observations, but was successful in varying degrees, as was the positioning of students as autonomous learners. For example, Fred’s class contained many advanced students who often solved mathematical tasks very quickly. Fred would ask those students to then generalize their solutions in order to create an algorithm. On the other hand, there were some students who could only solve certain mathematical tasks by drawing pictures for each solution, and Fred was not able to deepen those students’ understanding of the mathematical concept inherent in the task. Additionally, Fred was able to position his students as autonomous learners because they were mostly mature enough to persevere on mathematical tasks on their own. Contrary to this, Ana’s students needed more guidance and direction. Ana often provided
her students time to work alone, but that time was not always successful in that many students did not have the maturity to persevere on a mathematical task unless Ana was sitting next to them.

Similar to the green classroom, the creation of the purple classroom utilized the characteristics of a dialogic instruction model in combination with the characteristics of the observed teaching practice to create an understandable and manageable depiction of the teaching practice. As episodes of the purple teaching practice often involved more frequent back and forth dialogue, as well as mathematical tasks that are not typically seen in classroom observations, the goal was to present enough detail from the classroom episode that a stakeholder could understand the mathematics and the dialogue occurring in the classroom, but not so much detail that it was overwhelmingly long for the interview process.

**Not a ritualized teaching practice**

This teaching practice was somewhat familiar to me in that the importance of mathematical tasks is a well–established line of research; however it does not seem like a ritualized teaching practice because of the evidence that it is a fairly new practice to all of the teachers, and the fact that the professional development introduced and has been promoting the practice for only two years at the time of data collection. Following data analysis, there is some evidence of ritualistic aspects to the teaching practice, but not enough to categorize the practice as a ritual within this community. For instance, there is a basic structure that characterizes the teaching practice, the four major activities depicted in Figure 4-4, which indicate aspects of formalization occurring because there is a common pattern that can be used to describe each instance of the purple teaching practice. Similarly, meanings conveyed through the teaching practice about mathematical competence indicate that students arrive at the mathematics lesson with valuable mathematical knowledge and reasoning that is brought to bear during the lesson, as
evidenced in the large amounts of time that students are allowed to engage in solving a mathematical task without teacher intervention. This is evidence that the teaching practice also showed some evidence of being symbolic in nature, because it conveys the importance of student's unique contributions in order to obtain mathematical competence.

However, neither the students nor the teachers give any indication, through their conversations or their actions, that the practice is traditional or a performance. The teachers talk about having to practice productive group work with students, which indicates that there is not yet a collective understanding of how each participant should act during the lesson. For example, on November 12, Fred changed the way he engaged students in a mathematical task. Prior to this class, he read the task to the students and then let them move anywhere around the classroom and work with whomever they wanted. However, on November 12, he introduced the task by asking them to solve the first question on their own, quietly, and then asked them to talk to their “table groups” and then having a whole class discussion about their responses. When asked about the change in introduction, he said that he was worried that sometimes students don’t completely engage in the task, but instead work for a little bit of time, and then spend a lot of time just wasting time (Data Collection Journal, November 12). This episode demonstrates that there is not a collectively understood performance that dictates how the teacher and students will react to one another during the teaching practice. Furthermore, the teaching practice has not been used for a long enough time period that it has become a tradition in any way for the students or the teacher.

**Observed teachers’ assertions**

Phase I of data collection focused primarily on identifying prominent mathematics teaching practices, and describing their characteristics. As a result, minimal data was collected regarding the observed teachers’ beliefs, values, and opinions about mathematics teaching,
learning, and state assessments. However, through the formal and informal interviews with Ana, Beth, and Fred, each of their beliefs, opinions, and values were expressed to varying degrees. This section of the chapter will report on those expressions in three categories: observed teachers’ values and beliefs concerning mathematics teaching and learning; observed teachers’ values and beliefs regarding dialogic and direct instruction, and observed teachers’ opinions regarding mathematics state testing. The beliefs, opinions, and values are depicted through a variety of conversations, interviews, and observations. The word assertion is used to describe statements of belief, opinion, or value made by participants.

Values and beliefs concerning mathematics teaching and learning

Ana spoke the least about her values and beliefs out of the three observed teachers, but the one idea she frequently expressed is her belief that student “learning is much deeper if they come to it themselves, [rather] than just me telling them how to do it” (Ana, Interview 2). Her teaching indicates this belief as well, as most of the observations in her mathematics classes include students working alone or together, trying to solve problems. The one caveat to this is a daily Walk to Math period, which includes direct instruction as a tool for remediation.

Beth was extremely reflective about her own teaching, especially during her last couple of years of teaching because of her involvement with the professional development, and these reflections allow some insight into her beliefs and values regarding mathematics teaching and learning. For example, she claims “Some students don’t’ have the right behavior, attitude, self–efficacy, ability to memorize well, to be able to do well with rich tasks” (Beth, Interview 1). This implies a belief that students must have specific characteristics in order to be successful with certain types of mathematical activities. During the same interview, Beth says, “I realized that last year, the kids who grew were the ones who could access the level of discourse, so I’m
planning to lower that to be more accessible to all students [this year].” However, she also reflects that she needs to “move on before everyone gets it” because last year, “there ended up being a lot of wasted time.” This demonstrates Beth’s belief that while the content should be accessible for all students, there also has to be a teacher decision to move forward, even if all students have not successfully demonstrated understanding of the mathematical content.

Fred’s reflection on his own teaching is mainly regarding his desire to use the purple teaching practice rather than the green teaching practice during mathematics lessons. As a result of his personal dilemma between dialogic and direct instruction, he says “I’m trying to get away from using the textbook; I hate it” (Fred, Interview 1). When asked why he hates textbook work, he replies, “Because the kids aren’t engaged, so I don’t think they learn.” This exchange implies his belief that rote practice, by which he says using the textbook, does not engage students, and if students are not engaged in a mathematics lesson they will not learn. However, Fred also states “there are certain things the tasks don’t lend themselves well to,” for example, “the division algorithm. You just have to be taught it and you have to memorize the steps” (Fred, Interview 3). His internal struggle between using the two different teaching practices in his classroom stem from his conflicting beliefs that textbook work and memorization do not engage students, but there are some concepts that must be taught in that fashion. Additionally, similar to Beth’s sentiment, Fred indicates he belief that students are not always developmentally ready to understand certain mathematical tasks, for example tasks involving fractions (Fred, Interview 2). As an example, he says that his previous set of students “were immature and not yet ready for what was required of him to teach,” by which he meant the required curriculum (Data Collection Journal, October 15). Fred said that after leading students through the first four chapters of the textbook, he stopped give them chapter tests and focused on implementing rich tasks instead of using direct instruction and textbook worksheets. He reported that his state assessment scores “went through the roof by the end of the year” (Data Collection Journal, October 15).
Values and beliefs about dialogic and direct instruction

Although the terms *dialogic* and *direct* instruction were not used with nor mentioned by any of the observed teachers, they are utilized here to help describe the teachers’ assertions regarding their values and beliefs about teaching practices.

Ana demonstrates preference for dialogic instruction in her interview statements and use of mathematics tasks in her classroom. During Interview 1, she says she is proud of her use of “task selection, open-ended tasks, and [a focus on] concept understanding instead of algorithms.” This type of teaching practice is compared to “the show and then let them practice”, which she says is “not best for the kids” (Ana, Interview 1). While she does not comment directly on her use of direct instruction, she says, “I’ve focused less on content this year, but time wise I might get myself into a bind at the end of the year” (Ana, Interview 3). She indicates that she has not focused enough on development of “the algorithm” (Ana, Interview 3) in lieu of trying to engage students in mathematical tasks. From her statements, it is clear that she values a dialogic instructional model over a direct instructional model; however, she makes use of direct instruction almost every day during the Walk to Math portion of her class. Walk to Math is a 45–minute time period where students are working in groups, practicing mathematical skills such as adding or subtracting decimals via worksheets or computer games. During this time frame, Ana works with one group of students, following a direct instructional model of teaching where she demonstrates how to solve a particular exercise, and then presents students with additional, similar problems to solve on their own.

Beth expresses usefulness in both dialogic and direct instructional methods. For example, she states, “this year I want them to work not just on practicing, but also coming up with strategies and to reflect on those strategies” (Beth, Interview 1). While she indicates that she wants to focus more on task-oriented teaching, she also recognizes a need for students to have
practice and “basic skills” (Beth, Interview 2) in order to be successful at mathematical tasks and problem solving. As she reflects about her experience using mostly mathematical tasks to teach mathematics last year, Beth says, “Last year, there were a bunch of kids who really improved, but there were five kids who went down in terms of their test scores. My guess is that they needed more direct instruction that was based on skills” (Beth, Interview 1). She says that her current students need to have a large collection of mathematical lessons throughout the year, so she “can’t afford a big task every day” (Beth, Interview 3).

Similar to Beth, Fred expressed a need for both direct and dialogic instruction to best prepare students in his mathematics classes. During Interview 2, he talks about a need for basic skill development in order for students to perform well on the Smarter Balanced test at the end of the school year. He much prefers rich tasks to any type of textbook work or direct instruction, because he says students aren’t engaged during his direct instruction (Fred, Interview 2). When asked about the goals of each type of teaching, he clarifies that mathematical tasks “don’t always tie into a content standards, they are more about trying to hit the practice standards,” and furthers his sentiments by saying, “that’s why tasks are so important, so that hopefully they can see why math is the way it is” (Fred, Interview 3). During an informal conversation on October 15, Fred suggests that if he were not worried about assessment data, or parents and administration, he would not focus on basic skill development in lieu of focusing on implementing rich tasks during his mathematics classes (Fred, Interview 2). He says, “If I didn’t have accountability, I’d probably drop all of this,” and further clarified by saying that if he wasn’t accountable to the district, principal or parents, he would completely stop any focus on basic skills and just use rich tasks with students to teach math (Data Collection Journal, October 15).
Opinions regarding mathematics state testing

Ana reports that she is not motivated by state testing this year, because the state assessment, the Smarter Balanced test, is new to their district. She states her belief that the testing scores are going to be low this year regardless of how she teaches or what students learn, because the content on the assessment is completely unknown to anyone in the district. As a result, Ana reports that she has decided to use this academic year to practice implementation of rich tasks and development of student learning (Ana, Interview 2).

Beth is extremely focused on the coming state assessment, and discusses her desire to have students perform well on those tests, while balancing some problem solving abilities. During Interview 2 Beth says, “its always this delicate balance of are they ready for the state test they are going to take in the spring.” As she says in Interview 1, her guess was that students whose scores decreased during the previous academic year “needed more direct instruction” (Beth, Interview 1), and less of a focus on mathematical tasks. In Interview 2, she says, “students are defined by these tests. They open and close doors for you.” Beth goes on to explain that students who do poorly on state assessments are then tracked into lower–level classes and have a difficult chance of breaking free of that tracking. During Interview 3 she expresses her feelings that “I am doing them a disservice if I don’t hold them accountable to the types of assessments that they have to take.” Beth feels compelled to find medium ground between engaging students in more meaningful mathematical tasks and preparing them to succeed on a test that, she believes, requires more direct instruction and basic skill practice.

As implied in the previous section, Fred feels bound by the state assessments in terms of his teaching practices. Without the accountability of testing, he would prefer to focus on rich tasks and problem solving abilities (Fred, Interview 2). However, he expresses the opinion that there are certain basic skills on the state assessments that require students to just “memorize the
He also implies that there is too much content on the standards to be able to address each standard through rich task implementation (Fred, Interview 3).

As reported in this chapter, the findings from the first phase of data collection and data analysis centered on the classroom observations and interviews of Ana, Beth, and Fred. These findings include an unexpected connection to a professional development program, two prominent mathematics teaching practices, and the beliefs, opinions, and values of the observed teachers regarding mathematics teaching and learning as well as the required state assessments. The professional development was designed to improve teachers and students’ abilities to reason mathematically. One extremely prevalent aspect of the professional development was for teachers to create and use mathematical tasks to engage their students in generalizing and justifying mathematical claims. A clear result of the influence of the professional development was a dichotomy of two mathematics teaching practices observed in the elementary school. One is a more traditional form of teaching mathematics that is characterized by a teacher demonstrating how to solve a mathematical problem, and then allowing time for students to practice similar mathematical exercises. The other was promoted by the professional development, and is characterized by students engaging in generalizing or justifying through a mathematical task. Ana, Beth, and Fred’s beliefs, opinions, and values concentrated on engaging students in reflective thinking about mathematical tasks. Beth and Fred mention a concern in the amount of content required for students to perform well on the state assessments, and how the little amount of time often requires the use of direct instruction rather than dialogic instruction. On the other hand, Ana says that she is using the opportunity of a new state assessment, on which she assumes most students will not score well, to practice her ability to engage students in rich mathematical tasks. The next chapter reports findings from the stakeholder interviews, regarding their values, beliefs, and sense making of the green and purple teaching practices.
Chapter 5 Findings from Interviews: Stakeholders’ Values, Beliefs, and Sense Making

This chapter presents findings about the participating community’s sense making of mathematics teaching practices, both generally and as they were specifically observed in a local elementary school. While none of the reported findings are particularly surprising, as many of them are either confirmed in the literature or are what many mathematics educators might have predicted as responses to the interview questions, they are presented here so as to provide a foundation for later claims about the culture within the local educational community, as pertaining to mathematics teaching practices. Specifically, stakeholders’ beliefs, values and opinions are examined in keeping with the theoretical framing of the study. According to a sociocultural perspective of a classroom context, students’ learning is either directly or indirectly influenced by the beliefs, values, and opinions of educational stakeholders in the community. One result is that the stakeholders’ beliefs, values, and opinions about mathematics teaching practices can either support or hinder student learning, either directly or indirectly, or as Krainer (2014) says, stakeholders “have effects on students’ knowledge” (p. 54). For instance, if the stakeholders’ beliefs, values, and opinions are supportive of the mathematics teaching practices used by elementary teachers within the same community, the students within the community have an increased chance of hearing similar messages regarding mathematics learning. On the other hand, if stakeholders’ beliefs, values, and opinions clash with those of the teachers in the community, students may in turn be exposed to antithetical mathematical learning objectives.

The chapter is split into two main sections: (1) a report on the beliefs, values, and opinions from interviews with relevant educational stakeholders in the participating school district; and (2) a comparison of the stakeholders’ beliefs, values, and opinions and those of Ana, Beth, and Fred as reported in the previous chapter. The first section details what the participating
stakeholders think about mathematics teaching practices at the elementary grade levels, as well as how the stakeholders make sense of the teaching practices depicted in both the green and purple classroom storyboards. This sense making is described through the stakeholders’ beliefs, values, and opinions as discussed in the interviews in Phase II of data collection. The second section compares the observed teachers’ sense making of their mathematics teaching practices to the stakeholders’ sense making of those practices. This comparison helps to provide a more complete portrait of the participating community’s beliefs, values, and opinions regarding mathematics teaching practices because it illuminates similarities and differences among the community members who are actually utilizing the mathematics teaching practices and the community members who are simply observing the mathematics teaching practices from a distance. The comparison provides further insight into whether or not the teachers and the stakeholders are in agreement on how they make sense of mathematics teaching practices.

Findings about stakeholders’ beliefs, values, and opinions regarding mathematics teaching practices are presented in two formats. First, the beliefs, values, and opinions are reported within categorical topics. Second, those categories are compared to and contrasted against each other in order to examine the nuances and intricacies of the stakeholders’ sense making of mathematics teaching practices. As discussed in more detail in the methods chapter of this dissertation, I used indexing (DeWalt & DeWalt, 2011) to sort stakeholders’ statements into categories of meaning. Refinement of the categories and stakeholders’ statements resulted in four categories of beliefs, values, and opinions from the stakeholders. These four categories, seen in Figure 5-1, are: stakeholder interpretations of each observed mathematics teaching practice, stakeholder values and beliefs concerning mathematics teaching and learning, prevalent stakeholder experiences from grade school mathematics classes, and stakeholder opinions regarding state mathematics testing. Because of the conversational nature of the data, these four categories are meant to highlight particular aspects of stakeholder assertions, but will not always
be distinct from each other; there may be some overlap between the four categories as they are presented. Each category contains up to five prevalent assertions from stakeholders, all of which can be seen in Figure 5-1. The term prevalent is used to indicate an assertion that was mentioned by more than half of the total number of stakeholders. An assertion is a claim written by me, but using phrasing closely resembling stakeholder language. Throughout various stages of analysis, there were up to seventy assertions, but only those that are prevalent in the data are presented as findings in this chapter. Additionally, there are very few assertions that are prevalent with one stakeholder group and not another; therefore, most assertions presented are prevalent among all the stakeholder groups. Some assertions that are prevalent among only one or two stakeholder groups are presented and clearly labeled as such throughout this chapter.
Figure 5-1. A catalogue of all stakeholder assertion categories.

All categories and assertions were identified through analysis of the interview data from the sixteen educational stakeholders. The interview protocol can be seen in Appendix C. These stakeholders were either parents of elementary students in the district, elementary teachers who
taught in the same school as Ana, Beth, and Fred, principals of elementary schools in the district, including Ana, Beth, and Fred’s school, or university researchers who were Principal Investigators of a national professional development grant working with Ana, Beth, and Fred’s school. Most stakeholder interviews lasted for about an hour, and most of that time consisted of stakeholders’ reflections and statements. Stakeholders were frequently anxious to discuss their own mathematical experiences as students, and often did not recall many details; however, they became much more talkative after reading through the second storyboard, as they compared the two classrooms. At this point in the interviews, stakeholders began to talk more easily about their values and beliefs regarding mathematics teaching practices.

Four categories of stakeholders’ beliefs, values, and opinions

Stakeholders’ beliefs, values, and opinions are presented in four categories: (1) stakeholder interpretations of observed mathematics teaching practices; (2) stakeholder beliefs and values concerning mathematics teaching and learning; (3) prevalent stakeholder experiences from grade school mathematics classes; and (4) stakeholder opinions regarding state mathematics testing. The four categories were identified as addressing the research questions guiding this study, and further developed through analysis of stakeholders’ assertions. Each category is designed to illuminate portions of the stakeholders’ viewpoints of mathematics teaching and learning in their elementary school community.

Stakeholder interpretations of each observed mathematics teaching practice

The first category of stakeholder assertions is the most relevant to the research questions guiding this study because of its direct connection between participating stakeholders and Ana,
Beth, and Fred’s mathematics teaching practices. Table 5-1 outlines each assertion in this category, and provides details regarding the number of stakeholders who made statements that supported the creation of each assertion. As reported in the previous chapter, there are two prevalent teaching practices identified during data collection in Phase I. These two practices were presented to stakeholders as “The Green Classroom” and “The Purple Classroom.” Each storyboard can be seen in Appendix B. Stakeholders’ interpretations of classroom activities, including student and teacher actions, of each classroom storyboard are presented here to provide insight into what the stakeholders paid attention to, and how they made sense of the teaching practices presented in each classroom storyboard.

Table 5-1. Stakeholders’ interpretations of the teaching practices portrayed in the green and purple storyboards.

<table>
<thead>
<tr>
<th>Interpretations of the Green Classroom</th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct instruction approach to teaching</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Similar to own mathematics student experience</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Missing an understanding of why the algorithm works</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Content is important, but pedagogy could be improved</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interpretations of the Purple Classroom</th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High level of student engagement</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Teacher is goal–orientated</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Teacher focused on student thought</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Students seemed to be engaged in generalizing</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>
Stakeholder interpretations of the green classroom

Without prompting regarding what to focus on, stakeholders were asked to describe what they saw taking place in the green classroom. Prevalent characteristics were almost unanimous across all of the stakeholder responses. This section reports on how the stakeholders interpreted the storyboard of the green classroom. Stakeholder interpretations are similar to direct instruction teaching practices, to which the green teaching practice is compared in Chapter 4.

Fifteen stakeholders interpret the actions of the green classroom as a two-step process, which include the teacher presenting information on an algorithm, and the students practicing using the algorithm on a worksheet. According to researcher Rosa, the teacher is “telling them how to do it or showing them, demonstrating the algorithm. Not making any sense of why you do what you do but just that's what you do and then says work on it.” Researcher Rosa presents the most straightforward description; however, the other stakeholders describe teacher actions in a similar manner with phrases like “they’re basically just showing this is how numbers will look and this is how we put them together” (teacher Cleo), or “there’s lots of directions at the beginning” (principal Marie). Descriptions of teacher actions were followed by accounts of students are “sitting at their desk” (parent Ellie) or teachers “gave them that practice” (principal Leo). Researcher Martin is more clear when he says the teacher then “sets the students to work on a page of nearly identical problems.” Some stakeholders also mentioned the lack of student engagement in the lesson. For instance, parent Amelia says the “students give mostly one-word answers,” and principal Marie comments that the teacher is “not really have the students involved in the process as much as I would like to see.”

There is overwhelming consensus that the green classroom reminds stakeholders of their own grade school experiences, but there is not a general consensus on specific classroom characteristics that created this link between experiences and the classroom. Overall, the green
classroom is interpreted as a classroom with little student interaction or excitement. Fifteen of the 16 stakeholders recognize the teaching in the green classroom as similar to their own grade school mathematics teaching and learning experiences. Teacher Harriet connects to the classroom by relating it to her experience of “not really explanation as to why we would do this kind of math”. Teacher Susan connects to “you just sat at your desk and didn’t say anything”. Parent Helen says, “just that it was up at the front everyone’s staring at the front overhead or something and you know you can do this and can anyone ask me. One brave person can answer the question”. Researcher Martin says, “The general structure of here’s the thing to do. And then here’s a set of problems that are identical to what I told you to do. Where you can practice this method. That general structure is very similar to what I experienced”. Parent Amelia says, “Its’ pretty familiar. The, ‘Here’s a thing you need to do. Lets do an example. Now you do the example, and then you take some of it home with you.’ That’s pretty standard, what we did.” Parent Emily says it is similar because it looks like “the teacher in front and talking about stuff and then he’d get out of the way and they’d give it a try.”

The final two interpretations of the green classroom are somewhat related to each other. The first is that the lesson in the green classroom is missing some type of understanding about why the algorithm works. Twelve stakeholders make comments indicating a lack of opportunity for deeper student understanding, that goes beyond just knowing the algorithm. Most of the comments are straightforward indications that something is missing in the lesson. As an example, parent Helen says, “There’s no why would things be in decimal or what are decimals for.” Other stakeholders say statements such as, “there’s no use of investigating” (teacher Cleo), or “I’d like to see them come up with their own algorithm. You know using manipulatives or something to make sense of all this stuff” (researcher Rosa), or students will not have “a super deep understanding of the place value of the numbers” (principal Leo).
The second assertion is that the content is important, but there is some better way to teach the lesson. Given that a majority of stakeholders felt there was something missing from the lesson, it seems reasonable that eleven of the stakeholders would comment on there being a better way of teaching the lesson. Some stakeholders do this outright, making statements such as “I don’t know that it’s the best way to do it” (teacher Cleo), or “I think I would do it slightly differently.” Other stakeholders simply present their own ideas of how to improve the lesson. For instance, parent George says, “But he gave them like twenty minutes of silence. I guess that's good. But I was thinking he could've gone around then and like worked with them on the problems” And still others simply express concern at the way the lesson is being taught. For example, researcher Martin says, “I think it’s valuable for them to be able to do problems of this kind. My concern is that the way this has been taught the students may be able to do problems of this kind, but they may not understand what it was that they did.” Furthermore, he states that “as a result they may not be able to do problems that are slightly different but really fundamentally the same.”

Collectively, the stakeholders interpreted the green classroom as a teacher-centered lesson that was similar to their own classroom mathematics experiences. Stakeholders commented on the fact that there might be a better way to teach the mathematics content, and specifically that students seemed to be lacking an understanding of why the mathematical algorithm was useful to help solve addition and subtraction problems involving decimals.

**Stakeholder interpretations of the purple classroom**

This section reports the prevalent stakeholder interpretations of the actions observed in the purple classroom. Stakeholder interpretations of the purple classroom were not as unanimous as their interpretations of the green classroom. There are four total prevalent characteristics, and
one additional interpretation, which is stakeholder group specific, of the student and teacher interactions in the purple classroom. Stakeholders described the purple classroom as including a high level of student engagement, and led by a teacher who has a specific mathematical objective for the lesson.

The first assertion is that there is a high level of student engagement in the Purple Classroom. Some of the stakeholders say this directly, while others indicate it through a heavy focus on describing what the students are doing during the class period in combination with saying very little about teacher activity. For example, principal Leo points out a “high level of engagement, high level of involvement with the kids,” and parent Amelia says, “They are actually doing the job, instead of the teacher just telling them.” These are both examples of stakeholders being very direct about a high level of student engagement in the lesson. On the other hand, some of the stakeholders provide long explanations of all the student activity that is occurring during the lesson. These explanations provide evidence that the teacher is allowing a high level of student involvement during the lesson. An example is researcher Mala who says that students are “learning that their ideas might be important and it's worth exploring those ideas.” Researcher Mala’s focus on the fact that students’ ideas are being validated and explored indicates that students are able to share their ideas, and that those ideas form a substantial portion of the lesson.

The second and third assertions are related to each other, and are both prevalent with eleven stakeholders each; however, the stakeholders are not the same for each assertion. One assertion is that the teacher has a specific goal in mind and leads students to that goal through thoughtful questioning during the lesson. As teacher Harriet states, “This teacher know what she wants the kids to take away so she or he seems to be really guiding the conversation to that. It’s definitely … It doesn’t seem like anything is on accident.” Researcher Rosa complements that view by saying the teacher is “getting them to where she wants. So it's beautiful orchestrated. I mean she's sequencing activities and she is you know lets them explore and then and then poses a
question.” Researcher Eva and parent George both use a similar metaphor to describe the assertion, saying, “I think she or he kind of has this road map laid out where she wants to go” (researcher Eva), and the teacher “steers them a little bit in the right direction” (parent George).

The assertion that the teacher is leading students to a pre–determined goal through thoughtful questioning seems to imply that the teacher must be focused on student thought during the lesson; however, there is not a direct correlation between the stakeholders who commented on the previous assertion and the third assertion, which is that the teacher in the Purple Classroom is focused on student thought. Teacher Cleo explains assertion two that the teacher is “paying attention to the student learning, not what the teacher already knows, […] because he or she is waiting for them to tell her or him what they are learning, not what they’re supposed to be learning.” Parent Diana says the teacher is “listening to the students,” and principal Marie says the teacher is paying attention to the “thought process” of the students.

The fourth assertion is that nine stakeholders note that the students in the Purple Classroom are searching for a pattern. For example, parent Helen says the teacher was “letting the patterns emerge,” and researcher Eva comments that students are “looking at patterns, being able to talk about those patterns.” Parent Amelia identifies students are “trying to analyze patterns.” In addition, researcher Mala comments, “Enough of a pattern was identified that a good analytic justification really could be pulled out of this.” So, there is the added classroom characteristic that students are trying to figure out why that pattern is occurring and then try to explain it” (parent George).

The last assertion includes only seven stakeholders, not all of who made an explicit mention of patterns. Three teachers, one principal, and three researchers noted that students were making generalizations in the purple classroom. Teacher Mira says, “They're making those generalizations. They're seeing how this could apply to other things,” while Susan even connects it to the professional development by saying it reminds her a lot of the professional development
through the use of “the reasoning, the understanding, generalizing and justifying.” The researchers have varying degrees of noticing generalizing, with one saying the teacher “states that as a generalization” (researcher Eva), another saying, students could “make a general case like this” (researcher Martin), and the third noting “there’s that little generalization” (researcher Mala) in the classroom discussion.

In summary, the prevalent interpretations of the purple classroom include assertions that there is a high level of student engagement in the lesson, the teacher has a specific goal in mind and leads students to that goal through thoughtful questioning, the teacher is focused on student thought during the lesson, and that the students were searching for a pattern or engaged in some sort of generalizing activity. The stakeholders did view this classroom as vastly different from the green classroom, and the contradictions frequently led stakeholders to further clarify their own beliefs and values regarding mathematics teaching and learning.

### Stakeholder beliefs and values concerning mathematics teaching and learning

Beliefs and values are often explored together as similar types of statements. As previously described in detail, for the purpose of this study, beliefs are statements presented by stakeholders as a known truth about teaching or learning, and values are statements presented with some worth or importance associated with the statement. There was only one prevalent belief assertion from stakeholders; value assertions were much more common. Value assertions are presented in three categories: values regarding mathematics content, values regarding mathematics teaching actions, and values regarding student mathematical activity. Table 5-2 outlines all assertions for this category, and includes details regarding how many stakeholders made statements that were classified under each assertion. In general, stakeholders’ beliefs and values trended towards a dialogic form of instruction. They expressed viewpoints that there are
multiple ways of solving a mathematics problem, that students should take responsibility for their own learning, while teachers should be less engaged in mathematics lessons. Additionally, stakeholders expressed the view that students should engage in a conceptual learning of mathematics and understand the mathematics in which they are engaged.
Table 5-2. Stakeholders' values and belief about mathematics teaching and learning.

<table>
<thead>
<tr>
<th>Belief about mathematical learning</th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple ways exist to solve math problems</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Values about mathematics content</th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning basic facts is important elementary content</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Emphasize elementary students building number sense</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Values about mathematics teaching actions</th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching should include practice and conceptual problem solving</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Students should take responsibility of their own learning, with teachers having less of a role in lessons</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Direct instruction is useful under some conditions</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Values about student mathematics activity</th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students should understand why math works</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Students’ ability to problem solve is highly important</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Students should be able to express their mathematical thinking</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Group work and discussions are valuable</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
Stakeholder belief regarding mathematics learning

The only prevalent belief assertion made by stakeholders was the belief that there are multiple ways to solve mathematics problems. Eleven of the stakeholders expressed this belief during the interviews, but it was more prevalent in the group of professional educators than in the group of parents. Eighty percent of the teachers, principals, and researchers expressed this belief, while only fifty percent of the parents mentioned it. Some stakeholders stated this belief very clearly with statements such as students should know “that there’s not just one way to get an answer to a math problem, that they can explore, that there are infinite ways to get answers to math problems, and to learn the math problems” (teacher Cleo), or that that “there’s more than one way to do something and get the right answer” (parent Amelia). Other stakeholders made statements that allowed their belief to be inferred, such as principal Marie who believes “if a student knows how to do something, it doesn’t matter what method they use.” While she did not explicitly express the belief that there are multiple ways to solve problems, her mention of different methods indicates her belief that there is more than one way to arrive at a solution. Similarly, researcher Eva mentions disapproval in some of her university students who “don’t want to think about multiple ways to solve problems.” Because she mentions this with disapproval, it implies her belief that there are multiple ways to solve problems.

Stakeholder values regarding mathematics content

There are two notable assertions regarding mathematics content considered to be valuable by the stakeholders. These assertions stem from responses to interview questions that inquired about stakeholders’ notions of what students should learn by the time they leave elementary school. The response from stakeholders was that basic facts and number sense are the two most
important mathematics content that students should learn about during their elementary school experience.

When asked what students should learn by the time they leave elementary school, stakeholders overwhelmingly (13 of the 16 stakeholders) responded that basic facts are the most important type of content for students to learn in their elementary mathematics experiences. Basic facts are considered to include the four major operations of addition, subtraction, multiplication, and division. Some stakeholders mentioned the importance of basic facts outright, such as teacher Cleo when she said, “number one they [students] need is basic facts.” She further emphasized the importance when she said that students do not need to use a calculator in the younger grade levels because “it takes away from them learning their basic facts.” Likewise, parent Amelia responds to the question of what students should learn by saying “of course obviously the basics, that she has a good grasp of those, because I know if you can’t multiply, and you can’t do simple divisions, then all those algebra problems and geometry problems are going to be exponentially more difficult than they need to be.” Other stakeholders indicated their value of students learning basic facts when they mentioned the importance of one or more of the major arithmetic operations for elementary mathematics students. Researcher Rosa says that while she does not want students to rely heavily on memorization, she “would like them to know their multiplication facts.” Similarly, parent George said students should know “division” as an example of a “basic building block in algebra.” Additional stakeholders required more inference to demonstrate their valuing of basic facts in elementary content. For example, teacher Susan talks about the importance of knowing facts in connection with timed tests when she says, “Do you know your facts? Okay. If its takes longer than a minute, do you still know them?”

The second prevalent assertion regarding content that elementary students should learn was an emphasis on building number sense. This assertion was primarily prevalent with the stakeholder teachers, principals and researchers, with only two of the parents expressing this
value. Teacher Harriet expresses her angst in students who “don’t have number sense,” saying that she is not sure “at what point it can truly be fixed.” Principal Marie places a lot of emphasis on letting students “feel and see what numbers are like.” And, researcher Mala is straightforward about the value when she says, “I would want them [students] to have a reasonably strong number sense.” In contrast, the two parents are not as explicit in their value of number sense. Parent Emily says students should have “just all that really basic number sense stuff down.” She is not very clear on what she means, but does indicate an example of “what a digit really means as opposed to a number.” Likewise, parent Diana talks about the importance of students being able to physically see the connection between 10 and 100 by using “manipulatives and things that are visually telling them [students] what the numbers are telling them.” This is indirect evidence of a value of number sense because it describes a deeper understanding of how numbers are related to each other.

The reported stakeholder values regarding elementary mathematics content is in agreement with many of the Common Core State Standards for Mathematics (CCSSO, 2010) for the elementary grades. Most elementary teachers focus on teaching students basic mathematical facts, such as addition, subtraction, multiplication, and division. Teachers also focus on helping students develop a strong sense of what numbers are and how they relate to one another.

**Stakeholder values regarding mathematics teaching actions**

A subset of the stakeholders’ responses to interview questions about what students should learn implied some inclination towards a value on what the teacher should be doing during a mathematics class. There were three prevalent assertions that fall under this category. Two of the assertions are prevalent across all stakeholder groups, and one is notable for its appearance among only two of the stakeholder groups. These assertions include statements that indicate
teachers should provide students with opportunities for both exercise practice and conceptual problem solving; teachers should help students take responsibility for their own mathematical learning; and that students should play a larger role in the classroom than the teacher.

The first prevalent assertion was displayed towards the end of the interview, after the green and purple classrooms were discussed. Twelve stakeholders made statements that indicate a sentiment that mathematics teaching should include a combination of providing opportunities for exercise practice as well as opportunities for conceptual problem solving. Most stakeholders expressed a preference towards the teaching in the purple classroom, but stated that there should be some practice like in the green classroom that supports student learning. For example, teacher Mira thinks the types of teaching should be combined because “this discussion part is fantastic,” but students “also need a little bit of that time to apply it.” By discussion part, she insinuates that students are problem solving and focusing on conceptual understanding through having group discussions. She is less concerned with students getting exercise practice on their own, but says that students can either work independently or with a partner during that practice time. Similarly, a couple of parents felt that the teaching in the purple classroom was more exciting and could keep students interested in the lesson, but that the teaching in the green classroom was useful for practicing mechanics and basic facts. For instance, parent Emily says, “You could start off with the purple just to get people excited about it. Then go to green for keeping everybody on the same page with vocabulary and making sure everybody's kind of ... We're thinking about math facts here and getting all that kind of stuff back in the top of the brain. I think you could mix it up a bit.”

Another way this assertion manifests itself with some of the stakeholders is through a focus on how students will react to each type of teaching. Principal Marie says, “I think that there are some kids that are going to do very well in this [purple classroom], and I think that there are some kids that still need little bit of skill and drill because that's maybe a way that they learn, and
this [purple classroom] is harder for them to adapt to that.” Her reasoning for wanting a combination of practice and problem solving is in reaction to a belief that students may have a difficult time adapting to pure problem solving in the classroom, and that some may learn better through exercise practice.

The researchers generally expressed a strong preference for problem solving teaching similar to the practices in the dialogic–like purple classroom, but most of them did feel that some exercise practice was also useful. For example, researcher Eva says that her “ideal is that we would be doing more of this [this purple classroom] to build conceptual understanding. Then we may have practicing some skills that came from that [green classroom].”

Eleven of the stakeholders indicated an importance that students are taught to take responsibility for their own learning in some way. This assertion manifested itself in several different ways during the stakeholder interviews. Some stakeholders connected the assertion to the notion that teachers should not be showing students exactly how to solve problems, but rather supporting students’ learning in other ways. For example, teacher Cleo says teachers should encourage students to be involved in “figuring out how to solve it [a math problem] and not just being automatically shown, this is exactly what to do.” Teacher Mira provides some clarification on what the teacher should be doing when she says that students who are talking to each other helps to put “a lot of the thinking on them, and the teacher is there to guide what they’re [students] doing, help them learn.” Her focus is on students working together and learning from each other, rather than solely working through the teacher’s expertise.

Others of the eleven stakeholders present evidence that is more traditional with regards to the teacher’s role, but also include a focus on student responsibility for their own learning. Teacher Susan talks about her own teaching when she says, “I have a rich task that they [students] do investigations and they discover what it is before I tell them what it is.” There is a primary focus on students doing some investigating and exploration on their own, without teacher
intervention; however, she indicates that the lesson will continue with the teacher telling students a solution or an algorithm for solving a problem. Similarly, parent Diana says teachers should give students “a foundation of whatever the concept is that they’re trying to get at and [give] them some very specific things to do to get them started so they don’t just feel lost. Then, have the materials so they [students] can extend that [mathematical concept] for themselves.” This statement indicates some teacher–driven information at the start of a lesson, but focuses on the assertion that students should be able to take responsibility of extending their thinking on their own.

In contrast, others of the eleven stakeholders felt more strongly that the teachers should play far less of a role during classroom sessions than students should play. For instance, researcher Mala indicates that she does not want students to rely on teachers at all for problem solving skills. She wants students to “develop some problem solving strategies and some confidence in their ability to make sense of mathematical situations and solve problems rather than expecting someone else to show them what to do and then just copying.” This statement indicates more of a focus on the independent student responsibility portion of the value assertion. Likewise, parent Helen expresses value in the purple classroom because students are not “just accepting what’s being told. [They are] figuring it out for themselves.”

The final assertion in this section is that direct instruction is a useful form of teaching. This assertion is notable in the fact that three teachers and three parents were the only stakeholders out of the sixteen total who indicated this assertion as a value. Teachers indicated that it should be used to get students ready for a test or assessment as well as the next grade level when other methods of teaching did not work. For example, teacher Mira mentions a couple of students who were “getting confused with which way things went” with “double digit adding,” and she said that those students “just needed to have some direct instruction.” In contrast, parents seemed to have a sense that direct instruction was necessary for complete learning. Parent George
expressed the strongest preference for direct instruction. His ideal classroom would include the teacher “go through some step by step, well maybe explain some concepts first, in clear language that the students can understand. Make sure they understand the concepts first, before they go and actually try problems. And then maybe do some problem examples and then have them do work in the class.”

Stakeholders’ values related to teacher activity during a mathematics lesson are closely related to their values regarding student activity during a mathematics lesson. Both categories include a focus on students understanding of mathematical content, and a prevalent role for students in their learning of mathematics.

**Stakeholder values regarding student mathematical activity**

There are three prevalent assertions that reflect stakeholders’ values with regards to students’ activities and actions during a mathematics lesson. These include activities in which students should be participating as well as types of learning that students should be building in their mathematics classes in elementary school. There is one additional assertion regarding student activity in the mathematics classroom that is notable because of its prevalence among the responses from teacher and principal stakeholder groups. Overall, the assertions align with the previous category in that they focus on a high level of student activity and understanding, rather than a teacher–centered classroom environment.

Fourteen stakeholders mentioned the importance of students understanding why the mathematics that they are doing works. Teacher stakeholders expressed their desire to “see that they [students] understand the process” (teacher Cleo) and “have a deeper understanding that they can explain” (teacher Mira). Researcher stakeholders expressed a desire for students to have “an opportunity to explore how and why the algorithm works” (researcher Rosa). The principals
focused on “internalizing” a concept (principal Marie) and building “stronger conceptual frameworks” (principal Leo). Parent stakeholders communicated their satisfaction with students “figuring out the why” (parent Helen) and “understanding the concepts.” Parent Amelia says it supports “what they’re going to encounter later.” Her sentiments echo what other stakeholders implied, that an understanding of why mathematics works the way that it does will help students succeed in higher level mathematics. Four of the fourteen juxtaposed their desire for students to focus on understanding mathematics to the activity of memorizing. For example, teacher Mira says she wants students “not just memorizing what they need to do like an algorithm, but knowing what, why it works, and how it works so that they can apply it to different situations.” Teacher Susan states that “memorizing can only take you so far,” and parent Helen says she does not value activities like “memorizing the rules.”

Eleven stakeholders indicated that student ability to problem solve is of high importance for things students should know how to do by the end of elementary school. This assertion is similar to the desire for students to understand mathematical ideas conceptually, but is different because of its focus on students being able to interact with novel situations successfully. It was very important for these eleven stakeholders that students are not discouraged when they encounter novel problems in mathematics, other subjects, or outside of the classroom context. For example, researcher Martin says “I would want them to be able to have the capacity of reasoning to tackle a problem that they don’t know how to do.” Also, many comments seem to link to student self confidence, such as when principal Leo says, “I want all of our students to have that attitude that I can do some stuff if I try.”

Nine stakeholders mentioned the importance of students learning how to express their mathematical thinking. Six stakeholders in this group are principals and researchers, but two parents and one teacher also indicated the assertion. Teacher Mira says that her students “have to learn how to have a conversation,” and she provides examples of how she helps lead students
through many hours of practice talking to each other and having productive conversations about the mathematics they are learning. Principal Leo says, “you’ve got to dignify how they think, and you have to help them connect how they think towards what it is you want them to learn.” His focus is on supporting student learning through promoting and valuing student ideas. Researcher Martin hopes students will be able to “articulate those reasons” by the time they exit elementary school, and parent Amelia says it is “really awesome” and “empowering” for students to explain their thought process in mathematics.

The last assertion regarding student activity is notable for the fact that a majority of the teachers and principals (five in total), and few other stakeholders (one researcher and two parents) expressed value in group work and group discussions among students. Most of the teachers mention their own classroom practices regarding students working together. For example, teacher Mira says her students “have a math partner that they keep through the whole unit,” and she thinks “it just opens up more ways of learning” because students might be more willing to show vulnerability to each other than to a teacher regarding their mathematical struggles in class. Teacher Susan indicates this value when she focuses on and is excited about the fact that the students in the purple classroom are working in groups. Principal Leo pulls out a copy of the district–wide framework for teacher evaluation and shows that one measure of effective teaching is “using question and discussion techniques,” while principal Marie says the collaboration skills students are portraying in the Purple Classroom are almost more valuable that the content they are learning. Parent Amelia says groups are “always way less scary” for students in all classes because no single person has to hold responsibility for a wrong answer.

In summary, the prevalent stakeholder assertions regarding beliefs and values include one belief, values about mathematics content, values about teaching actions, and values about student activity. The prevalent stakeholder belief is that there are multiple ways to solve mathematics problems. The prevalent values regarding mathematics content are that basic facts are the most
important type of content for students to learn during elementary school, and there should also be an emphasis on building number sense. Prevalent stakeholder values regarding teaching actions are that mathematics teaching should include a combination of providing opportunities for exercise practice as well as opportunities for conceptual problem solving, students should be taught to take responsibility for their own learning, teachers should play far less of a role during classroom sessions than students should play, and some stakeholder teachers and parents felt that direct instruction is a useful form of teaching. Prevalent values regarding student activity are the importance of students understanding why the mathematics that they are doing works, the importance of students having the ability to problem solve, the importance of students learning how to express their mathematical thinking, and a majority of teachers and principals feel that there is value in group work and group discussions among students.

Collectively, stakeholders made it clear that they value a high level of student engagement in mathematics lessons and they expect students to take responsibility for their learning. They expressed the importance of students understanding the mathematical activity in which they participate, and the importance of learning how to express their mathematical thinking by the end of their elementary school experience.

Prevalent stakeholder experiences from grade school mathematics classes

Research findings, described in detail in the literature review chapter, demonstrate a connection between past experiences and current values and beliefs. For this reason, I attempted to gain insights into the stakeholders’ past experiences in mathematics classrooms and lessons. While the interview questions asked about stakeholders’ experiences in elementary mathematics classrooms and lessons (specific questions can be seen in Appendix C), some stakeholders discussed memories from middle and high school experiences. Therefore, this category of
assertions reports on findings related to the entire grade school experience from Kindergarten through Twelfth Grade. A complete list of assertions in this category can be seen in Table 5-3, and include the number of stakeholders who made statements that were considered evidence for each assertion. Memories mentioned by stakeholders regarding mathematics teaching and learning in their grade school experiences were similar across all stakeholder groups. Some stakeholders could remember their elementary mathematics experiences, while others could only remember as far back as their high school mathematics experiences. Most of the experiences depict a very traditional mathematics lesson that is similar to research findings reported in the literature review chapter of this paper. The experiences tend to be dominated by a teacher directed lesson in which students worked silently on mathematics exercises for most of the lesson.

Table 5-3. Stakeholders’ experiences in their own mathematics classes.

<table>
<thead>
<tr>
<th></th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning consistent with</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traditional math teaching:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>teacher at the front, tells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>students how to solve</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>problems, students work on</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>exercises</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performed well in</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>mathematics classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regardless of the specific grade level that was recalled, a vast majority of the stakeholders recalled that most of their grade school mathematics learning experiences followed a direct instructional model of teaching. Fourteen of the 16 stakeholders described their mathematics learning experiences with characteristics that define the direct instructional model of teaching that was described in the literature review section of this dissertation. These characteristics include the phrase “very traditional” (principal Leo) or “standard” (parent Amelia and researcher Martin) to describe what was happening in the classroom. Both phrases indicate a familiarity and a feeling of a shared and commonly accepted classroom experience.
Another mathematics classroom characteristic recalled by multiple stakeholders include depictions of the general pattern of activity in the classroom as follows: a teacher “stood up in front of the room, showed us what to do, and then [we] did a worksheet” (researcher Eva). A similar pattern of classroom activity was repeatedly reported in stakeholder interviews. For example, parent Ellie recalled teachers “showing us how to do something on the board, and then practicing doing paperwork.” The pattern of activity described by so many stakeholders is similar to Munter et al. (in press) descriptions of pedagogical moves in the direct instruction model. Pedagogy such as “demonstrating how to complete the target problem type” and “independent practice” (p. 10) is evidence of a direct instructional model of teaching that was the prevalent recollection of grade school learning experiences for most of the stakeholders.

Additionally, some stakeholders mentioned having to copy mathematics problems from textbooks or the chalk or white board before finding solutions during their work time. For instance, teacher Mira emphasized “writing math problems and copying them” as a prevailing part of her grade school experience, and teacher Susan remembered “a lot of copying of the board.” While copying problems from a textbook or board at the front of the classroom is not something that Munter et al. (in press) include in the description of direct instruction, it is a detail of the “independent practice” (p. 10) characteristic of direct instruction that was commonly recalled by stakeholders as a prevalent mathematics classroom experience.

While most of the grade school memories stakeholders talked about fit into the previously described direct instructional model, there were a few memories that stakeholders mentioned which were somewhat contradictory experiences from the prevalent responses. These memories did not define stakeholders’ most common experiences with grade school mathematics classes, but were memorable to stakeholders for their uniqueness in their experiences. For example, parent Ellie remembers her dad showing her a visual representation of multiplication by using coins to demonstrate how multiplying creates a rectangle, with the solution being the
number of coins in the total rectangle. And researcher Eva remembers a teacher trying to use manipulatives to demonstrate some mathematical concept, but it not working very well because the teacher did not completely understand the activity. These types of anomalies are important because of the way they contrast to the majority mathematics classroom experience described by the stakeholders.

During the interviews, ten of the sixteen stakeholders mentioned that they performed very well in their mathematics classes during grade school as a response to questions about their past experiences. All of the researchers and four of the parents made up a majority of that group. For example, parent Emily says, “I was always great at math. I never had any problem with it,” and researcher Rosa said she was “always top of the class or close to the top of the class” in terms of grades in mathematics classes and on mathematics tests. Researcher Eva said that math was easy for her, but she “didn’t really like math in elementary school, because it was so much memorization.” In addition, teacher Susan and principal Leo talked about being good at mathematics in grade school. Teacher Susan discussed her experiences in contests that pitted the fastest two mathematics students against each other, and boasted that she always beat the other students in the competition.

In summary, the prevalent grade school experiences of stakeholders entailed mainly direct instructional methods of teaching and learning, with the teacher showing students how to solve a problem, followed by allowing time for students to practice solving problems that were very similar to the example. It was also a prevalent assertion that stakeholders performed well in their mathematics classes. Therefore, while it was not unanimous, most of the stakeholders’ experiences included what research findings present as fairly common mathematics learning experiences in public schools, as discussed in chapter 2.
Stakeholder opinions regarding state mathematics testing

Towards the end of the interview, after stakeholders examined and discussed the two mock assessments, they were asked if they found the new state mathematics assessment, called Smarter Balanced, valuable (the term valuable was purposefully presented as an open-ended concept, and it was not described as to what was meant by the term). The university researchers had some familiarity with released practice questions from the Smarter Balanced website (SBAC, n.d.), as did some of the teachers; however, the Smarter Balanced test had not yet been used for student assessment at the time of the interviews (the first year of implementation was the year of data collection for this study). Therefore, most of the comments were made based on the types of questions that stakeholders had just seen on the mock assessments (seen in Appendix D) and discussed in the interview, and not from any personal interaction with the new state mathematics assessment. Stakeholders were reminded that the questions from the mock assessments were meant to mimic the types of questions that would be seen on the Smarter Balanced test, and that the questions came directly from the Smarter Balanced website practice test questions for grades four and five. Table 5-4 illustrates the stakeholder assertions for this category, as well as the number of stakeholders who made statements that were classified as a particular assertion. There is only one primary assertion in this category, which is that stakeholders felt the state mathematics assessment does seem valuable to them. Stakeholders were divided in their identifications of the specific value, as is discussed.

Table 5-4. Stakeholders’ opinions about state mathematics testing.

<table>
<thead>
<tr>
<th></th>
<th>Teachers (4 total)</th>
<th>Principals (2 total)</th>
<th>Researchers (4 total)</th>
<th>Parents (6 total)</th>
<th>Total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smarter Balanced is a valuable math assessment</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>
Overwhelmingly, stakeholders indicate that they believe the Smarter Balanced test is a valuable assessment. Most of the fourteen stakeholders who say it is valuable simply indicated their agreement with a few words, such as “definitely” (teacher Cleo), or “yes I do” (parent Emily). Researcher Martin is a little more emphatic when he says, “Oh my gosh, yes this is the first test I've seen that even comes close to testing what is important for students to know.” Additionally, parent George makes a distinction between the mock assessment questions. He says that questions one and two on both mock assessments are not as valuable because students can simply use a calculator in the real world to solve those; however, he believes that questions three, four, and five are “the more important one[s].”

Ten of the fourteen stakeholders express value in the Smarter Balanced test because the questions seem to elicit a deep level of student thinking and understanding. For example, teacher Mira compares it to her past experiences with other tests when she says, “the level of thinking required is a lot deeper on these Smarter Balanced questions than maybe in the past.” Similarly, parent Helen compares the current Smarter Balanced test to her own knowledge of previous state assessments when she says, “I think the smart tests are an improvement from the state tests because they are asking for more process.” By process, she indicates the difference between students just “plugging answers on the computers.” Teacher Susan connects the test to the Common Core standards and says, “the whole idea of the Smarter Balanced, Common Core is taking things deeper. It isn't just the algorithms. It's looking beyond, persevering.” Researcher Martin reports that he has seen and examined in his research “a lot of assessments in a lot of states and a lot of items. And I've never seen one that's as good as the as the Smarter Balanced for actually assessing higher–level reasoning.”

The four other stakeholders express value in the Smarter Balanced test because the test questions seem connected to the real world in some way. Three of these are parents, and one is a teacher. Parent Ellie says, “if you know the basics, but then you don’t apply it to real world, then
it doesn’t really help,” and parent Diana says, “I think that the other questions are more like things that give them sort of that mind flexibility and tests whether or not they actually can use math to solve problems that they might encounter.” Additionally, parent Amelia states, “There’s a more complex version of that, that’s real–world.” While it is clearer in parent Amelia’s statement than the other three, there seems to be a connection between mathematics that can be connected to real world contexts and mathematics that requires complex thinking. This connection indicates that while these four stakeholders use phrases that focus on real–world mathematics, their statements can be interpreted to mean that the Smarter Balanced test incorporates some type of deeper level problem solving.

In summary, the prevalent stakeholder opinion about the Smarter Balanced state test is that it is a valuable assessment because it requires a deeper level of student thought than previous state assessments. Both of the assertions that describe the value placed on the Smarter Balanced test seem to support the idea that a deep level of student learning is an important aspect of required mathematics assessments.

Categories of stakeholder assertions compared and contrasted

Prevalent stakeholder assertions were presented in the previous section of this chapter, according to four main categories, a summary of which can be seen in Table 5-5. This table contains only the prevalent stakeholder assertions, meaning there are some assertions presented previously in this chapter that are not listed in the table. This is due to the fact that this section is making sense of the assertions that primarily categorize the entire group of stakeholders. In this section, these assertions will be discussed with respect to their connection to direct or dialogic instructional methods, and the values and beliefs of stakeholders will be compared to their interpretations of each classroom as well as their opinions about the state assessments.
Table 5-5. A summary of prevalent stakeholder assertions in all categories.

| Interpretations of the green classroom | • Teacher presents information, and then students practice on a worksheet  
| | • Similar to own mathematics student experience  
| | • The lesson is missing some type of student understanding about why the algorithm works  
| | • Content is important, but pedagogy could be improved |

| Interpretations of the purple classroom | • Lesson contains a high level of student engagement  
| | • Teacher has a specific goal in mind and leads students to the goal through thoughtful questioning  
| | • The teacher is focused on student thought and understanding  
| | • Students are searching for a pattern, or are generalizing |

| Values and Beliefs Concerning Mathematics Teaching and Learning | • Belief that there are multiple ways to solve mathematics problems  
| | • Value in basic facts and number sense being taught during elementary school  
| | • Value in teachers providing both conceptual understanding and practice time for students  
| | • Value in students taking responsibility for their own learning, rather than relying on a teacher  
| | • Value in students understanding why mathematics works  
| | • Value in students ability to problem solve  
| | • Value in students expressing their mathematical thinking |

| Past Experiences | • The majority of stakeholders discuss being mostly engaged in traditional mathematics teaching practices, with a few memories of some concept building during their experiences as a student in mathematics classes |

| Opinions Regarding Mathematics State Testing | • Smarter Balanced seems like a valuable test, mainly because it elicits a deep level of student thought and understanding; but also because it connects mathematics to the real world |

Stakeholder beliefs, values, and classroom interpretations compared to direct or dialogic instruction teaching practices

According to Munter et al. (in press), the debate between dialogic and direct instruction does not contain a disagreement on mathematical content to be taught. Therefore, only the beliefs and values regarding mathematics teaching practices and student activity will be considered in
this section. As seen in Table 5-6, stakeholder assertions align primarily with the definition of
dialogic instruction. They want students to take responsibility for their own learning, rather than
relying on a teacher to provide answers, which aligns to providing students opportunities to
“wrestle with big ideas, without teachers interfering prematurely” (Munter, et al., in press, p. 17),
as well as positioning “students as autonomous learners and users of mathematics” (p. 17).
Additionally, stakeholders expressed a value of students understanding why mathematics works,
which aligns with tasks that “deepen their understanding of concepts” (p. 17). Stakeholders also
expressed a value to have students engage in some practice, and dialogic instruction includes
“carefully designed, deliberate practice” (p. 17). Furthermore, the value that students should be
able to express their mathematical thinking is similar to students having opportunities to “put
forth claims and justify them as well as listening to and critiquing claims of others” (p. 17).

Table 5-6. A comparison between the ideas presented by Munter et al. (in press) and those of the
participants of this study.

<table>
<thead>
<tr>
<th>Stakeholder participants’ beliefs and values</th>
<th>Munter et al. (in press) descriptions of dialogic instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students should take responsibility for their own learning, rather than relying on a teacher to provide answers.</td>
<td>In dialogic instruction, students should have opportunities to “wrestle with big ideas, without teachers interfering prematurely” (p. 17).</td>
</tr>
<tr>
<td>There is value in students understanding why mathematics works.</td>
<td>In dialogic instruction, teachers should position “students as autonomous learners and users of mathematics” (p. 17).</td>
</tr>
<tr>
<td>Students should be able to express their mathematical thinking.</td>
<td>Dialogic instruction allows students to have opportunities to “put forth claims and justify them as well as listening to and critiquing claims of others” (p. 17).</td>
</tr>
</tbody>
</table>

Stakeholder interpretations of both the green and purple classrooms align with the study
finding descriptions of each type of teaching practice presented in Chapter 4, as seen in Table 5-7.
Stakeholders describe the activity in the green classroom lesson as a teacher presenting
information, and students having a chance to practice that information. While not very detailed,
the broad description is similar to Munter et al.’s description of direct instruction as “describing an objective,” “demonstrating how to complete the target problem type; and providing scaffolded phases of guided and independent practice” (p. 16). However, Munter et al. also include aspects such as the teacher articulating “motivating reasonings for achieving the objective,” as well as the teacher leading an engaging lesson (pp. 16–17) in their definition of direct instruction model, both of which are not used to describe the green classroom teaching practices.

Table 5-7. Stakeholder interpretations of the green classroom compared to direct instructional teaching methods.

<table>
<thead>
<tr>
<th>Stakeholder interpretations of green classroom</th>
<th>Munter et al.’s (in press) descriptions of direct instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A teacher presents information, and students practice implementing information in the green classroom.</td>
<td>Direct instruction includes a teacher “describing an objective,” “demonstrating how to complete the target problem type; and providing scaffolded phases of guided and independent practice” (p. 16).</td>
</tr>
</tbody>
</table>

Likewise, stakeholder interpretations of the purple classroom align to the dialogic instructional model, as seen in Table 5-8. Stakeholders notice the teacher in the purple classroom steering “collective understandings toward the mathematical goal of the lesson” (p. 17). Furthermore, stakeholders comment on the high level of student engagement, and the teacher focus on student thought in the purple classroom. These comments demonstrate evidence of students having opportunities to engage in lessons, and teachers being deliberate with utilizing student thought to drive the lesson, which Munter et al. describe as evidence of a dialogic instruction model of teaching.
Table 5-8. Stakeholder interpretations of the purple classroom compared to dialogic instructional teaching methods.

<table>
<thead>
<tr>
<th>Stakeholder interpretations of purple classroom</th>
<th>Munter et al. (in press) descriptions of dialogic instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teacher in the purple classroom seems to have a mathematical goal in mind, that is used to direct students during the lesson.</td>
<td>Teachers using dialogic instructional methods steer “collective understandings toward the mathematical goal of the lesson” (p. 17).</td>
</tr>
<tr>
<td>There is a high level of student engagement, and the teacher is focused on student thought in the purple classroom.</td>
<td>Dialogic instruction includes opportunities for students to engage in lessons, and teachers being deliberate with utilizing student thought to drive the lesson.</td>
</tr>
</tbody>
</table>

**Stakeholders’ beliefs and values about mathematics teaching and learning compared to their interpretations of the green and purple classrooms**

Throughout the interviews, stakeholders presented insights into their beliefs and values regarding mathematics teaching and learning, and they reported interpretations of both the green and purple classrooms. This section will compare stakeholders’ beliefs and values assertions to their interpretations of the green and purple classroom. When examined through the direct instruction versus dialogic instruction framework, it becomes notable that stakeholders’ beliefs and values with regards to mathematics teaching and learning, and the stakeholder interpretations of the purple classroom both align with dialogic instruction models of teaching, and therefore align with each other. It is interesting that stakeholders’ past experiences lie primarily in a direct instruction model of teaching, but most of them clearly demonstrate a preference for dialogic teaching practices.
Stakeholders’ beliefs and values about mathematics teaching and learning compared to their opinions regarding mathematics state testing

As presented in a previous section, stakeholders’ beliefs and values about mathematics teaching and learning align with the description of dialogic instructional methods from Munter et al. (in press). This alignment demonstrates consistency in stakeholders’ stated opinion that the Smarter Balanced assessment seems valuable, particularly in its design to elicit deep student thinking and understanding about mathematical content. Dialogic teaching practices tend to be focused on students’ conceptual learning, which is a very similar focus to what the stakeholders seem to find valuable in the Smarter Balanced mathematics assessment.

Comparison between stakeholder assertions and Ana, Beth, and Fred’s assertions

As described in Chapter 4, conversations with Ana, Beth, and Fred focused primarily on attempting to understand and characterize the mathematics teaching practices I observed in each of their classrooms. However, Ana, Beth, and Fred did express some of their beliefs and values with regards to the teaching practices and state testing during some of the interview sessions, which were presented in Chapter 4. Those beliefs and values are compared and contrasted to the prevalent stakeholder’ beliefs and values in the following section. Connections or disconnections between the observed teachers’ beliefs and values and those of the stakeholders within the same educational community provide an important insight into that community’s potential engagement of their students in mathematical learning.
Stakeholder beliefs and values compared to those of the Ana, Beth, and Fred

Beliefs and values expressed by the Ana, Beth, and Fred are similar to those that were expressed by the participating stakeholders. The majority of participants, both stakeholders and observed teachers, express a preference for dialogic teaching practices, with a focus on student understanding during mathematics classes. A small subset of stakeholders (a group of six teachers and parents) provides evidence in their belief that direct instruction is a useful form of teaching and remediation for students in mathematics classes. This assertion is similar to Ana, Beth, and Fred’s expressed tension between the two types of mathematics teaching practices that became the focus of this study. The observed teachers note either the existence of direct teaching practices in their classroom environment (in Ana’s case), or express the necessity for direct teaching practices under some circumstances (in Beth’s and Fred’s case). As a result, the stakeholders and the observed teachers are in agreement that dialogic teaching practices, as seen in the purple classroom episode, are preferred to direct teaching practices, as seen in the green classroom episode. However, there is a caveat that the green teaching practices are useful in some circumstances during mathematics lessons throughout the school year. Most often these circumstances include practice for an assessment or remediation for students who have not yet mastered the ability to tackle some mathematical content.

Stakeholder opinions regarding mathematics state testing compared to those of the Ana, Beth, and Fred

As Ana, Beth and Fred were not asked explicitly how they feel about the mathematics state testing, their data is reflective of conversations that were primarily discussing mathematics teaching practices used in their classrooms. As a result, their comments on the mathematics state testing indicate that the tests seem to restrict the teachers’ use of a variety of practices, and
especially those practices that are more dialogic in nature. For example, Beth and Fred express their feelings of accountability towards their students succeeding on the new Smarter Balanced test, and express a desire to try to balance helping students master basic skills and helping them build problem solving strategies as a means to help students succeed. The attempt at balance is expressed through a tension between different teaching practices that they feel best prepare students. As described in Chapter 4, Beth and Fred feel like direct instruction helps students more with basic facts and dialogic instruction helps more with problem solving abilities. Ana does not express this tension directly, but rather comments on the freedom she feels this year because the tests are new and she knows her students will not do well anyways, so she is doing what she wants in term of practices. Indirectly, this indicates that there would be some sort of tension if she were more focused on the test results of her students this year.

While some teacher stakeholders do express the use for both direct and dialogic teaching practices in order to help prepare students for mathematics tests, most stakeholders simply discuss the value they see in the test because of the focus on eliciting student thought.
Chapter 6 Discussion, Implications, and Conclusion

This chapter presents direct answers to the research question and sub-questions guiding this study, discusses the influence of a professional development project on this study—an unexpected factor—explores the differences between stakeholders’ experiences and their values related to mathematics teaching and learning, examines the tension between the two distinct teaching practices among members of the participating community, and considers implications and future research.

Throughout the data collection and analysis of this study, multiple measures were taken to elicit honest responses from participants and present valid findings as they relate to the guiding research questions. Such measures include triangulation of data, elicitation of advice and interpretation from participating teachers, and a substantial amount of time spent within the community. The data examined and presented in this study arose from multiple sources. For instance, the observed teaching practices were identified over multiple days of observations and across multiple teachers’ lessons. Additionally, stakeholder assertions were identified across multiple stakeholder interviews and conversations. After the creation of the storyboards, the observed teachers were asked for advice and input on the stakeholder interview protocol. Specifically, teachers commented on the classroom representations and provided input on how the lessons were portrayed effectively. Over the course of five months, and about 20 hours in each of their classrooms, the observed teachers demonstrated their trust in me by asking advice about mathematics teaching decisions such as when to include more instruction during a lesson or whether or not it seemed like students understood the lesson. The trust that teachers and the administration had in me as a researcher was also visible when they helped recruit 16 stakeholders for Phase II of the study. The relationships I built with the observed teachers were communicated to potential stakeholder such as parents, teachers, and administrators.
Answering the research question

The guiding research question for this study is: How do educational stakeholders make sense of mathematics teaching practices observed in their local elementary school? This question was intentionally broad to adhere to ethnographic research practices and allow for a reasonably unbiased perspective of the participating community. However, in order to guide the data collection towards conversations regarding mathematics teaching practices, the research question is interpreted through three sub-questions. The term *make sense* is refined as beliefs, values, and opinions in order to direct the focus of this research on particular aspects of stakeholders’ sense making related to mathematics teaching practices in their local elementary school. Therefore, the three sub-questions are:

(A) *What are stakeholders’ beliefs, values, and opinions regarding mathematics teaching and learning, and how do those beliefs, values, and opinions relate to the mathematics teaching practices observed in their local elementary school?*

(B) *What are stakeholders’ experiences in mathematics classes, and how do those experiences relate to the mathematics teaching practices observed in their local elementary school?*

(C) *How do stakeholders’ beliefs, values, and opinions about mathematics teaching practices relate to the state mathematics assessment administered to students in their local elementary school?*

Prior to eliciting responses from stakeholders, I observed three elementary teachers’ mathematics lessons in order to identify prevalent mathematics teaching practices across all three classrooms. The two prevalent mathematics teaching practices observed in Ana, Beth, and Fred’s mathematics lessons were a direct instruction teaching practice, and a mathematics task oriented teaching practice, with an increased focus on student engagement in generalizing and justifying.
These mathematics teaching practices were used as the foundation for gathering information on stakeholders’ beliefs, values, and opinions regarding mathematics teaching, learning, and state mathematics assessments. Educational stakeholders participating in the study included university researchers, administrators, parents, and other teachers who worked in the same school as Ana, Beth, and Fred. These groups can be seen in Figure 6-1, which is an adapted representation of Figure 1-2, because this study did not examine whether or how stakeholders influenced the observed mathematics teaching practices, but rather the study examined stakeholders sense making and interpretations of observed mathematics teaching practices. The answer to the guiding research question for this study, specifically how stakeholders’ beliefs, values, and opinions relate to the two observed mathematics teaching practices is presented below.

Figure 6-1. Types of stakeholders who participated in the study.

**Answering the research sub–question A regarding mathematics teaching and learning**

The first sub–question is: *What are stakeholders' beliefs, values, and opinions regarding mathematics teaching and learning, and how do those beliefs, values, and opinions relate to the mathematics teaching practices observed in their local elementary school?* As a collective group,
the participating stakeholders expressed eight prevalent beliefs and values with regards to mathematics teaching and learning. To constitute a prevalent belief or value, more than half of the 16 stakeholders must have provided some indication of a particular assertion. Because the primary teaching practices observed in Ana, Beth, and Fred’s mathematics lessons ended up being well-researched and often viewed as opposing mathematics teaching practices, all eight of the prevalent stakeholder assertions about mathematics teaching and learning align with one observed teaching practice or the other, and, occasionally, stakeholders expressed a belief that combines both types of teaching practices. Figure 6-2 depicts the prevalent stakeholder assertions as they relate to the observed teaching practices.

![Prevalent stakeholder assertions aligned with the observed mathematics teaching practices.](image)

**Green Teaching Practice**
- Learning basic facts are important for elementary students.

**Both Teaching Practices**
- Teaching should include a combination of student practice and conceptual development.
- Students should take responsibility for their own learning, with teachers playing less of a role.

**Purple Teaching Practice**
- There are multiple ways to solve math problems.
- Learning number sense is important for elementary students.
- Students should understand why mathematics works.
- It is important for students to have strong problem solving skills.
- Students should express their mathematical thinking

Figure 6-2. Prevalent stakeholder assertions aligned with the observed mathematics teaching practices.

The green teaching practice is characterized through a pattern of three main activities: (1) the teacher states a mathematical topic and provides at least one example of how to solve a mathematical exercise within the topic area; (2) students work on practice exercises that are similar to the example(s) presented by the teacher in step 1; (3) if students finish early, there is
some mathematical activity, unrelated to the day’s topic, on which students can work until the lesson time is over. This pattern of activity is very similar to Stigler and Hiebert’s (1997) reported pattern of stated topics and practicing procedures, which they showed was prevalent in U.S. classrooms. As seen in Figure 6-2, there was only one stakeholder value that was directly aligned with the green teaching practice, and that is: learning basic facts are important for elementary students. While both the green and purple teaching practices could be used to teach students about basic facts, the stakeholders discussed the mathematical topic as something to be memorized, rather than explored, which fits more with the green teaching practice than the purple.

The purple teaching practice is characterized by a pattern of four main activities: (1) the teacher introduces a mathematical task by reading the question, and asking for any clarifying student questions; (2) students work on the mathematical task, often in groups; (3) the teacher strategically chooses students to present their solutions and thinking to the class; and (4) if time permits, the teacher explicitly talks about mathematical strategies that were useful in solving the task. As seen in Figure 6-2, most of the stakeholders’ values and beliefs align with the purple teaching practice. Through the independence that students are allowed when working on mathematics without being told how to solve a problem, in combination with the exploration of different strategies and solutions, students are implicitly taught that there are multiple ways to solve mathematics problems. Engagement in these two types of activities also promotes the idea that students should understand why mathematics works, have the ability to problem solve, and be able to express their mathematical thinking. The value that stakeholders place on elementary students building number sense can be applied to both the green and the purple teaching practices, but stakeholders imply that number sense is observed more in the dialogic–like classroom because of the limiting focus on student understanding in the direct–like classroom.

Two of the stakeholders’ values about mathematics teaching and learning described a combination of the green and purple teaching practices, as seen in Figure 6-2. The first is truly a
combination of valuing the teacher–directed learning seen in the green classroom with the student–centered teaching practices seen in the purple classroom. Stakeholders expressed value in both types of teaching practices, and felt that good teaching involved a combination of students having time to practice exercises and having time to develop a conceptual understanding of mathematics problems. The second value that aligns with both teaching practices was that students should take responsibility for their own learning, with teachers playing less of a role in the classroom. This value is under the category of both teaching practices because of the different ways it manifests itself during interviews with the stakeholders. Some stakeholders (such as teachers Cleo and Mira) felt that the teacher should guide students, but not provide answers. Specifically, when students struggle, the teacher’s role is to help direct the students towards the correct solution, but not explicitly give them solutions. Other stakeholders (such as teacher Susan and parent Diana) felt that students should have a chance to explore mathematics problems with little to no teacher interjections, but that the teacher should provide answers towards the end of the lesson. On the other hand, stakeholders such as researcher Mala and parent Helen felt that students should have a chance to develop their own problem solving skills, with the teacher playing an extremely minimal role in student learning. These three manifestations of the value of student responsibility are viewed as a combination of the green and purple teaching practices because they seem to fit on a continuum that includes both types of teaching practices.

In summary, all the prevalent stakeholders’ beliefs and values related to one or the other of the observed teaching practices, even though some of their beliefs and values were relayed through conversation prior to the introduction of the green and purple classroom storyboards. They trended towards more of a connection with the purple teaching practice, but were not devoid of connections to the green teaching practice. As previously stated, it is unsurprising that the stakeholders expressed values that all related, in some way, to the observed teaching practices. Because the two teaching practices are often viewed as opposing each other, it makes sense that
the stakeholders did not express a belief or value that did not align with one or the other of the observed teaching practices.

Answering the research sub–question B regarding stakeholders’ experiences

The second sub–research question is: *What are stakeholders' experiences in mathematics classes, and how do those experiences relate to the mathematics teaching practices observed in their local elementary school?* The stakeholders expressed two prevalent experiences from their interactions with mathematics as students. They are: (1) that stakeholders reported that they had mainly experienced what is considered a traditional form of mathematics teaching, and (2) that the majority of the interviewed stakeholders (10 out of 16) reported that they had performed well in their mathematics classes. The second experience does not relate to either teaching practice, but the first experience relates directly to the green teaching practice. Stakeholders expressed their past experiences as the teacher standing at the front of the classroom, telling students how to solve problems, and then giving students time to work on practice exercises. This prevalent experience was described by 14 of the stakeholders, and almost perfectly describes the pattern of three activities used to characterize the green teaching practice. While some stakeholders did express one or two learning events that helped them understand mathematical concepts, this experience was not prevalent among the group of stakeholders. Additionally, there was not a single stakeholder who said they had experienced anything like the teaching and learning environment portrayed in the purple classroom.
Answering the research sub–question C regarding state mathematics assessments

The third and final research sub–question is: How do stakeholders’ beliefs, values, and opinions about mathematics teaching practices relate to the state mathematics assessment administered to students in their local elementary school? This question is an opportunity to connect the beliefs, values, and opinions of a local community to the larger educational community within the state and the nation, as seen in Figure 6-3. Specifically, Figure 6-3 is an adaptation of Figure 1-1, but the levels of local community have been combined into one category. This sub–question provides an opportunity to connect the inner circle to the outer circle in this representation of local and societal communities. Overwhelmingly (14 out of 16), stakeholders expressed the opinion that the Smarter Balanced mathematics assessment was valuable. Stakeholders focused on the fact that the assessment seemed to require a deeper level of thinking than previous state assessments. Many of these opinions were drawn from the mock assessments provided during the interviews, seen in Appendix D, as the Smarter Balanced assessment was to be administered for the first time during the spring following data collection for this study. At the time of the writing of this manuscript, the status of Smarter Balanced and other assessments linked to the Common Core standards is questionable as an effective form of measurement of students’ mathematical abilities (Armario, 2015, August 31).
According to NCTM (2014), the Common Core standards and related assessments focus on student understanding of mathematics content, which aligns with the stakeholders’ opinions regarding the assessment. Stakeholders’ beliefs and values trend towards a focus on student understanding of mathematics concepts, and student ability to be flexible with problem solving. These prevalent values and beliefs align with NCTM’s (2014) discussions on the focus of the Common Core standards and related assessments. The result is that, at least among this group of stakeholder participants in this educational community, stakeholders seem to have beliefs and values that align with the learning goals put forth through the Common Core State Standards for Mathematics, despite stakeholders’ description of past experiences that do not align with teaching practices that are support the same type of focus on mathematics learning.

**Discussion**

This section discusses the three most compelling findings from this study. First, the impact of a professional development program on this study is explored. Second, a tension between dialogic and direct teaching practices is examined. Third, the differences in participants’
experiences and values related to mathematics teaching and learning are discussed. The subsequent section addresses implications that arise from these three discussion topics.

Impact of the professional development on this study

The association between the elementary school and a university designed and implemented professional development program about mathematics teaching was an unexpected factor in this study. Even when I became aware of the existence of the connection between the university and the school district, it was not clear if that connection would be an influence on this study. Therefore, research on professional development did not play a large role in the literature review or the guiding framework for the dissertation study. The study was initially designed to explore a “typical” school’s mathematics teaching practices, not the mathematics teaching practices of a school being directly and currently influenced by some type of mathematics professional development. Through Phase I data collection, it became apparent that the professional development was very influential on the participating teachers’ mathematics teaching practices, as well as their beliefs, values, and opinions about mathematics teaching and learning. As a result of the inclusion of the elementary school in professional development designed to implement change in the mathematics teaching practices of the participating teachers, I was afforded the opportunity to study the culture of a community during a period of transformation.

Studying a community during a time of transformation resulted in interviews with many stakeholders who had already been engaged in reflecting about their mathematics teaching practices. This led to some reflective statements about beliefs, values, and opinions that provided insights into the minds of the stakeholders that might have been more difficult to access if the stakeholders had not spent the previous two years thinking about their mathematics teaching
practices. Additionally, the situation of change that this community was undergoing brought about some tensions between old and new mathematics teaching practices, which will be discussed later in this chapter. The tension and reflection about old and new teaching practices, induced in some way by the professional development program, constituted the major findings of this study, particularly the two prevalent mathematics teaching practices observed in Ana, Beth, and Fred’s classrooms.

The direct instruction mathematics teaching practice, seen in the green classroom, was expected as an observed teaching practice, established from previous research studies on common mathematics teaching practices. For instance, Welch’s (1978) description of a mathematics lesson is very similar to the episodes during which the green teaching practice was observed. Specifically, “a brief explanation” of the mathematical content to be practiced during the lesson, with much of class time “devoted to students worked independently […] while the teacher moved about the room to answer questions” (Welch, 1978, p. 6). The same description could be used to describe many of the instances of the green teaching practice, including the one portrayed in the green classroom. Additionally, Stigler and Hiebert’s (1997) implications that many U.S. students are not heavily involved in thoughtful mathematical work during the school day is similar to student activity during the green teaching practice. Fred comments on the lack of engagement of his students during one such lesson, saying to them “Think about how you sat in here yesterday. Were you very excited?” The students respond with a collective “no,” and Fred reinforces their answer by saying “no” as well (Fred Observation, October 14). The green teaching practice created a classroom environment that engaged students in memorizing procedures and focusing on correct answers to exercise problems, which is what multiple research findings have indicated are prevalent in elementary mathematics lessons (e.g., Gill & Boote, 2012; Goodlad, 1984; Oakes, 1985)
On the other hand, the task–centered lesson that focused on students’ engaging in generalizing and justifying, seen in the dialogic–like classroom, was not expected as an observed teaching practice. However, engagement in mathematical tasks that required a high level of cognitive demand (Stein, et al., 2000), engagement in creating justifications (McClain, 2002), and engagement in student oriented mathematical discussions that lead to a specific mathematical goal (Stein, et al., 2008) are all researched best teaching practices that were examined in the literature review of this dissertation prior to data collection. Therefore, it seems reasonable that documented best teaching practices guided the professional development efforts to improve mathematics teaching practices in this community. Furthermore, evidence in documents from the university researchers demonstrates the inclusion of some of this literature in the creation of the professional development activities.

As a result of the influence of professional development on the participants of this study, I ended up gathering data on a school community that is in the process of trying to change its mathematics teaching practices. Because of the focus on increasing the amount of dialogic–like teaching practices, participating teachers were in the midst of wrestling with how to successfully implement a new type of teaching practice in their mathematics lessons. The result was an opportunity to observe and talk with a community that was already reflecting on their mathematics teaching practices, and was trying to negotiate tensions between their old mathematics teaching practices and the ones presented through the professional development program throughout the duration of data collection.

**Tension between two types of teaching practices**

While stakeholders expressed a value for dialogic instructional methods and reported past experiences that are more traditional, or in line with direct instruction teaching methods, they also
indicated that there is a tension between their beliefs and values regarding the two types of teaching practices characterized in the green and purple classrooms. This tension arose when stakeholders discussed the differences between the teaching practices in each of the classroom storyboards, especially when stakeholders thought about assigning value to one teaching practice or the other. The tension is expressed as a result of multiple dilemmas: time constraints, amount of content required by mathematics standards, and a perception that direct instruction helps to remediate or enhance basic skills.

Mainly the teacher stakeholders express the notion that teaching practices in the dialogic–like lesson often take up a lot of time to complete, and are not always possible to use as a result of time constraints. For instance, when teacher Harriet said, “there is always that professional tug between the curriculum and the other things that I think build conceptual ideas.” Additional stakeholders mentioned the amount of mathematical content that is required to be taught during each school year, and the strain that the large amount places on teachers. Specifically, the amount of content that must be taught restricts the time that teachers can spend on each topic. Therefore, while their values might be in line with the type of teaching in the dialogic–like classroom storyboard, stakeholders, especially the teachers, feel a pressure to limit the amount of student oriented teaching practices because of limited time they have for each lesson. Further adding to this tension is the assertion from three parents and three teachers that direct instruction is often a preferred method of remediation. This means that while these stakeholders claim to prefer dialogic instruction in mathematics classes, they feel that direct instruction also needs to be utilized to help struggling students.

It is interesting to compare the assertions of the participants to the definition of dialogic instructional model. Almost every participant expresses a call for some aspect of the teaching practices observed in the direct–like classroom storyboard to supplement the teaching practices observed in the dialogic–like classroom storyboard, even though the teaching practices observed
in the dialogic–like classroom storyboard are clearly preferred in participants’ description of an ideal mathematics lesson. The aspects of the teaching practices observed in the direct–like classroom storyboard that are identified as necessary are mainly related to directed student practice, and some form of direct instruction to speed up the lesson. What is interesting is that the observed teachers, especially Beth and Fred, seem focused on the fact that dialogic teaching methods are not enough to prepare their students for the required assessments. The characterization of dialogic instruction from Munter et al. (in press) includes space for directed student practice, but does place a focus on student centered learning, which often does take more time than just telling students what to do.

This research study builds on and contributes to the findings from Munter et al. (in press) in two ways. First, the findings presented in this study demonstrate that while Munter et al. present direct and dialogic teaching practices as two opposing viewpoints, people in educational communities have the potential to see value in, and desire the use of both perspectives. Both the stakeholders and the observed teachers expressed the idea that some amount of the green teaching practice should be utilized with the purple teaching practice for an ideal mathematics learning environment. Second, when the two teaching practices are viewed through a ritual lens, each type of teaching practice could be ritualized or not ritualized, which may affect the way in which it is used in the classroom. This translates the dichotomous relationships described by Munter et al. into a more dynamic relationship, potentially like the one seen in Figure 6-4. Rather than teaching practices lying on a continuum of direct to dialogic, they can also be interpreted on a continuum of ritualized to non–ritualized. For instance, Fred’s engagement of his students in the direct–like teaching practice (seen in the green storyboard) shows evidence of ritual and direct teaching. This instance of teaching practice would lie in the upper left quadrant of the representation in Figure 6-4. However, as Munter et al. point out, the best form of direct teaching practices should be engaging for students, which may lie on the bottom left part of the diagram, if teachers are
reflective about their practices and do not allow them to become ritualized. Furthermore, dialogic teaching practices could be implemented in various ways, and may be ritualized or not depending on the teacher and the community in which they are used. For instance, the type of teaching seen in the dialogic–like purple classroom was not ritualized and would be placed in the bottom right part of the diagram. However, if students were engaged in dialogic–like lessons where they were largely performing repeatable actions and teachers were not reflecting on those actions, the lesson could be characterized as ritualized dialogic instruction.

![Diagram](image)

Figure 6-4. A two–way continuum classification system for teaching practices.

An additional aspect of ritual that the field of education researchers needs to take up is the difference between a ritual and a routine. For the purposes of this study, a routine is differentiated from a ritual by the presence of intent and meaning behind repeated actions. While both are actions that are observed frequently, a routine has intent or purpose (especially content specific purpose) behind it, whereas a ritual does not have any verbalized or obviously inferred purpose and is seemingly repeated merely because it was done before. However, this distinction
can be blurred when working with teachers and trying to infer meaning or intent behind teaching practices. Therefore, it would behoove the educational research field to further explore and define the difference between the two types of action.

**Difference between experiences and values**

There is a discrepancy in the experiences that stakeholders described regarding their own mathematics learning, and the values they expressed regarding what and how students should be engaged in learning mathematics. Fifteen stakeholders describe their past experiences in mathematics classes as fairly traditional experiences, comprised with mainly direct instructional teaching practices. This assertion is in contrast to fourteen stakeholders’ expression of value in dialogic instructional teaching practices for current students. This contradiction is interesting, in part, because of its distinction from previous research findings. Multiple beliefs studies (e.g., Nespor, 1987; Raymond, 1993) have found that past school experiences influence, and are often similar to, current beliefs regarding teaching and learning. For example, Raymond (1993) finds that past school experiences have strong influences on mathematics beliefs of teachers. However, the stakeholders in this study indicate values regarding mathematics teaching and learning that are distinctly different from their recollections of past mathematics school experiences.

One potential explanation is the professional development associated with the local school district. The professional development PI’s worked with the district for four years, and during that time many teachers came to embrace the focus on building students’ capacity for mathematical reasoning, which means it influenced their teaching in some way. Indirectly, this has influenced parents as they gather information on how their students are engaged in learning mathematics. Additionally, Leo, a principal, mentioned directly talking to some parents about the changes in mathematics teaching practices. He said, parents came to him and said their children
“don’t know how to do the [math] problems; can’t the teacher just explain?” Leo further said “the parent was looking for the old model” and that the parents’ concerns came “out of their own lack of understanding of what we were doing, [which] indicates, of course, that we’re not educating the parents well enough.” He further explained that the school hosts a “curriculum night” for parents where the teachers explain the curriculum in which students will engage throughout the school year. If the teachers and principals value this type of instruction, and they try to help parents understand the values of this type of instruction, this collective movement towards dialogic teaching methods could be a reason that educational stakeholders in this study seem to value a different type of teaching than the teaching they experienced in their own grade school mathematics classes. The teacher and parental outreach by professional development leaders is similar to Cobb and Jackson’s (2011) call for supporting a community through the process of teacher change.

Another potential explanation is that with the introduction of the Common Core State Standards for Mathematics (CCSSO, 2010), educational stakeholders are starting to adopt the notion that students’ capacities for reasoning mathematically are an important part of mathematics learning in our culture. With the introduction of the Smarter Balanced state assessment, teachers, parents, and principals have to pay more attention to building students’ conceptual understanding of mathematics content because of the increased focus of conceptual understanding on the state tests.

On the other hand, it may be a direct reflection of the study participants. Most of the stakeholders who indicate a preference for dialogic instructional teaching practices are associated with one of the local universities. This association, which often includes some form of teaching, may have provided extra professional development or a culture of a move towards concept building for students. One parent, Amelia, commented on the fact that she knows other parents who do not agree with her values regarding mathematics teaching. She reports that she knows
parents who argue that students should “just do the plug and chug numbers,” and she wants to remind those parents, “That [method] didn’t work for us. We’re all pretty math illiterate.” This is an example of parent Amelia using her past experiences to justify her value of teaching mathematics in a different way than the one in which she learned.

**Implications**

This study builds on and contributes to work in three areas of mathematics education research. First, findings from this study provide a call for us to focus our attention on teacher professional development in a new way. Second, the methodological approach presents a contribution to research methodologies used for mathematics education research. Third, this study extends and supports current research on teaching practices. These three implications for future research in the area of mathematics education are explored.

**Implications for teacher professional development**

This study changes the way we should study professional development by focusing more on stakeholders and rituals within an educational community. Ethnography “says to all investigators of human behavior, ‘Before you impose your theories on the people you study, find out how those people define the world’” (Spradley, 1980, p. 14). The major implication of this study for teacher professional development is encapsulated by this quotation from Spradley: the idea that there is value in understanding how an educational community defines its world, and specifically how they make sense of mathematics teaching practices used in their local school, before trying to alter teaching practices within the community. The findings from this research study indicate that professional development leaders should identify rituals within mathematics
teaching practices, and then understand, as much as possible, the value that community sees in each ritual.

While we know that parents and administrators need to understand and favor new mathematics teaching practices in order for successful change to occur (e.g., Heck, Weiss, Boyd, Howard, & Supovitz, 2003), little attention has been paid to rituals as a way of identifying value within an educational community. Similar to a case study, this study illustrates an exemplification of one school community as it attempts to transition into dialogic–like mathematics teaching practices. At the time of data collection, university researchers had been working with Beth and Fred for three years as part of a professional development project (Ana was engaged in district–wide professional development led by Beth, Fred, and other teacher leaders from the professional development project over the course of the year previous to data collection). The goal of the professional development was to increase the instances of dialogic–like teaching practices in their mathematics lessons. Specifically, the university researchers hoped for student–centered lessons that engaged students in generalizing and justifying mathematics content. While it is unsurprising that direct–like teaching practices were still used in some of the mathematics lessons observed, the conversations I had with all participants in the community helped to illuminate why those less desirable teaching practices were still in use; specifically, because the participants expressed value in the direct–like teaching practices as a useful tool to help students to learn mathematics.

Additionally, research has found that teachers need to have at least one positive mathematical experience in order for them to begin to accept and start utilizing new types of mathematics teaching practices (e.g., Drake, Spillane, & Hufferd-Ackles, 2001); however, this study provides additional insights into what happens as teachers start to change their mathematics teaching practices. Within the participating community, this finding about the value that participants expressed in a direct–like teaching practice has implications for the professional development program that was working with the school district. Particularly, the community
might benefit from an exploration of how to incorporate what they considered the valuable aspects of direct–like teaching practices into the more desirable dialogic–like teaching practices. Expanding this implication to other communities, a suggestion for other professional development endeavors is to begin their efforts with an attempt at understanding the culture with which they are going to work. One way of doing this is to examine the rituals within the community in an attempt to understand educational values that are held within those rituals. As Thompson (1984) writes:

> If teachers’ characteristic patterns of behavior are indeed a function of their views, beliefs, and preferences about the subject matter and its teaching, then any attempt to improve the quality of mathematics teaching must begin with an understanding of the conceptions held by the teachers and how these are related to their instructional practice (p. 106).

Furthermore, the stakeholders provide insights into the “web of supporting beliefs for myths that explain and justify the way these routines are played out” (Nuthall, 2005, p. 920). As an example, the participating community in this study expressed value in mathematics practice for students during classes, as well as value in a focus on student reasoning and conceptual understanding. Teachers in the community expressed a tension between trying to implement the teaching practices put forth by the professional development, while also trying to engage students in practice on problems, so they can succeed on assessments. The researchers describe focusing on how to help teachers utilize mathematical reasoning during their lessons. Even though most of the researchers admit there is a need for some practice during lessons, the focus of the PD is not on how to incorporate student practice into task–based lessons. While it makes sense to focus a professional development on new teaching practices because teachers already have much experience with older teaching practices, it leaves a gap for the teachers to address in their instruction. To fill this gap, teachers like Beth, Fred, and Ana refer back to their known type of teaching strategies and revert back to the ritual of direct instruction. If, however, the researchers identify the ritual of direct instruction, attempt to understand the value that the community places
in that ritual (in this case: a perceived need for students to practice mathematics problems), and collaborate with teachers about how to incorporate student practice with the mathematical reasoning tasks, a tension may be resolved as the value from the old teaching practice has been incorporated in the new teaching practice.

As a field, we need to work with teachers to learn what they value from their current practices, and work with teachers to create a vision for instruction that combines the usefulness in the ritualized teaching practices with the usefulness in the professional development leaders’ desired teaching practices. Professional development may be more useful if teachers and researchers collaborate with one another, and teachers understand that researchers are not implying that teachers should contradict their own experiences or values with regards to teaching (such as engaging students in practicing skills), but that teachers’ experiences and values are an important part of the newly introduced instructional methods. The researchers can help to make the ritualized teaching practice more useful by retaining the value of the ritual and promoting teacher reflections about how to better engage students.

Implications for research methodology

The field of mathematics education will benefit from two research methodologies used in this study. An analytical lens of ritual, and the creation of storyboards to depict teaching episodes are two relatively unexplored methodological tools from which the field of mathematics education research can benefit. A consideration of the use of these tools is described below.
Ritual as an analytical lens

The use of ritual as an analytical lens is one that provides our field with many opportunities to improve our understanding of impacting change in mathematics teaching practices. “Rituals may be perceived as carriers of cultural codes (cognitive and gestural information) that shape students’ perceptions and ways of understanding” (McLaren, 1993, p. 3). Using the concept of ritual as an analytical tool for this study allowed me to identify ritualized teaching practices within the participating community, and implored me to examine them for cultural meaning. Extracting the cultural value out of a ritual, rather than discarding the ritual as a negative aspect to formal education allows researchers the opportunity to better communicate with and work with educational communities towards the common goal of improving student learning.

For instance, Fred clearly indicates his dislike of direct instruction, and indicates his conflicting belief that direct instruction is necessary, at times, for students to be successful on formal assessments. There are two ways researchers could approach teachers in Fred’s position. One is that they could enter the community armed with new teaching practices that make no use of direct instruction, instruct teachers on how to make use of the new practices, and ignore the fact that the teachers hold some value in another type of practice. The second is that researchers could attempt to understand teachers’ beliefs and values, and help teachers incorporate their values into new practices. Reflecting on Fred’s circumstance, this second type of reaction from researchers could be to help Fred reflect on the value he sees in student practice and direct instruction, and learn ways to capitalize on that belief through using dialogic–like mathematics teaching practices. He would not have to keep doing this “boring” (his word) direct instruction and student practice just because there is some value imbedded in it, but rather he can learn ways to engage students in practice that are more meaningful and engaging.
Storyboards as an interview tool

The use of storyboards as an interview tool provides our field with a beneficial instrument as we characterize classroom episodes with the purpose of communicating those happenings to others outside of the classroom. The development and use of storyboards as a way to elicit stakeholders’ beliefs, values, and opinions regarding mathematics teaching practices was useful in that it protected the anonymity of observed teachers, presented a concise illustration of teaching practices, and was successfully interpreted as a real life classroom. Other researchers have used animations as a way of working with teachers to analyze episodes of classroom lessons, and found that teachers successfully interpreted animations as characterizing mathematics lessons (Chazan & Herbst, 2012). However, the storyboards used for this study were not created as animated videos, but rather as animated comic strips, without the comical inference that is typically attached to comic strips. The storyboard allowed for representations of classroom episodes to be portrayed to stakeholders in a way that protected the identity of the students and teachers who participated in the depicted lesson. The actual words from students and teachers could be attached to animated characters and used in the classroom representations without showing their faces. This also allowed gender, race, or any other identifying characteristics of the teacher and students to be removed from the episode so that stakeholders could focus primarily on the teaching practices.

Furthermore, the storyboards presented a concise (three page) document that was easily used in interviews without needing any technological tools during the interview. Stakeholders’ interpretations of the teaching practices were similar to the observed teachers’ intentions behind the teaching practice, as well as my intended illustration for the teaching practices, which imply that the storyboards successfully represented the observed teaching practices. While the tool of
storyboards was not validated in this study, there is evidence that they could be explored as valid methodological tools for other interviews that make use of representations of teaching episodes.

**Implications for existing research**

There are three ways in which this research extends and supports current research in mathematics education. First, the findings point to an added dimension to the dichotomy of direct and dialogic teaching practices. Second, the findings supports research that calls for examining culture as a benefit to education, rather than only as a detriment. Third, the findings extend research about how teachers interpret and make use of “reform oriented” teaching practices.

As described in the discussion part of this chapter, the findings from this study imply a new element to the dichotomy of direct and dialogic teaching practices. Using ritual as an added scale with which to characterize teaching practices provides another dimension that can be used in combination with a scale that characterizes teaching practices as direct, dialogic, or somewhere in between. A representation of this multi–dimensional scale can be seen in Figure 6-4. Teaching practices can be characterized as ritualized and direct, non–ritualized and direct, ritualized and dialogic, or non–ritualized and dialogic. The multi–dimensional characterization scheme allows for analysis of teaching practices to include additional nuances, which can help identify strengths and weaknesses within specific teaching practices.

Research such as Gill and Boote (2012) and Latour (2005) advocate for examining culture without attached value, rather than using culture as an explanation to “villainize” some aspect of teaching. Culture is frequently used as an explanation of why teachers are engaging in practices that have been proven to be not productive, but these studies call for culture to be used as a way to explore the intricacies of teaching, rather than demonize them. My research study follows in this fashion in that it examined aspects of culture without placing value on those
aspects. Specifically, the two teaching practices were identified and explored as existing teaching practices, or observed events, rather than positive or negative with respect to student learning. This type of research focus allows for a more effective discussion around improving student learning because it does not vilify teachers or an educational community. It allows a space to explore improvements to student learning without making teachers feel like they are doing something wrong.

Another well-known research finding is descriptions of teachers who believe they are successfully implementing “reform oriented” teaching practices, but are actually mainly still using traditional teaching practices (Cohen 1990; Gill & Boote, 2012). Cohen (1990) reports on the case of Mrs. Oublier, a teacher who expressed value in the importance of reform–oriented teaching practices and reported her belief that she was successfully using those types of practices. However, through observations of her teaching practices, it was determined that her teaching practices were actually still traditional in nature. Similarly, Gill and Boote (2012) report on the case of Mrs. Bryans who “appropriated some of the rhetoric and practices of problem–solving–based practice, her goals and assessment methods and most of her instructional methods were not consistent with common ideas of problem–solving mathematics” (Gill & Boote, 2012, p. 33). The findings from observations in Ana, Beth, and Fred’s classrooms are contrary to the findings about Mrs. Oublier and Mrs. Bryans in that all three teachers demonstrated successful implementation of dialogic–like teaching practices. Furthermore, Beth and Fred expressed an awareness of the tension between their use of direct teaching practices and their use of dialogic teaching practices. This implies a progressed state of awareness from the previous research findings, and a faithful implementation of researched best teaching practices.
Future research

Based on the findings and implications from this research study, there are a multiple next steps for future research. One future direction is to interview additional stakeholders in the participating community, such as parents, teachers, or administrators who are not involved in the professional development, or students within the community. Additionally, it would add a new perspective to hear from stakeholders who may have different opinions than those of the participants. For instance, some stakeholders mentioned teachers or parents within the community who did not agree with the espoused values and beliefs of the participating stakeholders. One example is parent Amelia, who said she knows parents who believe that students should “just do the plug and chug numbers.” As we already know that parents have expressed frustrations in the new ways of doing mathematics that are different than the ways they learned how to do mathematics (e.g., Civil, Diez-Palomar, Menendez, & Acosta-Iriqui, 2008; Civil, Planas, & Quintos, 2005; Ginsburg, Rashid, & English–Clarke, 2008; Westenskow, Boyer-Thurgood, & Moyer-Packenham, 2015), and it would provide additional insight into the culture of the community to add the perspective of stakeholders with this differing viewpoint of educational goals, and to examine how they make sense of the direct–like and dialogic–like teaching practices observed in their community.

Furthermore, I made a decision to not include the students of Ana, Beth, and Fred as stakeholders in the study. This decision was made through conversations with Ana, Beth, and Fred because it did not seem that students would have much to say about the teaching practices in their classrooms. However, Star, Smith, and Jensen (2008) point out that students’ opinions about reform teaching programs is often ignored and undervalued. A follow–up study with a focus on students’ values, beliefs, and opinions about the teaching practices would be provide another layer of insight into the values and beliefs of this community. Their responses may provide
information on whether or not dialogic–like teaching practices are influencing the way students think about mathematics lessons.

Additionally, the field needs to take up additional studies that examine stakeholders’ values and beliefs with regards to mathematics teaching practices. There is not enough existing information on how stakeholders impact the implementation of mathematics teaching practices, or what stakeholders think about such practices. One way of doing this is to use the characteristics of direct and dialogic teaching methods to create storyboards that can be used in stakeholder interviews. Interview questions might focus on the nuances of the two types of teaching practices so as to capture detailed distinctions made by stakeholders between the two types of teaching practices.

Another direction for future analysis of the same data is to use the ritual framework on smaller grain–size units from the classroom episodes. The current study used the analytical framework to identify whether a larger teaching practice was ritualized or not. Additional analysis could examine things like lesson warm ups or teacher and student discourse for evidence of ritual. This would be especially fruitful when examining for ritual within all the episodes of one teacher’s lessons.

Furthermore, a set of questions could be created, based on the questions used for this study as well as the categories of results, that would help educators engaging in professional development better identify and understand the educational communities’ values with respect to mathematics teaching and learning before engaging teachers in professional development activities. These questions could be developed into an observation guide that would help structure teaching observations to be efficient at identifying rituals within mathematics teaching practices.

An additional follow up research question to this study is: are educational stakeholders starting to adapt the CCSSM ideals and move away from their own experiences with regards to their values about mathematics teaching and learning? If so, how can mathematics education
researchers capitalize on this movement and provide support for an increase in the use of research–based mathematics teaching practices? While there are some findings that resulted from this study with regards to the Common Core Standards for Mathematics, a follow–up study or further analysis regarding stakeholders’ responses to interview questions about assessments would be beneficial in helping to answer the proposed future research questions.

A more minor contribution of this dissertation is the development and use of storyboards as a way of eliciting beliefs, values, and opinions from interview participants regarding teaching practices. A future direction includes validating the means by which a storyboard is created to represent a teaching episode. The ability to represent teaching episodes in a way that is non–threatening to the teachers and students within the episodes, and in a way that is accessible way to stakeholders is a valuable tool for both data collection methods as well as professional development efforts with teachers. A storyboard provides a less identifiable but still authentic alternative to a video recording of classroom episodes.

**Concluding remarks**

This study presents descriptive findings of direct–like and dialogic–like mathematics teaching practices within an educational community, and educational stakeholders’ sense making of those teaching practices. The findings provide evidence of the importance of examining values held by an educational community before attempting to change aspects, such as teaching practices, within the community. This study also demonstrates the usefulness of using the concept of ritual as a tool for better understanding culture, rather than using educational rituals as reasons for an undesirable teaching outcome. Moving forward, the field of mathematics education researchers needs to develop a more clear distinction between ritual and routine so as to allow for stronger findings regarding rituals in mathematics teaching practices. Additional studies on
ritualized mathematics teaching practices need to be conducted and used to inform future professional development endeavors. Working together with teachers, our field has the ability to create sustainable and long lasting improvements in how our students are educated in the discipline of mathematics.
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Appendix A: Teacher Interview Questions

Formal Interview #1 Questions:

1. How do you define teacher practice?
2. Are there any practices you're particularly proud of that you are using this year?
3. Are there any practices you're trying to change this year?
4. How long have you been teaching?
5. Are there any practices you think lots of other teachers are using in the school?
6. Are there any practices you remember seeing when you were a student?
7. Do you remember anything your teachers did?
8. What types of influences have made an impact on your practices?
9. Have there been any others?

Formal Interview #2 and #3 Questions:

Note: These questions were divided between two interviews, depending on interview time.

1. What makes up a rich task?
   a. Can you give me an example of multiple entry points?
   b. Can you give me an example of multiple solutions?
   c. Can you give an example of [insert any other characterization of rich task introduced by teacher]?
2. If someone walks into your classroom, what might they look for to tell whether or not students are working on a rich task?
3. How long does a lesson with a rich task usually take?
4. What do students do if they are finished with a rich task before the period is over?
5. What does more traditional math class look like?
   a. Can you provide some examples?
6. What would textbook work look like in a classroom if I walked in?

7. When do you decide to wrap up a traditional lesson? (What tells you to move on?)

8. How long does a traditional lesson generally take?

9. What do you do if a student finishes early with a traditional lesson?

10. Do rich tasks link to standards?

11. Does textbook work link to standards?
Today you’re going to do addition and subtraction of decimals. I’m going to show you some basics, give you the assignment, and then after you are done with the assignment, you can do some math games.
Alright, so what’s the rule when you’re adding decimals? What’s the thing that you have to do, to make your addition or subtraction work?

Always move the decimal on the same.

Yep, so you want to always line up your decimal points.

So the problems that I’m going to give you today, for example, are going to be written like this. Because when I look at other problems and they stack it for you, there’s no skill there.
So, the first thing you want to do, is you’re going to look at your decimals and you’re going to set it up in an algorithm. So, I’m going to line up my decimal spots.

What numbers are here?

Well, you could put zeros.

I could put zeros.
So let’s do this. We’re going to add these two together. And then you just do addition, right?

Okay, what if my number was this? So, again, I’m going to line up those decimal spots. And then you just do subtraction, right?
So addition and subtraction, it's not that hard. The biggest thing to remember is to line up your decimals and then put it in your answer down below.

So here's what I'm going to have you work on. Okay, you get to choose eight addition and eight subtraction problems.
And then you’re going to keep it today, do not turn it in, because you’re going to take it home and do ten for homework.

I need you to show your work on notebook paper or graph paper. Because when I check your work, if you’re making errors, I need to see what the problem is to help you.

Students work in silence for about 20 minutes, until the math class is over. During this time, the teacher walks around the class, and helps some students on the assigned problems.
A Day in the Purple Classroom

For today’s task, there are four bags of numbers. Choose any three numbers out of the four bags and add them together.

Now choose any three new numbers, add them together. I want you to do this three more times. So, you’re going to have five sets of numbers that you’ve added together.
After you get your five sums, I want you to start looking at the sums. What’s going on? You can talk amongst your groups, start talking.

For 10 minutes students talk in groups about what they are noticing about their sums. The teacher talks to each group individually.

Um, all of mine are thirty.

They’re all integers.

Okay, why is that?

They’re all between twenty and fifty.
Alright, let’s get some initial ideas out on the floor. We’ve got some understanding, now we need to generalize and justify why it’s happening.

They’re all multiples of three.

Yeah.

Seven plus seven plus ten is not.

Seven plus seven plus ten is twenty-four.

Okay, so hold on. We’re critiquing your reasoning. Okay, so is that a multiple of three?

Yes.

Are there any answers that you got who’s sums are not multiples of three? Have you found any counterexamples?

Thirteen plus seven plus seven.

Thirteen plus seven plus seven is twenty-seven.
Okay, so now we’re generalizing that whatever three numbers you choose out of any bucket, any bag of numbers, you’re always going to get a number or sum that is a multiple of three. Why? Now we have to understand why this is happening.

I want you to look specifically at the addends, the numbers that we’re adding together. Because there’s something special about these specific kind of addends that is going to get you where we want to go, or a justification. So talk amongst yourselves, power through and see if you can figure out what’s happening with the addends that will result in a multiple of three.
It’s three away from the other numbers.

Because there’s three numbers.

If you add two of any of those numbers you won’t get a multiple of three, but if you add three of them, you do.

For 10 minutes students talk in groups about why they think the sums are multiples of three. The teacher talks to each group individually.

So what is happening, what is so special about the addends that are in the bag? Some of you figured this out pretty rapidly. There’s a reason why these specific numbers added together will end up as a multiple of three.

They are not multiples of three.

They, by themselves are not multiples of three, true. And there’s more to it.
Well, each number is a multiple of three. So, if you take seven minus one you get six; ten minus one is nine; thirteen minus one is twelve; sixteen minus one is fifteen. So, when you’re adding the three of them together, since they’re equal to one more than a multiple of three, you’ll get three more than a multiple of three, which is a multiple of three.

Does that make sense?

Yes.
Appendix C: Stakeholder Interview Protocol

Pay attention to participant’s language to use within the interview. Ethnographic interview questions are broad, and rely heavily on the responses of participants. Follow up questions will be focused on eliciting more detail about participant’s experiences and beliefs.

Introduction:
Hi, my name is Monica. I’m working on my dissertation in math education from Penn State. I want to better understand how students learn math through their interactions with the people around them. I’m interested to know what you think about some teacher practices that are commonly used around the country to teach math.

As is stated in the consent form, this study is not an evaluation on teaching or teachers, and our conversation is confidential. It will not reflect on any teachers or students. I’m trying to better understand your beliefs, thoughts and past experiences as they relate to math teaching.

I would like this to be more of a conversation between the two of us than an interview. So if any of my questions are unclear for any reason, please feel free to ask any questions of your own. Also, I might ask you some follow-up questions, so that I can better understand your answers.

This should take 45 minutes to an hour. Is it all right if I record our conversation today? Do you have any questions before we get started?

If at any point in the interview you would like me to turn off the recording devices, please just let me know. After I begin recording, I will state the date and time, and ask you on record that you are all right with being recorded.
**Start recording device.**

**General Questions:**

1. Can you talk to me about your experience with math classes when you were in elementary school?
   a. Favorite or least favorite math classes or teacher?
   b. If not elementary, what about middle or high?
   c. Was this typical of math classes in your experience?
   d. What makes it similar to or different from a typical experience?

2. Can you talk to me about your contact or interaction that you have with the local public schools, particularly the elementary schools?
   a. How long have you been in that position?

3. What do you think children should learn from their elementary math classes?
   a. Do you think these things are important? Can you elaborate?

4. Talk to me about how teachers teach math in elementary school.
   a. Is there anything different that the teachers in Pullman do to teach math?
   b. How do you know what the teachers in Pullman do?

5. What do you think children are learning from their elementary classes in Pullman?
   a. Do you think that is important? Can you elaborate?

6. In what way do you think your own experience is similar to or different from what happens in elementary math classes today?
Example-Specific Questions:

I have a couple of storyboards of 4th or 5th grade math lessons that I’d like to show you to see what you think about them. These are compilations of teaching from a Pullman elementary school from multiple teachers, and are not meant to represent any single teacher or classroom.

The first is the Green Classroom. [Allow time to read through storyboard, provide math problem document along with the storyboard.]

1. Can you talk to me about what is happening during this lesson?
2. What kinds of things does it seem like the students are learning? [Can show potential standards list here, if needed]
   a. Do you think these things are valuable for students to learn? – In relation to what you think students should get out of their elementary math classes.
   b. Do you think this kind of teaching helps students to learn math?
      i. What kind of math are the students learning?
      ii. How do you think it helps them to learn?
      iii. OR Why do you think it impedes their learning?
3. What does it seem like the teacher is paying attention to during the lesson?
   a. Why do you think a teacher might teach this way?
4. How does this compare to what you experienced as a math student?
   a. Did you ever experience this type of learning/teaching?
   b. Can you tell me about a teacher who taught this way?
5. You talked with me before about how teachers teach elementary math in Pullman. How does that compare to what you see in this comic?

This is a mock assessment I made from practice test questions found at the Smarter Balanced and PARCC websites. Smarter Balanced is the Washington state test that students take at the end of each year in math grades 3-8, testing Common Core Math content. PARCC is the similar test bank for the east coast states. [Show Green Assessment]

If students were given this assessment, how well do you think the Green Classroom teaching methods would prepare them for the test?
**The second is the Purple Classroom.** [Allow time to read through storyboard, provide math problem document along with the storyboard.]

1. Can you talk to me about what is happening during this lesson?
2. What kinds of things does it seem like the students are learning? [Can show potential standards list here, if needed]
   a. Do you think these things are valuable for students to learn? – In relation to what you think students should get out of their elementary math classes.
   b. Do you think this kind of teaching helps students to learn math?
      i. What kind of math are the students learning?
      ii. How do you think it helps them to learn?
      iii. OR Why do you think it impedes their learning?
3. What does it seem like the teacher is paying attention to during the lesson?
   a. Why do you think a teacher might teach this way?
4. How does this compare to what you experienced as a math student?
   a. Did you ever experience this type of learning/teaching?
   b. Can you tell me about a teacher who taught this way?
5. You talked with me before about how teachers teach elementary math in Pullman. How does that compare to what you see in this comic?

**Here is a second mock assessment created from the same bank of practice questions.** [Show Purple Assessment]

If students were given this assessment, how well do you think the Purple Classroom teaching methods would prepare them for the test?
Comparison & Assessments

1. Do you see these classrooms as being the same or different?
   a. What are you seeing as some differences?
   b. What are you seeing as some similarities?
   c. Do you have a preference of one classroom over the other?

2. Do you know much about the Washington state assessments (Smarter Balance)?
   a. Which classroom cartoon would better prepare students to do well on the state assessments?

Looking at both mock assessments, and knowing that the real state test is much longer than either of these, do you think the assessment is testing something important for students to learn in elementary school?

Conclusion

- Do you have any questions that you’d like to ask me, or any last things you’d like to say before we end?
- Thank you for spending some time talking with me today. As I’m going back through our discussion, would it be all right if I contact you if I have any clarifying questions about what we talked about?
- Please feel free to contact me if you have any questions about the study in the future.
Appendix D: Mock Assessments for Stakeholder Interview

Green Mock Assessment

Source: Common Core Testing Banks: Smarter Balanced and The Partnership for Assessment of Readiness for College and Careers (PARCC)

Question 1

5.63 + 14.37 =

Question 2

What is the sum of 64.835 and 2.67?

Question 3

Use this pentagon to solve the problem.

![Pentagon diagram]

Enter the perimeter, in centimeters, of the pentagon.

Question 4

Connor is buying tickets to a concert. The concert he and his friends want to see costs $4.75 per ticket. Connor has $26.00 total.

What is the greatest number of tickets Connor can buy?

- 4
- 5
- 6
- 7
Question 5

The bed of a truck is stacked with boxes of paper. The boxes are stacked 5 boxes deep by 4 boxes high by 4 boxes across, as shown in the picture.

- When the driver is in the empty truck, the mass is 2948.35 kilograms.
- The mass of 1 box of paper is 22.5 kilograms.
- The driver delivers some of the boxes of paper at his first stop.
- The truck has to drive over a bridge on the way to the next stop.
- Trucks with a mass greater than 4700 kilograms are not allowed to drive over the bridge.

Enter the minimum number of boxes of paper the driver must deliver at the first stop to be allowed to drive over the bridge.
Purple Mock Assessment

Source: Common Core Testing Banks: Smarter Balanced and The Partnership for Assessment of Readiness for College and Careers (PARCC)

Question 1

Enter the quotient.
3125 \div 25

Question 2

Ten numbers are shown in the box.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>36</td>
<td>58</td>
<td>64</td>
<td>80</td>
</tr>
</tbody>
</table>

Which list includes all the multiples of 8 that are shown in the box?

- 8, 58, 80
- 1, 2, 4, 8
- 8, 24, 64, 80
- 1, 8, 24, 64, 80

Question 3

Decide whether each number is a multiple of 6, a factor of 6, or neither. Each number may be matched to more than one description. Click in the table to respond.
Question 4

An input-output table is shown. The numbers in the output column are produced by applying the same rule to each number in the input column. Enter values to complete the table.

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Question 5

The two-eyed space creatures, the three-eyed space creatures, and four-eyed space creatures are having a contest to create a group with 24 total eyes.

How many two-eyed space creatures are needed to make a group with 24 total eyes? How many three-eyed space creatures are needed to make a group with 24 total eyes? How many four-eyed space creatures are needed to make a group with 24 total eyes? Somebody told the five-eyed space creatures that they could not join the contest. Explain why five-eyed space creatures cannot make a group with 24 eyes.
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Selected Publications


Selected Presentations
