“Collectively We’re Stronger Than We Are as Individuals”: Understanding the Development of Inquiry-Oriented Communities of Mathematics Teachers

Hannah Jane Nieman

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Reading Committee:
Kara Jackson, Chair
Elham Kazemi
Mark Windschitl
Julia Aguirre

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Abstract

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Hannah Jane Nieman

Chair of the Supervisory Committee:
Dr. Kara Jackson
College of Education

Students' engagement in meaningful, rigorous mathematical work and seeing themselves as mathematics learners with power and agency requires that teachers have the support of colleagues in a robust, generative *community.* While we have examples of such communities, we know little about how they form and the role of professional learning facilitators and school administrators in fostering and sustaining them.

As a principal contribution of this dissertation, I build on a rich body of work related to teacher community and teacher learning to put forth a framework for subject-specific groups of educators in schools, what I call *inquiry-oriented professional community*. An inquiry-oriented professional community of mathematics educators engages in ongoing exploration together in relation to, for example, community members' instructional practice, students' mathematical thinking, and underlying discourses about who is capable of engaging in rigorous mathematical activity. Community members open up authentic problems of practice for the group to wrestle with, making often personal ideas and concepts public so they are open for clarification, disagreement, refinement, and, perhaps eventually, some consensus. At the heart of inquiry-oriented professional community is the aim of shifting and shaping accepted ways of teaching.

I make use of this framework in three analyses, which together contribute to the field's understanding of how these communities form and their leadership and facilitation. In Chapter 2, I examined 42 studies of eight inquiry-oriented professional communities of mathematics educators to understand the features and role of leaders supporting the development of such communities. The findings from this review highlight the foci of inquiry, aspects of vision, routine structures, normative practices, and leadership tasks that might contribute to the development and sustainment of robust, generative communities. I also illuminate a number of gaps in the literature, including an explicit focus on the role of school leaders and the experiences of teachers in such communities.

In Chapter 3, I report on a qualitative case study of the practice of the principal and two instructional coaches at Forest Middle School as they worked to develop inquiry-oriented professional community among the mathematics department. The findings implicate a set of considerations for the practice of other leaders supporting inquiry-oriented professional communities and illuminate the critical role of the school administrator.

In Chapter 4, I report on a qualitative case study of the Forest Middle School mathematics department's work in relation to tensions that emerged as two novice teachers in the department worked to enact their commitments in practice. Specifically, I identified routine structures and discourse practices that appeared to support the two teachers to both surface and navigate tensions. The findings of this study shed light on facilitation and leadership in support of a community's generative learning.

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… and no thanks at all to COVID-19.

DEDICATION

To Calla. May you stay curious.

CHAPTER 1. INTRODUCTION

Supporting students to engage in rigorous mathematical activity and to see themselves as mathematics learners with power and agency is challenging work. Teachers must surface and challenge discourses about what it means to do mathematics (e.g., Gutiérrez, 2012; Horn, 2007), what it means to teach mathematics (e.g., DiME, 2007; Munter, 2014), and who is capable of rigorous mathematical activity (e.g., Jackson, Gibbons, & Sharpe, 2017; Nazemi, 2017). They must also deepen their own mathematical knowledge for teaching (e.g., Hill, Ball, & Schilling, 2008; Shulman, 1986) and develop forms of teaching practice that build on students' thinking and experiences (e.g., Aguirre, Mayfield-Ingram, & Martin, 2013; Franke, Kazemi, & Battey, 2007; Wilson, Nazemi, Jackson, & Wilhelm, 2019). At the same time, teachers must be able to adapt their practice to support the individual students in their classrooms to thrive – particularly those from communities historically marginalized in and oppressed by mathematics and schooling (e.g., Gutiérrez, 2002; Joseph, Hailu, & Matthews, 2019).

This highly complex and challenging work requires the support of colleagues in *community* (Franke, Carpenter, Levi, & Fennema, 2001; Little, 2002; McLaughlin & Talbert, 2001; Nasir, Cabana, Shreve, Woodbury, & Louie, 2014). Participating in a community, in turn, requires that colleagues remain committed to one another's students and to one another's learning and development (e.g., Grossman, Wineburg, & Woolworth, 2001). In robust communities that support teachers' and students' learning and wellbeing, colleagues help each other actively recognize assumptions that might otherwise remain tacit and press one another to question and explore ideas and their implications (e.g., Horn, 2007). Teachers lay bare their practice and the dilemmas that have arisen in their teaching experience in order to explore and

investigate them with one another (e.g., Jaworski, 2006; Little, 2003). As Little (2003) has described, colleagues in such communities

> …collectively question ineffective teaching routines, examine new conceptions of teaching and learning, find generative means to acknowledge and respond to difference and conflict, and engage actively in supporting one another's professional growth. (p. 914)

Building on a rich body of literature on teacher communities, I will describe in the chapters that follow communities displaying these characteristics, which I call *inquiry-oriented professional communities.*

Robust examples can be found in the literature, pairing mathematics teachers who work together in inquiry-oriented professional communities with evidence of powerful changes in practice. For example, studies of the mathematics department at Railside High School have provided images of teachers engaging in authentic, collective inquiry into instructional practice oriented toward ambitious and equitable learning aims for students, accompanied by compelling evidence that students' learning and sense of themselves as mathematics learners improved (Boaler, 2002; Boaler & Staples, 2008; Nasir et al., 2014).

While the field has specified characteristics of productive communities (e.g., Kruse, Louis, & Bryk, 1995) and provided existence proofs of communities that result in meaningful learning for students and teachers (e.g., Railside, as cited above), little is known about how such communities develop. It is critical that we explore and take note of the processes and structures through which inquiry-oriented communities take root and flourish. A central aim of this dissertation is to contribute to the field's knowledge base regarding how these robust communities for generative learning are developed and sustained.

Developing an inquiry-oriented professional community requires more than teachers' will and agency; it requires changes in the organization of schooling (Bannister, 2018; Gutiérrez,

2000) and attention to the institutional context of the community (Cobb, McClain, de Silva Lamberg, & Dean, 2003). Research indicates that school administrators (e.g., principals and vice principals) and professional learning facilitators (e.g., instructional coaches) play an essential role in shaping schools to support community among subject-specific groups of teachers (e.g., Gutiérrez, 1998; Horn, Kane, & Garner, 2018). School administrators, for example, hold in their purview the structure of the workday and communication of expectations to teachers, both of which matter significantly for a community's work (Halverson, 2003). Professional learning facilitators likewise play a critical role in fostering the conditions for meaningful community to form (Andrews-Larson, Wilson, & Larbi-Cherif, 2017). For example, facilitators can foster a group culture conducive to inquiry, one in which group members feel safe enough to be vulnerable with their practice and press on each other's ideas (cf. Lefstein et al., 2019). A second central aim of this dissertation is to contribute to the field's knowledge base regarding the role of leaders in the work of supporting inquiry-oriented professional communities.

Forest Middle School as a Site for Empirical Study

"A common thread [connecting my experiences with colleagues at Forest Middle School] is this idea that collectively we're stronger than we are as individuals … and that really means a lot to me, this idea that every person has something they can contribute, and that collectively our wisdom is so much more, our knowledge and our capability is so much more than it would be as individuals. That means a lot to me as a teacher."

Bea, sixth grade mathematics teacher at Forest Middle School

I empirically investigated the development and leadership of a community by studying a specific mathematics department. I purposefully (Patton, 2003) selected the Forest mathematics department for this study as a case of teachers, school leaders, and professional learning facilitators working intentionally to develop the kind of community described above. They were working to *improve teaching* together (Lampert, 2001) and, as Bea suggests above, coming to

see each other as indispensable on the journey. The principal, Jack, and instructional coaches Patty and Ada were developing and facilitating a rich set of experiences for the mathematics department at Forest, all organized toward the development of an inquiry-oriented professional community. The Forest leaders' aims for the mathematics department and their intentional work to design and enact a connected and rich set of professional learning experiences make the Forest mathematics department an especially rich case in which to explore how inquiry-oriented professional communities might be developed and supported.

These leaders aimed for the department to see the immense value and even necessity of collective work with colleagues. They also aimed for the department to make their practice public and available for inquiry, an approach they termed "open doors" (Ada, fall interview). Toward this end, they intentionally employed a school-based professional learning model called Math Labs (e.g., Kazemi et al., 2018), which involved structured time to work in classrooms together and to discuss representations of teachers' and leaders' own practice. The three leaders also intended for the department to emphasize *inquiry* in its work. They provided opportunities for teachers and leaders to engage in inquiry into instructional practice, and they aimed for the department to develop a stance of curiosity toward both their practice and students' learning and experiences. Crucially, they aimed to uphold this inquiry stance across role groups. That is, teachers were not the only ones engaging in inquiry at Forest. Leaders explicitly named themselves "co-learners," leaders who were "learning together" with the department (Ada, fall interview). Foundational to this entire undertaking was leaders' shared and deep commitment to their students' learning and students' sense of themselves as mathematicians.

While I do intend in my investigation of the mathematics department and leaders at Forest to suggest an image of hope, I have nonetheless made concerted effort in my writing to

articulate the nuance and complexity of the situation. Immense challenges continue at Forest, not only in the work of the mathematics department and in teachers' classrooms but also in the school generally. However, as I point out later in this dissertation, facing certain kinds of enduring challenges is, in part, what it means to be a community that cultivates meaningful learning and growth. Uncertainty, questioning, and a myriad of other tensions are inherent in the work of teaching and learning in authentic ways that confront and disrupt the status quo.

Roadmap of the Dissertation

As noted above, the overarching goal of this dissertation is to contribute to the field's knowledge base regarding how such robust communities for generative learning are developed and sustained, with a particular focus on the role of school leaders. This dissertation is comprised of three parts, each of them a paper in itself: a systematic literature review and two empirical studies of the mathematics department at Forest Middle School. While the three papers have different foci, each of them attends to the role and practice of school leaders as an essential aspect of the development and sustainability of communities.

In Chapter 2, I review the literature regarding what is known about robust, generative communities of mathematics educators, especially the content of their work, how they are established and sustained, and the role facilitators and school administrators play in the work of such communities. I also propose and make use of a framework for discipline-specific communities – *inquiry oriented professional community.*

In Chapters 3 and 4, I report on empirical analyses of the developing inquiry-oriented professional community among the mathematics department at Forest Middle School. Chapter 3 explores the work of school leaders in supporting the community's development; Chapter 4 explores teachers' experiences of tension and the responses to tension that appeared generative in

terms of the community's development and teachers' learning and growth. In Chapter 5, I discuss connections and themes across the three papers.

CHAPTER 2. A REVIEW OF THE LITERATURE ON INQUIRY-ORIENTED COMMUNITIES OF MATHEMATICS EDUCATORS

There is immense possibility in teachers' work together in subject-specific communities. Studies have suggested that such work can support teachers to hone and develop meaningful instructional practice (e.g., Wilson & Berne, 1999), support the learning and wellbeing of students historically marginalized by schooling (e.g., Langer, 2000; McLaughlin & Talbert, 2001), and feel inspired and cared for in their work (e.g., Datnow & Park, 2019). In recent decades, there has been widespread reform in schools to structure time in the school day for teachers to work with their colleagues in subject-specific groups (i.e., in departments). However, structuring such time is not a panacea. Horn, Kane, and Garner's (2018) analyses of teachers' collaborative time in the Middle School Mathematics and the Institutional Study of Teaching (MIST) offer a prime illustration. In their partner districts, which had invested heavily in building time into the school day for teachers' work together, "effective teacher collaboration that had the potential to support teachers' development of ambitious and equitable instructional practices happened relatively infrequently" (p. 94).

In light of this variability, researchers and practitioners alike have argued that, while time to collaborate is critical, it is not just time that makes a generative community of educators (cf. Bannister, 2018; Horn, Kane, & Garner, 2018). In authentic communities, educators are interdependent, participating together in discussion and decision-making, and engage in practices that both shape their community and are shaped by it (Bellah, 1985). In the most generative of communities, educators engage in meaningful ways with content and each other and feel nurtured and cared for in their work. The development of such communities requires particular conditions and intentional effort on the part of stakeholders (e.g., Westheimer, 1999).

A growing body of literature documents the characteristics that matter in schools and departments to benefit teachers' instructional practice and students' learning, including a shared commitment to students and their communities, the development of productive norms for collaborative work, and collective inquiry into instructional practice and long-standing assumptions about teaching and learning (e.g., Cochran-Smith & Lytle, 2009; Grossman, Wineburg, & Woolworth, 2001; Jaworski, 2006; Kruse, Louis, & Bryk, 1995; Little, 2003). We also have examples of mathematics communities that embody these characteristics. For example, studies of the mathematics department at "Railside High School" provide powerful images of teachers engaging in authentic, collective inquiry into instructional practice oriented toward ambitious and equitable learning aims for students, accompanied by compelling evidence that students' learning and senses of themselves as mathematics learners improved (e.g., Boaler, 2002; Nasir, et al., 2014).

However, very few of the studies of powerful communities like that at Railside explicitly explore how the communities were established, sustained, facilitated, or supported by school leadership (for exceptions, see: Dooner, Mandzuk, & Clifton, 2008; Halverson, 2003; Westheimer, 1999). This is critical knowledge at this time and place in the U.S., given the widespread structuring of time in the school day for educators to work together. We need to be able to answer questions such as: What conditions are necessary outside of and during collaborative time, in order for a community to develop that "nourishe[s] and support[s]" teachers in their work and results in meaningful learning experiences for students (Nasir & Louie, 2014, p. 199)? What conditions are necessary to sustain it? What role do facilitators (i.e., district-supported professional development facilitators, instructional coaches) and school administrators (i.e., principals, assistant principals) need to play to support such a community?

Building time into the school day for teachers' collaboration is critical and opens huge possibility for progress, but we need to know how to do this well to support teachers and students alike to thrive in schools.

Review Approach and Research Questions

In this paper, I first propose a framework for school-based, subject-specific teams of educators working to transform their instructional practice by engaging in collective inquiry into their practice and into long-standing assumptions about teaching and learning. To do so, I drew from a range of studies of teacher communities and the professional learning of subject-specific groups of teachers. Building on a rich history of work, I call these communities *inquiry oriented professional communities.*

Against this framework, I gathered literature on *mathematics*-specific communities. Although there is much to be learned by looking at the development and support of communities across subject areas, narrowing to mathematics allows me to generate a rich description of the focus of the communities' inquiry, as it relates to a vision of mathematics teaching and learning. Further, mathematics reform efforts have required significant shifts in teachers' visions and practice and provide a particularly rich opportunity through which to understand communities working to shape and change the status quo.

While little research examines how robust school-based subject-specific communities are established or the role *leaders* play in supporting them, a more substantial body of work explores *teachers'* work in such communities. I examine this body of work to see what insight can be derived. The studies of mathematics teacher communities reviewed here vary across important dimensions: some involve communities engaged in structured professional development while others involve communities as they engage in their day-to-day work together; some involve

communities that are new to working together while others involve communities that have worked together for many years; some involve direct participation from a school administrator, while studies of others include no mention of administration. Thus, the themes identified in this review are likely to be worth considering for the research and practice of communities across a range of forms and years working together. I asked the following questions:

1. What do we learn about the focus of the communities' work, especially productive lines of inquiry?
2. What do we learn about how inquiry-oriented professional communities are established and sustained?
3. What do we learn about the role of professional learning facilitators and school administrators in supporting inquiry-oriented professional community?

In what follows, I first describe the criteria and process guiding the selection of literature I consider in this review. I then describe my methods for selecting inquiry-oriented professional communities of mathematics educators for review and analyzing the literature, and I describe the context of each of the communities. In three parts, I detail my findings in relation to each of the research questions guiding my review. In the final sections of the paper, I discuss the implications of the review's findings for the development and research of communities, and I highlight areas where more empirical work is needed.

Inquiry-Oriented Professional Community

Community is a powerful entity when it orients collective work in schools. Our communities include those people with whom we feel most connected, sharing values and mutual respect. Bellah and colleagues (1985) define community as "a group of people who are socially interdependent, who participate together in discussion and decision-making, and who

share certain practices that both define the community and are nurtured by it" (p. 133). In contrast to *collaboration* which can involve collective work in a particular moment in time, *community* suggests collective work as a part of ongoing relationships and sustained improvement efforts (Robutti, Cusi, Clark-Wilson, Jaworski, Chapman, Esteley, Goos, Isoda, & Joubert, 2016). Further, community promises space for teachers and leaders to be "nourished and supported" in the difficult work of supporting meaningful aims for students (Nasir et al., 2014, p. 199). In community, individuals are seen as whole people and are cared for, known, and respected (Santoro, 2018). The fact that the word "community" has become prevalent in the field of education speaks to how compelling this idea is in relation to the work of teachers and leaders. Teachers want to feel connected to colleagues and a part of a larger effort to support students; districts want to promote cohesive, sustained efforts among schools toward students' learning.

The word community has been applied to a wide range of collective work, including authentic communities in which educators in fact are, as Bellah describes, interdependent, in which they participate together in discussion and decision-making, and engage in practices that both shape their community and are shaped by it. At the same time, with the rise of policies mandating that teachers engage in collective work, the word "community" has also increasingly come to describe spaces in which teachers gather and perhaps engage collectively in some ways but do not fundamentally shape their practice.

Characteristics of a Robust Professional Community

I draw on the concept of professional community as specified in a set of studies by Kruse, Louis, Bryk, Marks, and their colleagues of teachers' collective work in Chicago schools (e.g., Kruse, Louis, & Bryk, 1995; Louis & Marks, 1998). Their work is grounded in the long history of scholarship integrating community with professionalism, in which the term "professional

community" signals distinct community sharing standards particular to the profession at hand (e.g., Goode, 1957). Professional communities of educators are centered on student learning and a shared set of norms and values. The authors specify that such communities also feature collaboration, deprivatized practice, and reflective dialogue. While these five characteristics of professional communities were identified in the context of school-wide professional community (i.e., community among teaching staff), a robust body of literature suggests that they are likewise critical for work within departments. In the rest of this section, I briefly review the literature on teachers' learning in their departments in relation to *collaboration*, *deprivatized practice, reflective dialogue, shared norms and values,* and *a collective focus on student learning.*

Collaboration involves working together to produce materials and new approaches to teaching. Within subject-specific groups, meaningful collaborative processes can involve, for example, planning instructional activities (Lampert & Graziani, 2009), analyzing students' work (Kazemi & Franke, 2004), or making key decisions about curriculum and instruction (Datnow & Park, 2019). Whether this kind of collaboration succeeds depends in part on community members seeing value in collective work with their colleagues (Hargreaves, 1994) in light of the fact that "the collective's knowledge exceeds that of any individual" (Grossman, Wineburg, & Woolworth, 2001, p. 45).

When community members *deprivatize their practice*, they open their classrooms to their colleagues, allowing colleagues to see aspects of their everyday work by sharing representations of their own practice. These representations are the center of *reflective dialogue*, critical discussions of teaching and learning. Representations of practice can include accounts of teaching such as verbal "replays" of what happened in a given lesson (Horn, 2010), artifacts of student work (Kazemi & Franke, 2004), lesson plans (Ball & Cohen, 1999; Lampert, 2001),

video-recordings of teaching (van Es & Sherin, 2008), or data about students' experiences of aspects of a lesson (Jackson, Nieman, Kochmanski, Campos, & DiGiacomo, 2019). For example, a group of Algebra teachers at East High School (called Railside elsewhere), had developed ways of engaging in dialogue together to paint a rich picture of classroom interaction. These "replays" of what happened in the lesson provided the group with opportunity to engage in critical discussions of teaching and, as described in more detail below, of narratives about students' abilities (Horn, 2007).

Literature on professional learning among subject-specific groups has documented structures for deprivatizing practice that involve planning a lesson with one or more colleagues, observing or co-enacting a lesson, and debriefing the lesson afterward (e.g., cognitive coaching: West & Staub, 2003; Lesson Study: Fernandez, 2002; Math Labs: Kazemi et al., 2018; Studio: Teachers Development Group, 2010). Studies of opportunities for teachers' learning within these structures has shown immense potential for teachers to engage in pedagogical reasoning with colleagues in spaces where practice is made public. For example, Gibbons and colleagues (in press) document a classroom visit in a Math Lab, involving three fifth grade teachers, the school principal, the school-based mathematics instructional coach, and a university mathematics teacher educator. In this visit, the group paused instruction in the moment of teaching and "grappled with whether to press [a student] to explain his equation or elicit additional equations," allowing them to reason about when to press students to explain their thinking and when to elicit additional ideas from other students.

Professional communities *share norms and values* related to students, teaching, and learning. Literature suggests that generative norms among subject-specific communities include, for example, established trust and care for each other as humans (Sztajn, White, Hackenburg, &

Allexsaht-Snider, 2007); an orientation toward one another's wisdom and knowledge (e.g., Edwards, 2010; Grossman et al., 2001; Little, 2002); and a stance toward the work of teaching as involving ongoing learning (e.g., Little, 2002). Critical among teachers' shared values is a *collective focus on student learning.* The most effective department work interconnects content, instruction, and students, making available for discussion each of these vertices of what has been called the "instructional triangle" or "teaching triad" (e.g., Cohen & Ball, 1999; Jaworski, 1994).

We know professional communities matter for meaningful work among educators in schools, and Kruse and colleagues offer a robust image of their characteristics. However, these characteristics could potentially describe communities which advance modal, even harmful ideas about teaching and learning. When a department is aiming to transform practice and challenge longstanding assumptions about teaching, learning, and the discipline itself, attending to the *nature* of the community's work is crucial.

As in any community, professional communities of educators can reinforce harmful ideas and ways of working (Wenger, 1998). Despite best intentions among teachers, an authentic focus on student learning poses a challenge in many department communities, given entrenched ways of talking about students' capabilities reified in aspects of the systems that surround schools (e.g., Jackson, Gibbons, & Sharpe, 2017; Talbert & McLaughlin, 1994). For example, categories emerging in the way teachers are asked to classify students according to performance on state assessments can lead teacher groups to devote less focus to the learning of particular students, often further marginalizing students from communities historically marginalized by schooling (Horn, 2016). As another example, in Wilson, Sztajn, Edgington, Webb, and Myers's (2017) documentation of an elementary school staff engaged in professional development together to learn how children develop an understanding of fractions (i.e., an equipartitioning learning

trajectory from Confrey, 2012). The professional development was designed to support educators' careful attention to the details of students' mathematical thinking alongside research on trajectories of students' learning. The teaching staff collaborated to make sense of their students' mathematical thinking on equipartitioning tasks, with students' work at the center of their conversations. Wilson and colleagues found that harmful narratives about the abilities of students were perpetuated (and even further reified) over the course of the professional development, and they conjecture that this was, in part, because the group had not established more critical ways of engaging in conversation together. This case highlights the importance of maintaining a critical stance in the group's discussions, and a focus on inquiry at the heart of what the professional community does. Jaworski (e.g., 2006) is especially helpful in having theorized the importance of inquiry both as a way of interacting together and as an ongoing stance in communities of teachers.

A Focus on Inquiry in Community

Jaworski's (2004, 2006, 2008) specification of *inquiry community* assumes that to both challenge the status quo and ask critical questions about what it is achieving are essential to the work of teaching. In an inquiry community, members surface deep-seated ideas and, rather than accepting them at face-value, "explore what else is possible" through their collective work (Jaworski, 2008, p. 313). *Inquiry*, in such a community, consists of "a willingness to wonder, to ask questions, and to seek to understand by collaborating with others in the attempt to make answers to them" (Wells, 1999, as cited in Jaworski, 2006, p. 200). This concept offers immense purchase in the context of mathematics departments working to surface and challenge normative ideas about what it means to do mathematics (e.g., Gutiérrez, 2012; Horn, 2007), what it means to teach mathematics (e.g., DiME, 2007; Munter, 2014), and who is capable of rigorous

mathematical activity (e.g., Jackson, Gibbons, & Sharpe, 2017; Nazemi, 2017). Especially when equity and justice orient teachers' aims for their instructional practice, ongoing inquiry proves crucial (Wager, 2014).

Central to an inquiry community is *critical* alignment with the teaching profession. In any community of practice, a key process involves individuals' alignment with the conditions or characteristics of the practice (Lave & Wenger, 1991; Wenger, 1998). Jaworski argued that, while conforming alignment can perpetuate harmful ideas and practices, "… if we bring a critical attitude to alignment – that is if we question, we explore, we seek alternatives while engaging – then we have possibilities to develop and change the normal states" (Jaworski, 2008, p. 315).

Also central to Jaworski's conception is that engaging in inquiry as a practice leads to "inquiry as a way of being" (Jaworski, 2004, p. 27). That is, the sustained work of collectively wondering, asking questions, and seeking answers leads to an orientation toward or *stance* of curiosity. Cochran-Smith and Lytle (2009) describe an inquiry stance as "a worldview, a critical habit of mind, a dynamic and fluid way of knowing and being in the world of educational practice that carries across professional careers and educational settings" (p. 120). Inquiry as a *way of being* or *stance* lives beyond any particular professional development session the community engages in and moves with individuals throughout their professional lives. When a community has developed inquiry as a way of being, everyone in the community, including teachers, school leaders, and researchers, views themselves as learners about and from each other and each other's practice. A "spirit of mutual inquiry" transcends title, role, and status (Jaworski, 2006, p. 205).

As depicted in Figure 2.1, an *inquiry-oriented professional community* brings together conceptions of professional community and inquiry community. It is characterized by the

features of professional community, namely collaboration, deprivatized practice, reflective dialogue, shared norms and values, and a focus on student learning (Kruse, Louis, & Bryk, 1995). Further, an inquiry-oriented professional community engages in ongoing inquiry together in relation to, for example, their instructional practice, students' mathematical thinking, and underlying narratives about who is capable of engaging in rigorous mathematical activity. Inquiry is both a *tool* the community uses in its work together and a *stance* it maintains. It is worth noting that Figure 2.1 is meant to indicate that in an inquiry-oriented professional community, each of these characteristics is linked to each of the other. It is not meant to suggest the order in which a community might develop these characteristics, or which characteristics depend on others. I return to this point in the concluding chapter of this dissertation.

Inquiry-oriented professional community stands in direct contrast to what Grossman, Wineburg, and Woolworth (2001) describe as *pseudocommunity*:

> The imperative of pseudocommunity is to "behave as if we all agree." An interactional congeniality is maintained by a surface friendliness, hyper-vigilant never to intrude on issues of personal space. The maintenance of pseudocommunity pivots on the suppression of conflict. Groups regulate face-to-face interactions with the tacit understanding that it is against the rules to challenge others or press too hard for clarification. This understanding paves the way for the illusion of consensus. (p. 955)

By contrast, in an inquiry-oriented professional community, vulnerability proves essential as individuals open up authentic problems of practice for the group to wrestle with and engage together. Community members make specific ideas and concepts public so they become open to clarification, contradiction, refinement, and, perhaps eventually, some consensus. At the heart of inquiry-oriented professional community is the aim "of challenging the status quo, of questioning accepted ways of being and doing" (Goodchild, Fuglestad, & Jaworski, 2003, p. 396). Where pseudocommunity depends on the suppression of challenging and pressing on ideas, inquiry-oriented professional community depends on the presence of it.

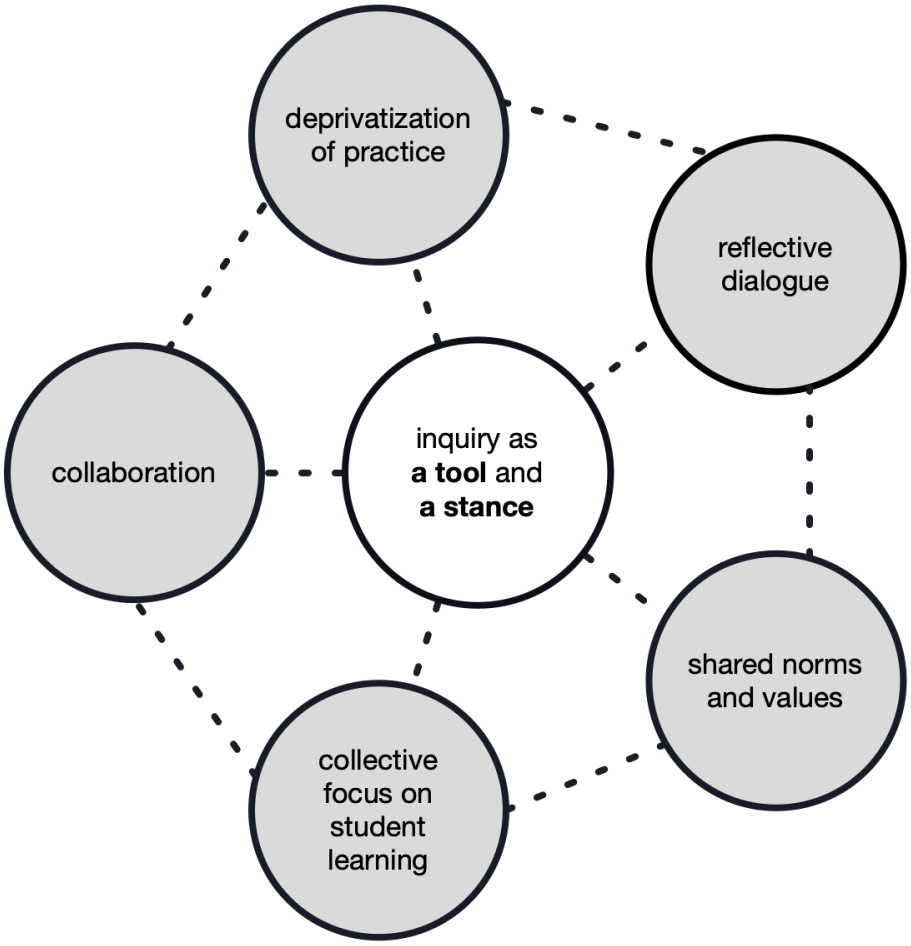

Figure 2.1. Inquiry-oriented professional community, building on the characteristics of professional community specified by Kruse, Louis, & Bryk (1995) and centered on inquiry (Jaworski, 2006)

Selecting Inquiry-Oriented Professional Communities for Review

Selection Criteria and Process

I use this conception of inquiry-oriented professional community to guide my selection and investigation of the literature on communities. In particular, I examine studies of school-based inquiry-oriented professional communities of mathematics educators within the United States. The restriction to the United States takes into account the body of literature detailing the particular challenges of supporting teachers' collaboration and forming sustained communities in

the United States context (e.g., Lortie, 1975; Little, 1987). As described above, I focus on communities of mathematics educators, first, because it allows me to make sense of the work of communities in light of a particular vision of teaching and learning and second, because reform efforts in mathematics have required significant changes for teachers' vision and practice.

The unit of analysis in this review is the *community.* In relation to my search for literature, this meant that I gathered "sets" of literature analyzing the same context. I aimed to identify scholarship about groups of educators in the same school focused on issues of mathematics teaching and learning (e.g., a middle or high school mathematics department working to improve instruction; a team of kindergarten teachers working to improve their mathematics instruction), and with the characteristics of inquiry-oriented professional community described above. For inclusion in this review, literature had to provide some insight into the work of such a community. Most studies were empirical (articles, book chapters, or theses); nonempirical studies were included when they detailed the educators' work, providing insight into the content of the work or development of the community. In the rest of this section, I describe my search and selection process in more detail.

Because there is wide variation in language used to describe school-based discipline-specific groups of teachers working collectively on issues of teaching and learning (cf. Levine, 2010; Vangrieken, Dochy, Raes, & Kyndt, 2015), I cast a wide net in my search for literature in order to encompass groups of teachers conceptualized by these varying terms. In a first pass, I sought candidates for communities from articles included in relevant reviews (e.g., Bannister, 2018; Borko, 2004; Jaworski et al., 2017; Lefstein, Louie, Segal, & Becher, 2019; Levine, 2010; Vangrieken, Dochy, Raes, & Kyndt, 2015; Robutti et al., 2016; Vescio, Ross, & Adams, 2008). My initial inclusion of candidate communities depended on three criteria: (1) the group was

focused on issues of mathematics teaching and learning; (2) the group was school-based; and (3) studies of the group provided description of the community's work together.

As an example, I excluded the studies of schools in the Washington Park school district by Cobb, McClain, and their colleagues (e.g., Cobb, McClain, de Silva Lamberg, & Dean, 2003) on the basis of criteria (2) and (3) above. These analyses focused on a pull-out professional development model involving teachers from the three middle schools in the district. While there may have been school-based work among teachers at the same middle schools, the analyses at hand detailed cross-school interactions rather than in-school ones. Cobb, McClain, and colleagues (2003) argued that the group of teachers under study had after 18 months of work together developed characteristics of a robust, inquiry-oriented professional community. However, because the focus of this paper is on school-based communities, I excluded this set of studies from review.

As a part of my search, I read and summarized the literature, including citation information, the main points of the article, an overview of the research design and methods, details about the research site and context, key findings, and limitations noted by the author(s). Because I was interested in "sets" of literature analyzing the same context, I made note of references to other studies of the same group and added them to the list to review for that context.

As my aim in this review is to understand the development of *inquiry-oriented professional communities*, I narrowed the set of contexts to only those that exhibited efforts to deprivatize practice, collaborate, engage in reflective dialogue, develop shared norms and values, focus on students learning, and develop a focus on and stance toward inquiry in their work together (see Figure 2.1). To accomplish this, I created a data display for each of the prospective

communities. As I read and summarized literature related to the community, I asked the questions detailed in Table 2.1, and made note of any evidence found in that study.

Table 2.1. Selection criteria for focal school-based communities of mathematics educators (all questions adapted from Kruse, Louis, & Bryk, 1995 unless otherwise noted). Communities were selected for this review if I could answer "yes" and detail evidence for each of the seven aspects.

Aspect of inquiry-oriented professional community	Questions asked of the body of literature about each community
Collaboration	Is there evidence that the community worked together for particular aims, for example (a) improving student learning; (b) improving their professional role in the school; (c) learning to use new resources; (d) creating a professional network; or (e) discussing institutional reforms and demands related to curriculum or evaluation?
Deprivatization of practice	Is there evidence that community members shared and discussed their representations of their teaching practice with others?
Reflective dialogue	Is there evidence that the community engaged in critical discussions together?
Shared norms and values	Is there evidence that the community worked to affirm common commitments regarding at least one educational issue?
Focus on student learning	Is there evidence that the community worked to focus on student learning? Is there evidence that the community worked to cultivate and maintain an assumption that all students can learn at reasonably high levels and teachers can help them?
Inquiry as a tool[1]	Is there evidence that the community was engaging in inquiry (e.g., in relation to their practice, student work, students' thinking, narratives about students)? That is, do we see community members collectively wondering, asking questions, and seeking to understand?
Inquiry as a way of being[1]	Is there evidence that the community was aiming toward an ongoing stance of curiosity among community members?

[1] Code and definition from Jaworski (2006)

Unless there was clear evidence that a community *was not* working toward all seven characteristics of inquiry-oriented professional community, I did not exclude a candidate community from the review until I had read and summarized all relevant pieces about the context. It was critical to review the entire set of pieces about a community before making the decision to exclude a piece, because evidence of the characteristics of inquiry-oriented professional community was often distributed across the set of literature. One piece may provide evidence of deprivatization of practice, for example, and another of reflective dialogue.

To ensure I had a complete set of pieces about a particular community, I conducted search queries with the school's or group's pseudonym, looked to authors' curriculum vitae who had conducted studies of the community, and in some cases reached out to authors directly. For example, when my queries related to the community at Crestview Elementary School were coming up short, I reached out to Kazemi to ask about other studies of the context.

As examples of exclusion at this point in my selection process, I found that studies of the Esperanza (e.g., McLaughlin & Talbert, 2001) and Monterey (e.g., Gutiérrez, 1995; 2000) High School mathematics departments did not provide clear evidence that there was deprivatization of practice (i.e., centering conversations on representations of teachers' own practice) or reflective dialogue (i.e., engaging in critical discussions). This appeared to be a result of the nature of the data sources. For example, Gutiérrez's analyses of the Monterey mathematics department are based on interviews with teachers in a follow-up study to "a six-year national study which looked at student performances and attitudes to mathematics and science as they relate to the schooling environments of those students" (Gutiérrez, 1996, p. 502). Studies of the Esperanza mathematics department were based on similar data, from a multiyear study of 16 California and

Michigan high schools, conducted by the Center for Research on the Context of Secondary School Teaching (CRC). Data sources included a 1991 survey of teachers, two prior surveys of the same teachers, and three years of interviews. In both projects, because the interviews with teachers did not focus on the detail of teachers' interactions in the department, the nature and focus of the groups' conversations were unclear.

I narrowed the pool of communities further, selecting only communities for which there was evidence of students' learning, teachers' learning, or both. By "learning," I relied on the conceptions of the authors conducting the studies[2]. As an example of narrowing the pool of communities, I excluded the studies of the mathematics department and Geometry Team at Union High School (e.g., Louie, 2015). Louie's (2015, 2016, 2017a, 2017b) studies of the group provide a nuanced and complex image of the group's conversations, detailing both productive lines of inquiry and less productive ones. As Louie (2016) states: "It is possible that the group described here is on a productive trajectory, with strengths that could be built upon to better support teachers' learning" (p. 18). I excluded the community as it is unclear whether the trajectory of the group is a fruitful one. As such, my selection criteria resulted in a set of robust inquiry-oriented professional communities, both in terms of their characteristics and their outcomes.

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[2] In the case of Septima Clark High School and Railside High School, studies showed *opportunities* for teachers' learning and not teachers' learning itself. These authors argue that opportunities for learning are a prerequisite to learning (e.g., Horn & Kane, 2015; Horn, 2010).

Community Contexts

My literature search and selection process led to the inclusion of eight communities, analyzed across 42 studies (see Table 2.2 for a summary of the types of studies included in the review).

Table 2.2. Summary of the number and types of studies reviewed for each community

School site of the community	Professional development approach / structure, if applicable	Number of studies reviewed	Type of study			
			Peer-reviewed empirical article	Peer-reviewed conceptual article	Unpublished thesis/ dissertation	Book/ book chapter
Elementary						
Crestview	Cognitively-Guided Instruction	6	2	1	1	2
Hilltop	Cognitively-Guided Instruction Math Lab	3	2	0	1	0
Mapleton	Video club	3[3]	3[3]	0	0	0
Western	Lesson study	1	1	0	0	0
Middle						
Magnolia		5	4	0	0	1
Nile	Video club	2[3]	2[3]	0	0	0
High						

[3] These communities were written about in the same piece.

Railside	Complex Instruction	19	10	1	3	5[4]
Septima Clark	Complex Instruction	4	2	1	1	0
Total		**42**	25	2	6	8

Critically, each of the communities exhibited evidence of working toward becoming an inquiry-oriented professional community and evidence of students' and/or teachers' learning. Appendix A documents each of the communities in relation to evidence for each of the inclusion criteria. The communities were each documented at different time points in their work together, and for different lengths of time. This variation allowed me to attend to conditions that appeared to matter across maturity of community.

In the rest of this section, I describe the context of each of the communities, including details about the school in which each community is situated and its student population, professional learning efforts influencing the community, and any goals for teachers' learning documented in studies of the community.

[4] These book chapters are from the volume edited by Nasir and colleagues (2014). I selected the book chapters that detailed work among teachers and key chapters in the book that detail classroom instruction and student learning.

(1) Cross-grade level groups at Crestview Elementary School. Four cross-grade level (kindergarten through fifth grade) teams at Crestview were documented in their work by Franke, Kazemi, and colleagues during the 1997-2000 school years. Crestview is in a small urban school district, and the student body at the time of their work was primarily Latinx (90%) and primarily received free or reduced lunch (90%) (Kazemi, 1999). The school was organized into heterogeneous classes of students, and each classroom was bilingual, speaking both English and Spanish during the class period (transitioning toward mainly English in upper grades). At the time of data collection, the school had recently moved to a year-round school calendar, which organized teachers and students into four heterogenous "tracks," each of which took breaks at different times in the school year.

In the 1997-1998 school year, each track of teachers formed a workgroup which met after school with either Franke or Kazemi facilitating and other staff members and administrators participating. Each workgroup met monthly and engaged in inquiry into the particulars of and the development of their students' mathematical thinking, drawing from and building on Cognitively Guided Instruction (e.g., Carpenter, Fennema, & Franke, 1996). The groups analyzed student work from mathematics problems they collectively chose and individually posed to students in their classrooms. Members of the research team also visited teachers' classrooms periodically to build relationships and to learn about students' thinking and teachers' instruction. In the subsequent two years, teachers rotated between workgroup meetings in their cross-grade level tracks and workgroup meetings with grade-level colleagues. By the end of the 1998 - 1999 school year, teachers (who named themselves "mathematics teacher facilitators") began facilitating the workgroup meetings. Franke and colleagues (2005) document that four years after the research team's involvement at Crestview ended, workgroups were continuing to meet.

The professional development efforts at Crestview Elementary School were designed to support "new ways of working together," "new ways of being," and new ways of operating in classrooms ("experimentation") (Kazemi & Franke, 2004, p. 232). In particular, they aimed to more squarely center artifacts from teachers' own practice were in teachers' work together, especially artifacts of their own students' thinking and learning, and more squarely center students' ideas in teachers' practice (Kazemi, 1999). The primary goal of the workgroups at Crestview was to provide ongoing space "for teachers to share, challenge, and create ideas about the development of children's mathematical thinking," to build relationships with each other, and to make their instructional practice public and open for collective inquiry (Franke et al., 2005, p. 211).

(2) Teaching staff at Hilltop Elementary School. The teaching staff at Hilltop was studied in the 2011-2014 school years. Hilltop is a racially, linguistically, and ethnically diverse elementary school in the Pacific Northwest with "a high percentage of students living in poverty" (Kazemi & Resnick, 2020). It serves over 400 students in kindergarten through fifth grade. At the time the community at Hilltop was studied, the school was partnered with University of Washington mathematics educators as a part of a School Improvement Grant to improve students' outcomes in mathematics (Gibbons, Kazemi, & Lewis, 2017). School leaders and university mathematics educators co-designed and co-facilitated a set of professional learning experiences, including one-on-one classroom visits and an ongoing job-embedded professional learning opportunities called Math Labs. Math Labs were designed as full- or half-day professional development for grade-level teams of teachers, specialists, and school leaders. Math Labs followed a cycle of collaborative planning, enactment, and reflection on an instructional activity in one of the participating teachers' classrooms (Kazemi et al., 2018). At the beginning

of the five-year grant, university mathematics educators primarily facilitated the Math Labs. By the end of the grant, the school's instructional coach facilitated all of the Math Labs, as they had become "integrated into the daily rhythms of the school and teachers' workplace lives" (Gibbons, Kazemi, Hintz, & Okun, under review).

The Math Lab structure required shifts in teachers' work with colleagues, toward enacting instruction together and engaging in inquiry in the moment of instruction (Gibbons et al., under review). Further, teachers were shifting the nature of their teaching practice. The School Improvement Grant was especially focused on the adoption of a new approach to teaching fractions guided by Empson and Levi's (2011) book, *Extending Children's Mathematics: Fractions and Decimals*. This approach involved learning on multiple levels, including developing new content knowledge for teaching mathematics, a shared vision for instruction, and an understanding of students' trajectories of learning fractions (Lewis, 2016). These goals were apparent both in how the instructional coach talked about her work and the planning decisions she and the university educators made for professional learning (Gibbons, Kazemi, & Lewis, 2017; Lewis, 2016). They also appeared explicitly in Math Labs. For example, Lewis (2016) documents the goals posted at the front of the room during a particular Math Lab: "(1) plan and implement an instructional activity focused on comparing fractions; (2) examine how students make sense of fractions and the strategies they use to compare fractions; (3) analyze [data from interviews with students about math problems] - use it to inform instruction; (4) identify the big ideas of the fractions unit" (p. 124).

(3) The lesson study group at Western Elementary School. A group of three teachers at an elementary school serving students in kindergarten through fifth grade in the western U.S. were documented in their first year of lesson study. Western Elementary School is located in a

city which at the time the school was studied had "mixed-income socioeconomic status, with 24% of students at the school belonging to socioeconomically disadvantaged households and 32% of students designated as English Language Learners and receiving special instruction at the school" (Murata, Bofferding, Pothen, Taylor, & Wischnia, 2012, p. 620). Other markers related to the student population (e.g., racial and ethnic makeup of the student body) are unclear.

Three teachers of different grade levels (second, third, and fourth grades) and with varying years of experience teaching (13 years, two years, and 16 years, respectively) engaged in lesson study together, facilitated by Murata, a researcher and mathematics educator who also documented the group's work together. Lesson study involves a "cycle of (a) goal setting, (b) curriculum analysis, (c) lesson planning, (d) teaching a lesson while being observed, and (e) debriefing and reflecting, in an open and collaborative setting" (Murata et al., 2012, p. 618). This cycle spanned the school year, with goal-setting and curriculum analysis happening in the fall, lesson planning happening early winter, and observation and debrief of lessons happening in the spring.

At Western Elementary School, teachers were working to teach mathematics in ways that supported students' meaningful, conceptual understanding of ideas, as described by the National Council of Teachers of Mathematics (e.g., 2000). Teachers found these ways of teaching challenging, in part because they were different than the ones they had experienced as students and different than modal ways of teaching in the district (Murata et al., 2012).

Several goals guided the group's work, emerging in conversations among the teachers and Murata in the year prior to the lesson study cycle. As a primary goal, the group "wanted to find a way to help students in second and third grades approach problems in more structured ways while also helping fourth grade students use algorithms with more conceptual

understanding" (Murata et al., 2012, p. 624). They identified as a focus for the lesson study cycle the use of number lines to represent students' strategies on multi-digit subtraction problems and connect them to problem contexts.

(4) Video club at Mapleton Elementary School. A group of seven teachers at Mapleton Elementary school were documented in their first year engaging in a video club together, during the 1996-1997 school year. Mapleton is located near a large midwestern city, and the student body at the time it was studied primarily identified as African American (Sherin & van Es, 2009). Other markers related to the student population (e.g., socioeconomic status of students' families) are unclear.

During data collection, all seven fourth and fifth grade teachers at Mapleton were engaged in a video club, gathering to watch and discuss excerpts of videos from each other's classrooms. The meetings were facilitated by van Es, one of the researchers who studied the community's work together. The group met once or twice per month over the course of the school year, for a total of 10 meetings (Sherin & van Es, 2009; van Es, Tunney, Goldsmith, & Seago, 2014). van Es collaborated with a colleague, Sherin, who was facilitating a video club at Nile Middle School (see below) to design and plan for the Mapleton video club meetings.

Mapleton was studied in the context of reform efforts centering discourse-oriented instructional practice (e.g., NCTM, 2000). Scholars have argued that such practice depends on teachers' capacities to notice in particular ways, and that such noticing is a shift for teachers from prior ways of engaging during instruction (Sherin, 2001). Sherin and van Es designed both Mapleton's and Nile's video club meetings to make space for teachers to notice the particulars of students' mathematical ideas and to inquire together into their instructional practice. These

meetings were further intended to support teachers to learn how to effectively use video on an ongoing basis with colleagues to examine their practice.

(5) Video club at Nile Middle School. Members of the Nile Middle School mathematics department were also documented in their work together in the 1996-1997 school year. Nile is located in the San Francisco Bay area, and the student body at the time largely came from upper-middle class families in the neighborhood and was approximately 70% white and 20% Asian (Sherin & Han, 2004).

During data collection, four of the seventh- and eighth-grade mathematics teachers at Nile were engaged in a video club meeting once per month for a total of seven meetings (Sherin & van Es, 2009). As noted above, the video club was facilitated by Sherin, one of the researchers who studied the community's work, and who collaborated with van Es (facilitating the video club at Mapleton Elementary) in designing and planning for the Nile video club meetings.

Nile Middle School was studied under similar circumstances as Mapleton Elementary School; teachers were working to shift what they *noticed* during instruction (Sherin & van Es, 2009). van Es and Sherin aimed for teachers to notice students' mathematical ideas, collectively inquire into practice, and learn how to collectively inquire into video of their practice with colleagues.

(6) Sixth Grade Team at Magnolia Middle School. The sixth grade team at Magnolia Middle School was documented in its work by Horn and colleagues. Magnolia is in a large, urban district that was part of the MIST project, which investigated districts' support of mathematics teachers' instructional improvement. The district (called District D in MIST studies) had leaders who, as described in other studies from the MIST project, "made unusually strong commitments to the improvement of mathematics instruction at scale" (Kane, in press). At

the time the sixth grade team at Magnolia was studied, the district had adopted an inquiry-oriented mathematics curriculum for its middle schools. In the student body served by the district as a whole, approximately 55% of students identified as white, 35% as African American, 5% as Hispanic, and 2% as Asian. 58% of students were eligible for free or reduced price lunch (Cobb, Jackson, et al., 2018). These studies do not describe the student body of Magnolia Middle School in particular.

Grade-level teams at Magnolia Middle School met weekly during common planning time. The sixth grade team meetings involved four teachers and were facilitated by a school-based instructional coach and the assistant principal, who were both experienced mathematics teachers. The team engaged in a three-week assessment cycle and used their time together to understand and respond to students' mathematical thinking evidenced in students' work on the assessments.

While studies of Magnolia do not illuminate particular goals for teachers' learning or the state of instruction prior to data collection, in the district more broadly, leaders aimed for teachers to develop "ambitious and equitable instruction" (Horn, Garner, Kane, & Brasel, 2017). These aims were in response to reform efforts centering discourse-oriented instructional practice (e.g., NCTM, 2000). The sixth grade team's work reflected these goals in that their conversations during three-week assessment cycles focused on developing aspects of ambitious and equitable instruction.

(7) Railside High School mathematics department and Algebra Group. The Railside High School[5] mathematics department was documented in their work from the mid-1980s through 2009 by a number of researchers and members of the department community (and, in several cases, both; e.g., Horn, who both researched interactions among the Algebra Group at Railside and taught a section of Algebra I in the 1999 - 2000 school year). Railside is situated in an urban area of a western state in the U.S. and at the time it was documented had an ethnically, culturally, and linguistically diverse population of students (Boaler & Staples, 2008).

The Railside High School mathematics department developed a shared "equity pedagogy" over the span of many years, in response to the reality in the mid-1980s that most students were struggling in their mathematics classrooms (Nasir et al., 2014). In response, the mathematics department "detracked" the mathematics classes at Railside and met together regularly to solve and talk about mathematics tasks in an effort to implement more meaningful tasks in their classrooms. This early reform at Railside involved engaging in professional development together, for example hosting a workshop on the California Math Framework, attending the California Mathematics Conference at Asilomar together, piloting and revising lessons with developers of the Investigations Mathematics Curriculum Project, contributing to the College Preparatory Mathematics Educational Program (CPM) curriculum, and piloting tasks from the Balanced Assessment Project.

Eight years into these reform efforts, the school as a whole decided to adopt and support the development of an approach called "Complex Instruction" (Cohen, 1994; Cohen & Lotan,

[5] I use "Railside" throughout this paper in keeping with the volume edited by Nasir and colleagues (2014). Studies of this school have also used the pseudonyms "East High" (Little, 2002, 2003; Little & Horn, 2007; Horn 2005, 2007, 2010; Horn & Little, 2010, 2014) and "San Lucio" (Lieberman, 1997).

1997). At its core, Complex Instruction aims to counter social and academic status differences in classrooms. Cossey, a doctoral student at Stanford at the time, and Tsu, the mathematics department chair at Railside, co-taught a course for 8th graders which other mathematics teachers observed. These observations informed conversations in the department's regular meeting times. The department also engaged in regular workgroup meetings with colleagues teaching the same course (e.g., the Algebra Group), which focused on building and enacting a vision of Complex Instruction for the particular context and students at Railside. This vision continued to be developed and refined over many years. Key practices included: (1) structuring lessons to support students' participation in groupworthy tasks; (2) approaching mathematics concepts through multiple representations; (3) organizing curriculum around big ideas; (4) using justification to push students to articulate their mathematical thinking; and (5) making student thinking public and valued (Cabana, Shreve, & Woodbury, 2014).

(8) The Freshman Team at Septima Clark High School. The Freshman Team in the Septima Clark mathematics department was documented in their work in a six-year partnership with researchers from a local university, including Horn and Bannister, from the years 2004 - 2009. The partnership aimed to support teachers' enactment of Complex Instruction (Cohen, 1994; Cohen & Lotan, 1997). The university team involved several individuals who had worked at Railside High School to specify practices of Complex Instruction for the context there. Septima Clark is a large high school (serving 1,595 students in the 2005-2006 school year) in an urban district in the northwest U.S. (Bannister, 2015; Horn & Kane, 2015). At the time of the partnership, about half of the student body identified as white (43% during the 2005-2006 school year), 30% as African American, 20% as Asian, 6% as Latinx, and 1% as Native American. 22% of students qualified for free and reduced lunch (Bannister, 2015).

The Freshman Team consisted of five teachers all teaching first-year college preparatory mathematics and engaged in daily collaboration during a common planning period (in addition to their personal planning period). These meetings were sometimes attended by members of the research team and a district instructional coach. About half of the time, they were attended by a Complex Instruction coach who had previously supported the mathematics department at Railside High School.

In the year prior to data collection, 50% of students taking the freshman mathematics course at Septima Clark High School were failing. In light of what they called the "struggling student problem," the Freshman Team decided to adopt the Interactive Mathematics Program curriculum and work to develop and enact Complex Instruction (Bannister, 2009, 2015). The curriculum was a shift from what teachers had used in years prior, in that it centered students' problem-solving and sensemaking and required that teachers facilitated meaningful discussions among students. Complex Instruction also required changes in teachers' practice in that it more squarely centered teachers' attention on social and academic status differences arising in their classrooms, in relation to their teaching practice. The university team (including the Complex Instruction coach) and teachers collaborated "to create [classroom] activities that fit theoretical principles about equitable mathematics teaching while also serving the teachers' goals" (Bannister, 2009, p. 23). They tried these activities out in their classrooms, and in their daily meetings, they debriefed their instruction, making sense of students' participation in relation to their practice.

Analysis of the Literature

During my first round of analysis of the corpus of literature, I kept notes in which I extracted the research focus and/or questions of each study, the methods of analysis, key

findings, and arguments. See Appendix C for a summary of foci of the studies under review. In order to further inquire into the research questions guiding this review, I used both inductive and deductive analytic approaches, as described below.

Phase 1: Describing the Foci of the Communities' Work

In my analysis of the foci of the communities' work, I attended in particular to how, in their conversations and work, the communities engaged with *instruction, students,* and *mathematics content* and the relationships among the three. These foci have their origin in the "instructional triangle" or "teaching triad" (e.g., Cohen & Ball, 1999; Jaworski, 1994), which many scholars' arguments identify as the focus of teachers' professional learning (e.g., Prediger, Roesken-Winter, & Leuders, 2019; Zaslavsky & Leiken, 2004). Such models rest on an understanding of instruction as the interactions and relations between each element of the triad – for example, between the teacher and students, students and mathematics, students and each other, teacher and mathematics, and so on (Cohen & Ball, 1999; Jaworski, 1994). Given the field's robust theory regarding the foci of generative communities of mathematics educators, my analysis of the foci of the communities' work tended to be descriptive in nature.

Phase 2: Understanding How Such Communities Are Established and Sustained

How robust communities are established and sustained is a topic less thoroughly explored in the literature. For this reason, I used the constant comparative method (Strauss & Corbin, 1998) to generate categories pertinent to how the communities under review were established and sustained. To begin, I analyzed studies of the mathematics department at Railside High School (19 studies total) according to both dimensions suggested by the literature to be generative in relation to understanding how communities are established and sustained, including *vision* and *routines* (described in more detail below), while also remaining open to emergent

themes. I then summarized the studies of Crestview Elementary School (6 studies total) according to the same dimensions, adding to and revising the themes that had emerged in my analysis of the Railside studies, while noting any recurring issues. I continued to add one community at a time, formalizing the themes and categories. Finally, I systematically reviewed the whole corpus of literature with the themes and categories identified. These included, for example, "experimenting with instructional practice" and "authentically engaging with one another's ideas."

The literature suggests the importance of attending to the vision guiding communities' work, rather than solely to the features of that work (e.g., Kennedy, 2016). I take up Hammerness's (2001) definition of vision as an image of ideal practice, one that serves as "a guide and a measure" for work – in this case, the work of the communities (p. 146). In keeping with a growing argument to attend to multiple levels of vision, I attended to the visions for both students' and teachers' learning that appeared to guide the communities' work (e.g., Hubbard, Mehan, & Stein, 2006; Kazemi & Resnick, 2020; Sztajn, Campbell, & Yoon, 2011; Wayne, Yoon, Zhu, Cronen, & Garet, 2008). As an example from the literature reviewed here, in a compendium of research analyzing the work of teachers and experiences of students at Railside High School, the authors articulated a descriptive set of principles comprising a vision for supporting students' and teachers' learning (Nasir et al., 2014). Components of this vision included the following: seeing all teachers and students as learners; working from strengths while making space for vulnerability; redefining "smart"; redefining what it means to do math in school; and recognizing the importance of relationships. The authors argued that these components of the vision were crucial to understanding the work of the professional community at Railside: "The aspects of teaching practice and professional community at Railside were only

powerful when connected to important and meaningful overarching principles" (Nasir et al., 2014, p. 235).

In making sense of how a community is established and sustained, attention to elements of the community's *routine* is generative, meaning the "repetitive, recognizable pattern(s)" in the community's work (Feldman & Pentland, 2003, p. 311). Attending to what happens regularly in a community proves an especially fruitful way of discerning how that community might be sustained. I attended to both routine structures and routine ways of interacting inside those structures. A *routine structure* is a sequence of events that recurs regularly and both involves and is recognizable by multiple role groups as routine. For example, at Hilltop Elementary, the Math Lab was a routine structure organizing the teaching staff's work. Math Labs followed a cycle of collaborative planning, enactment, and reflection on an instructional activity in one of the participating teachers' classrooms (Kazemi et al., 2018). It was a *routine* structure in that it involved a sequence of events that recurred regularly in the school year and both involved and was recognizable as routine by teachers and leaders at Hilltop. Other examples of routine structures in the literature under review included video clubs at Nile and Mapleton, Lesson Study meetings at Western, and teachers' collaborative time at Septima Clark, Railside, and Magnolia.

Within the routine structures, interactions between and among individuals can become routinized. Building on Coburn and Russell's (2008) analysis of how coaches and teachers work together in the context of mathematics education reform, I define *routine interactions* as patterned ways of engaging together "intended to guide conversation between adults on matters of instruction" (p. 217). For example, at Hilltop Elementary, the leaders aimed for teachers to routinely pause during their collective instruction in Math Labs to engage in inquiry together (for more elaboration on "teacher time out," see Gibbons, Kazemi, Hintz, & Okun, in press). These

pauses were routine interactions in that they occurred regularly when teachers and leaders were enacting instruction together and made space for particular kinds of conversations about instruction. One of the studies in the corpus of literature focused on the routine interactions in the communities (Gibbons et al., in press; Appendix C).

When attending to what is regular about a community's work, it is also important to attend to the normative practices in which communities come to engage over time (Little, 1982; McLaughlin & Yee, 1988). *Normative* practices are visible in the responses of community members to each other's actions and narratives; they are accepted or even celebrated (Jackson, 1966). Seven of the studies under review[6] focused on the normative practices of the communities (Appendix C). However, in studies which provided rich examples of the community's interaction, I was able to attend to normative practices by finding patterns in the community's conversations and responses to one another.

Phase 3: Understanding Leaders' Role in Supporting Such Communities

I attended to facilitators' and school administrators' roles in supporting the vision, routine structures and interactions, and normative practices that emerged in my analysis in Phase 2. Few of the studies reviewed here focused on facilitation or school leadership practice.[7] However, all eight communities involved or were influenced by such leaders: for example, university-based mathematics educators, instructional coaches, principals, and others with formal leadership titles. I attended carefully to references to these individuals in the description of the community

[6] Studies focusing on the nature of conversations include: Horn, 2007, 2010; Horn, Garner, Kane, & Brasel, 2017; Horn & Kane, 2015; Horn & Little, 2010, 2014; Little & Horn, 2007.
[7] For exceptions, see (1) van Es and colleagues' 2014 study of facilitation across the video clubs at Mapleton Elementary and Nile Middle and (2) Gibbons, Kazemi, and Lewis's 2016 study of the work of the instructional coach at Hilltop Elementary.

context, episodes detailing their interactions in the community, and discussion of these roles by the authors. It is worth noting that in six of the eight communities reviewed, at least one author of the study also interacted in a leadership capacity with the community, often as a facilitator. In my analysis, I worked to separate authors' commentary about their own stance and role.[8]

To analyze the leaders' roles, I attended to the leadership *tasks*, or activities, involved in establishing and executing the routine structures, routine interactions, and normative practices that supported the community's work (Spillane, 2006). For example, as I will explicate below, an important leadership task involved structuring professional learning events such that they did not add undue burden to teachers' schedules (e.g., Horn, Kane, & Garner, 2018). Critical to analyzing tasks is naming the *functions* these tasks address. Spillane (2015) has argued that leadership practice and its purpose cannot be analyzed or taken up separately; aspects of practice are understood only in light of the functions they serve. The function of practice has often been left implicit in analyses of leadership and school reform, but actively grounding any specification of practice in the purpose it intends to serve is critical to maintaining the complexity and meaning of the work (Spillane, 2000). A function-centered approach to analysis allows researchers to "attend to the daily work of school leaders without losing sight of the big picture" (Spillane et al., 2001, p. 24).

In what follows, I review the studies of the focal inquiry-oriented professional communities, beginning with the foci of the communities' work, and then I turn to what we can learn about how such communities are established and sustained and the role professional learning facilitators and school administrators play in supporting communities' work. Given

[8] I include a section related to author-facilitators' stance toward teachers in my findings regarding leaders' role in the communities' work.

arguments made by scholars regarding differences in the development and support of professional community across elementary and secondary spaces (e.g., Grossman & Stodolsky, 1994; McLaughlin & Talbert, 2001), throughout these findings, I distinguish elementary and secondary communities as sub-groups where possible. I conclude the review with considerations for the development and research of communities, based on these findings.

What Is the Focus of an Inquiry-Oriented Professional Community's Work?

The foci of the communities' work fell into several categories, or lines of inquiry, including inquiry into mathematics content, inquiry centered on students (e.g., into students' mathematical understandings; into widespread narratives about students' capabilities), and inquiry into instruction (see Figure 2.2). Note that as the figure suggests, there was overlap among these lines of inquiry. That is, instances of the communities' inquiry might involve inquiry into instruction, mathematics content, students, any two of these in relation to each other, or all three. In this section, I describe each of the lines of inquiry separately for the sake of space.

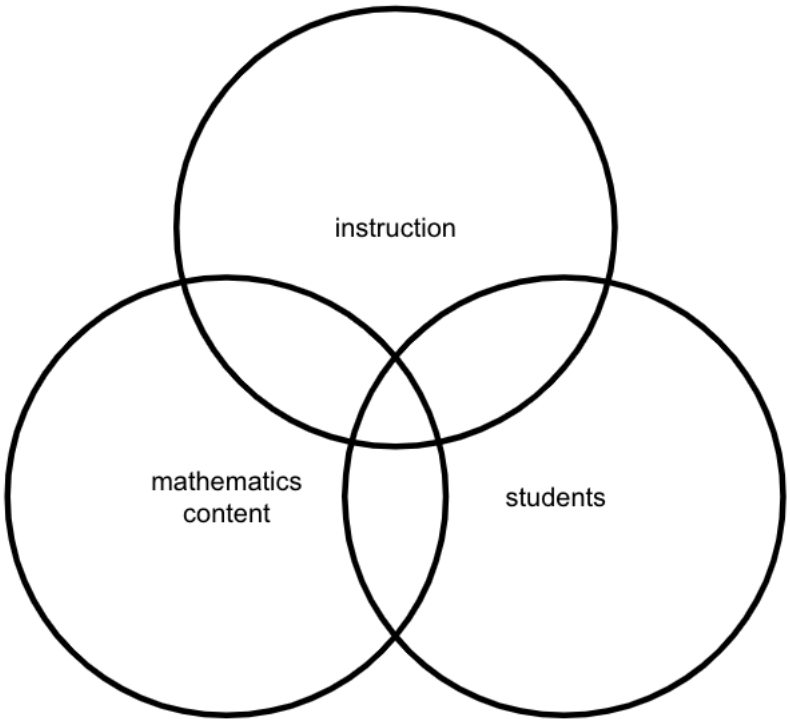


Figure 2.2. Overlapping lines of inquiry conducted by the communities.

Inquiry Centered on Students

Studies of all of the communities provide evidence that they each engaged in inquiry centered on their own students. These lines of inquiry included investigating their students' mathematical understandings and participation and critically exploring widespread narratives about students' capabilities.

Inquiry into students' mathematical understandings and participation. Each of the communities "[kept] their eyes on student learning" by inquiring into *their own* students' mathematical understandings and participation together (McLaughlin & Talbert, 2001, p. 82). Studies of five elementary and secondary communities document collective analysis of their own students' written work. Teachers' grade-level meetings at Crestview Elementary, Hilltop Elementary, Western Elementary, Magnolia Middle School, and Septima Clark High School involved routinely bringing students' written work to meetings in order to make sense of

students' strategies together. For example, at Crestview Elementary School, teachers brought student work to the group based on a problem they had each posed in their classes. They analyzed what the strategies revealed about students' mathematical understandings (e.g., Franke et al., 2005; Kazemi, 1999). At Railside High School, teachers are documented sharing student work informally with each other in quick visits to colleagues' classrooms (e.g., Cabana, Shreve, & Woodbury, 2014). In these communities, student work was analyzed after having implemented particular tasks they themselves had engaged with as learners during a meeting together. As such, their analysis of student work built on and enriched their understanding of how students develop particular mathematical ideas (e.g., Kazemi, 1999).

Two elementary communities conducted student interviews through which to delve deeply into their students' mathematical understandings. In the lesson study group at a western elementary school studied by Murata and colleagues (2012), clinical interviews with students in the year prior to the lesson study cycle formed the basis for their work together. As another example, teachers at Hilltop used one-on-one interviews with students in which they posed a task, observed the student solving the task, and asked follow-up questions to make sense of their various decisions, in order to make further sense of particular students' mathematical understandings (Lewis, 2016).

Studies document three elementary and secondary communities analyzing students' understandings as they emerged during instruction. The video clubs at Mapleton and Nile Middle Schools analyzed students' thinking as it was made visible in videos of community members' teaching (e.g., Sherin & van Es, 2009). At Hilltop Elementary School, teachers enacted instruction together in one of their classrooms during Math Labs. They paused strategically in

the moment of instruction to engage in discussion together, and a common topic of these pauses was the student's strategy at hand (e.g., Gibbons, Kazemi, Hintz, & Okun, under review).

Two secondary communities are documented engaging in analysis of students' participation patterns. At both Railside and Septima Clark High Schools, the mathematics departments attended to, for example, how small groups of students functioned, how students supported each other in group work, and who was participating in discussion (e.g., Bannister, 2015; Tsu, Lotan, & Cossey, 2014). Further, the communities connected constructs such as *status* to the particular participation patterns of individuals and groups of students and, in doing so, attended to the access and opportunities for learning students do and do not have in their classroom (e.g., Bannister, 2015).

Surfacing and challenging widespread discourses about students' capabilities. The field of mathematics education has identified harmful discourses that are prevalent in U.S. society and impact schools and teachers' work. One prevalent and harmful set of discourses about who is and is not capable of engaging in authentic mathematics limit the access that students – especially those from historically marginalized communities – have to high-quality instruction (Wilhelm, Munter, & Jackson, 2017). In a subset of the communities under review, their inquiry into students' mathematical understandings, mathematics content, and/or their instructional practice surfaced these kinds of harmful discourses and allowed the community to investigate and work to disrupt them.

Horn's (2007) documentation of the Algebra Group at Railside provides a rich example of a community's inquiry into instruction providing space through which to surface and collectively challenge discourses about mathematics that are related to discourses categorizing students' abilities. Horn reminds us that school mathematics has long been seen as a sequential,

procedural endeavor; this conception equates being good at mathematics to achieving speed and correctness. Horn details how Tina, a teacher in the Algebra Group, gave a rich description of a particular episode of instruction, highlighting a gap between the "fast" and "slow" learners in her classroom. Through conversation, Tina and her colleagues surfaced discourses deeply embedded in U.S. mathematics classrooms about what it means to be capable of rigorous mathematics. The department then examined instructional decisions in relation to these discourses about students. Tina's colleagues, Guillermo (the department chair) and Carrie, challenged the categories of "fast" and "slow" by connecting to a broader conversation about what it means to engage in the discipline of mathematics. The group's initial inquiry into a specific interaction during instruction opened space through which to inquire about labels used to categorize students, tied to widespread discourses about the discipline of mathematics (i.e., to be good at math is to be "fast"), what it means to support students' learning (i.e., a teacher's role is to move along "slow" students and give "fast" students more to do) and students' capabilities (i.e., some students are just good at mathematics, and others are not).

The studies under review more generally suggest that communities' inquiry into mathematics and into students' understandings and participation can broaden teachers' conception of what counts as mathematical activity. For example, as the Railside community engaged in doing mathematics together, "by sharing their own solution processes and analyzing experiences of doing the math, teachers were able to see different ways of thinking, reasoning, making sense, and finding solutions, which facilitated the group redefining what it meant to learn math in high school" (Cabana, Shreve, & Woodbury, 2014, p. 176). Hand (2012) notes that Railside teachers' orientation toward "what students *were* doing (and had an opportunity to do) instead of what they *were not*" (p. 241, emphasis added) gave the community opportunities to

see the mathematical richness and competence in students' non-standard representations and discourse. This appeared to deepen and broaden community members' own understandings of what counts as mathematical activity and, in relation, what it looks like to be competent and capable.

Approaching students' work and participation with questions such as: "What *do* students understand?" and "What *are* students doing?" appear to be generative in terms of surfacing and challenging discourses about students' capabilities (e.g., Hand, 2012, Kazemi, 1999). More normative in schools are questions about what students are lacking, what they do not understand, and what they are not doing; such questions can lead to a deficit orientation toward students. Exploring what students *do* understand and what they *are* doing appears to require, first, a close and detailed attention to students, a curiosity about what they are doing and thinking, and why (e.g., Franke et al., 2005). Second, this kind of exploration reflects a general assumption that students' actions and responses make sense, placing the onus for supporting students' learning and experiences upon teachers and leaders. As Kazemi and Franke (2004) note of Crestview Elementary School:

> Our analysis of the data revealed that teachers did not only learn to attend to the details of students' strategies, but also learned that the practice of detailing children's strategies provided opportunities to recognize that students had powerful mathematical ideas. (p. 223)

Attending to specifics of students' strategies appeared to provide space through which to consider and reconsider what it means to learn and engage in mathematics, and who is capable of significant and meaningful engagement in mathematics.

In this analysis, I also attended in particular to racialized discourses in relation to discourses about students' capabilities. For example, a prevalent and harmful set of discourses suggests there is a racial hierarchy of ability with respect to mathematics or that poor children of

color lack the ability to engage in authentic mathematical practices, such as modeling and abstraction (Martin, 2009; Martin, Gholson, & Leonard, 2010; Shah, 2017). A growing body of research conveys the importance of racialized discourses being aired and available for direct inquiry (cf., White, Crespo, & Civil, 2016). There was no evidence in this body of literature that such discourses were a focus of conversation, perhaps because of the nature of questions asked of the communities (Appendix C). I return to this point in the discussion of this chapter.

Inquiry Into Mathematics Content

Each of the communities also inquired into mathematics content, unpacking mathematical concepts and making sense of particular solution strategies in relation to those concepts and problem contexts, thereby deepening their own conceptual understanding of the mathematics they would teach. Many of the communities (_ of the eight) inquired into mathematics content as it emerged in relation to students' understandings. That is, they inquired into the mathematics of their students' enacted strategies. For example, at Crestview Elementary, as the group explored students' mathematical understandings made visible in the student work they each brought to the group, they inquired together into the mathematics in the strategies in order to make sense of them in relation to the Cognitively Guided Instruction framework of students' development of mathematical understandings.

Some communities (four of the eight) made a practice of doing mathematics together in order to anticipate students' strategies, solving and discussing tasks they would later use in their classrooms. For example, at Railside, the department worked for many years to build a cohesive curriculum with meaningful and "groupworthy" tasks for students (e.g., Nasir et al., 2014). Teachers brought prospective tasks to the department and enacted them with their colleagues as they would with students. The department did the mathematics of the task together, and inquired

into, for example, the particular mathematical ideas in their solution strategies and how the mathematics in the task built from the mathematics of prior tasks students would have experienced.

In two elementary contexts, the communities both inquired into mathematics content prior to enacting a task, and afterward in relation to students' strategies. For example, in the planning phase of Math Labs at Hilltop Elementary School, community members first engaged in discussion about a shared reading about fractions. They then experienced a math task as learners, facilitated by either the mathematics instructional coach or a university-based mathematics educator (or both). In the community's discussion of the task, they connected to their shared reading about fractions, and they anticipated students' strategies that might emerge when they co-enacted the task together in one of their classrooms later in the same morning. They specified together what it would look like to solve the task with understanding. After enacting the task together, they gathered evidence of students' strategies (pictures of the board, student work), and they debriefed, inquiring into the mathematics of the task through an inquiry into students' understandings. The community at the western elementary school studied by Murata and colleagues (2012) followed a similar cycle, spread out over the school year rather than within a school day. Early in the school year, the group solved mathematics tasks together from their curriculum, anticipating how students might solve the tasks. Later in the school year, after each teacher had enacted the task in a public lesson study, the group debriefed, inquiring into mathematics content through their analysis of students' understandings.

Inquiry Into Instruction

Critically, each of the communities inquired into instruction; their discussions were both linked to more general principles of teaching and learning and centered on specific, meaningful

moments from teachers' own instructional practice. The communities under review were working, in part, to generate knowledge together about the practice of mathematics instruction. To do so, their conversations made links from particular interactions in a lesson to general principles of teaching and learning. Horn and colleagues' analyses of Magnolia Middle School and Railside and Septima Clark High Schools (Little & Horn, 2007; Horn, 2010; Horn & Kane 2015; Horn, Garner, Kane, & Brasel, 2017; Horn, Kane, & Garner, 2018) focus on this issue in particular. Horn (2010) argues that community members' specific descriptions of instructional moments provide a means through which to develop "pedagogical concepts," more generalized knowledge about teaching and learning. As Little and Horn (2007) describe, such conversations include "dialogue [that] does more than simply report on or point to problems of practice, but supplies specific means for identifying, elaborating and reconceptualizing the problems that teachers encounter and for exposing or generating principles of practice" (p. 81).

These studies document the communities pressing each other to describe instructional episodes with specificity in terms of task and interactions, "replaying" a past interaction or "rehearsing" an anticipated one. For example, Betty in the Septima Clark Freshman Team described students' confusion on a task, rehearsing what she anticipated students might say in relation to their confusion:

> So if they're getting stuck there, can we ask the question as a teacher. Like when they get there, they can say, "What were we supposed to answer for this?" "Okay, so what *are* those numbers talking about? Don't just give me the number but show me what it's comparing. (Hall & Horn, 2012, p. 247)

These replays and rehearsals gave the group an evidence base from which to draw as they generalized to principles of teaching and learning. In the case of the conversation in the Septima Clark Freshman Team, the group used the various episodes of instruction they had constructed to

arrive at a more general principle: "[Students' confusion] was no longer an obstacle to instruction but a critical—and even desirable—component of it" (Hall & Horn, 2012, p. 249).

Throughout the corpus of literature, the communities did not engage in inquiry into instruction on its own; rather, they engaged in inquiry into instruction *in relation to* students' thinking or *in relation to* their exploration of mathematics. For example, in the Railside mathematics department, after the group engaged in a mathematics task together as learners and as they inquired into the mathematics, they also inquired into the instructional decisions they might make in order to "open up" the mathematics to students (Cabana, Shreve, & Woodbury, 2014). In terms of the development of community, it is likely that inquiring into instruction in relation to mathematics or to students' understandings orients the group toward common goals (i.e., supporting students' learning; understanding the conceptual sequence of curricular materials) and away from a sense that anyone's instructional practice is being evaluated.

How Are Inquiry-Oriented Professional Communities Established and Sustained?

Few[9] of the studies reviewed here attend to the early years of the focal community to understand its establishment, and none of the studies are longitudinal, making sense of how the community was sustained over time (see Appendix C). Nonetheless, my analysis of the literature uncovered what appear to be critical aspects of the communities' work in their development and sustainment. These include two aspects related to the vision underpinning the communities' work: an explicit vision for mathematics instruction and a shared vision for the community's work. Aspects also include three normative practices for the communities' work: inquiry into

[9] The communities at Western, Mapleton, Crestview, and Hilltop Elementary Schools, Nile Middle School, and Septima Clark and Railside High Schools were all studied early in their work together. However, these analyses did not focus on the *development* of the communities.

authentic problems of practice; experimentation with instructional practice; and authentic engagement with one another's ideas. In what follows, I discuss each of these aspects of the communities' work and the routine structures and interactions that appeared to support them.

An Explicit Vision for Mathematics Instruction

There is evidence in the studies reviewed that all of the communities engaged in professional learning that targeted an *explicit vision for mathematics teaching*. Centering an explicit vision appeared to allow the communities space through which to wrestle with the ideas at hand, challenge them, and revise them for their own context, shaping their own image of ideal mathematics instructional practice together.

For example, the Railside High School mathematics department worked together to learn to enact Complex Instruction, through a set of routine structures, including workshops, observations of an 8th grade course co-taught by the department chair and a university-based mathematics educator, observations of each other's' instructional practice, and regular inquiry in workgroup meetings. Complex Instruction required a "break from the traditional view of mathematics as a hierarchical collection of procedures best learned quickly by someone with a good mathematical mind" (Tsu, Lotan, & Cossey, 2014, p. 136). The department had opportunities to think deeply and in new ways about mathematics learning and equity, and to specify the implications of these new ways of thinking for instruction. That is, the mathematics department both *learned about* Complex Instruction and *shaped a shared vision* for Complex Instruction in their context, with their particular students.

As another example, at Hilltop Elementary School, teachers and leaders worked together to learn new ways of enacting instruction about fractions, following the approach of Levi and Empson (2011), which builds from students' current understandings (Lewis, 2016). The staff

learned about Levi and Empson's approach to fractions instruction through an initial whole-staff meeting. The staff collectively specified and shaped this approach for the context of Hilltop and its students through a set of routine structures including Math Labs, ongoing classroom visits from the mathematics instructional coach and university-based mathematics educators, and informal conversations with each other. Lewis (2016) found that after three years of engaging in these routine structures together, each teacher had developed a more sophisticated vision for instruction that was more aligned with the other teachers at Hilltop.

Not all of the communities were centered around a *named* approach for mathematics instruction (e.g., "Complex Instruction" or "Levi and Empson's approach to fractions instruction"). Many communities were working more generally to improve instruction, grounded in documents reflecting national reform efforts (e.g., the Common Core State Standards for Mathematics; NCTM, 2000, 2014). However, these communities also had embedded opportunities to surface and specify a vision for mathematics teaching. For example, in the Nile Middle School community's work to analyze students' mathematical thinking and to reflect on both students' mathematical understandings and their instructional practice by watching videos together, they had opportunities to make their vision for instruction increasingly more explicit. We see for example that when watching a clip from a teacher's classroom, the community engaged in conversation about the students' comfort level disagreeing with one another, specifying students' argumentation as a component of their shared vision for instruction (Sherin & Han, 2004).

A Shared Vision for the Community's Work

Another aspect of vision that emerged in my review concerned an ideal image of how the community would engage together, including their commitments and ways of engaging together.

While few studies in this corpus explicitly highlighted the community's vision for its work, the studies of the communities at Crestview and Hilltop Elementary Schools and Railside High School suggest that it is critical that such a vision become shared. Researchers reflecting on their aims in the community at Crestview Elementary School noted that they hoped to "...creat[e] school learning communities in which teachers see themselves as intellectuals and recognize the importance of teachers learning through activities embedded in their everyday work" (Franke et al., 2005, p. 211). That is, their work was organized to support teachers to view themselves and each other as both intellectuals and learners. Researchers at Crestview hypothesized that this vision for the community's work was, in part, what supported the sustainment of the community in the years following the researchers' direct involvement in it (Kazemi, 1999). In relation to Railside High School, Nasir, Cabana, Shreve, Woodbury, and Louie (2014) reflect on a set of stances taken on by the mathematics department, including "All teachers and students are learners," which underpinned their work together. As with Crestview, Nasir and colleagues (2014) hypothesize that these stances supported the sustainability of the community's work, the flourishing of the "the openness and unconditional support for intellectual engagement that characterized the Railside professional teacher community" (p. 235). The vision community members have for their work with colleagues appears to be a critical and under-specified aspect of establishing and, in particular, sustaining meaningful community.

Inquiring Into Authentic Problems of Practice

A normative practice across the communities involved inquiring about authentic problems from teachers' own work. It is worth noting that *how* the communities inquired into problems of practice varied (e.g., the agenda for the community's time, who set the agenda, whether problems of practice were raised organically or selected or some combination of the

two). What was common, however, was that the groups were raising issues arising from their own practice and exploring them together, and there were routine structures through which to do so.

Each of the communities engaged in routine structures which centered representations of teachers' own practice and supported transparency (Little, 2002). For example, in the Railside Algebra Group, "checking in" served as a key routine structure through which teachers raised current problems of practice (e.g., Little & Horn, 2007). As will become clear in the sections below, a normative practice in the community involved pressing each other for specificity in terms of the task and interactions involved in each problem of practice, so the community was able to engage in meaningful inquiry into the problem. As another example, at Crestview Elementary School, a routine structure for the community's work involved bringing their students' work from a problem the group had identified together. In this case, the facilitator often determined which work would be centered and collectively analyzed.

In many of the communities, there were also routine structures and interactions which allowed for the community to engage in a shared instructional experience. At both Hilltop and Western Elementary Schools, there were structured opportunities to for the community to be in a classroom together, through which problems of practice emerged for inquiry. Through structured Math Labs, the community at Hilltop collectively taught an episode of instruction in a colleague's classroom and discussed problems of practice that emerged in that instructional experience both during instruction ("teacher time out," Gibbons et al., under review) and in a debriefing conversation following instruction (Lewis, 2016). Through the Lesson Study cycle, the community at Western Elementary School engaged in discussions of anticipated problems of practice prior to observing "research lessons" enacted by colleagues and in discussions after

observing these lessons (Murata et al., 2012). At Mapleton Elementary School and Nile Middle School, the communities shared a common instructional frame of reference by watching video from each other's classrooms.

Experimenting With Instructional Practice

Another normative practice that emerged in my analysis of the communities' work involved experimenting with instructional practice. This practice is rooted in the idea that the work of teaching is a craft that requires ongoing inquiry and growth (e.g., "artisanship," Talbert & McLaughlin, 2002, p. 336). That is, teaching involved continually trying out aspects of instructional practice connected to the community's vision for instruction, bringing reflections and data back to the community for inquiry, and trying them again. There is evidence that teachers saw their work as involving experimentation in response to the particulars of their school and classroom contexts. For example, a teacher in the mathematics department at Railside reflected on the community's work:

> As we learned together we began to probe deeper, to become more reflective. But our questioning, reflecting and probing was always grounded in our work in the classroom with our students. We came to view our classrooms as laboratories in which we put into practice the theories that we had generated in our meetings. … We were learners together. Inside our classrooms, we were learning about our students, what they knew, what they needed to learn, what approaches facilitated their learning. Outside the classroom we were striving to make sense of what we saw in the classroom and to search for further resources which would enable us to more effectively work with our students and support their learning. (Tsu, 1998, pp. 17-18)

The idea of teachers' work as laboratories involving experimentation with instructional practice also appeared in studies of the communities at Crestview and Hilltop. For example, at Crestview, "...the teachers were finding ways to experiment within their own classrooms and use the workgroup as a place to further reflect on their experimentation" (Kazemi & Franke, p. 231). Kazemi and colleagues coined the term "Math Labs" in their work with the community at Hilltop

Elementary to reflect the community's understanding of their work as a laboratory in which they were experimenting with instructional practice.

Critically, and as will be elaborated below in the discussion of leaders' work, establishing experimentation with instructional practice as normative appeared to involve important work on the part of leaders and members of the group who may naturally be seen as experts. In the Railside mathematics department, for example, the whole community engaged together as learners, continually trying new things and getting feedback, which depended upon a guiding principle in the department, that "...there was no individual that could be seen as an expert" (Cabana, Shreve, and Woodbury, 2014, p. 178). Everyone in the department was seen as learning alongside others. Similarly, of the Lesson Study group at Western Elementary School, Murata and colleagues (2012) describe:

> Lesson study holds the potential to transform teacher learning from the transmission of knowledge from an "expert" to the teacher, to a journey in which the teacher's ideas are coordinated, with different ideas interacting and shaping teacher learning, guiding them toward a purposeful learning goal and destination. (p. 644)

Interacting with teaching practice in an experimental manner requires assurance that no one is being evaluated; rather the community, including any leaders involved, is working together to improve teaching.

Authentically Engaging With One Another's Ideas

Inquiry-oriented professional communities surface and explore ideas (e.g., about what it means to engage in the discipline of mathematics, what it means to teach mathematics, and who is capable of rigorous mathematical activity). The studies reviewed suggest that such conversations require a normative practice of authentically engaging with one another's ideas. In studies with transcripts of the communities' conversations, rather than acting as if everyone

agreed or taking ideas at face value, community members appeared to press for clarification and elaboration and ask critical questions as a normative way of engaging in conversation together.

Consider this example of the fourth and fifth grade workgroup at Crestview Elementary School challenging each other's ideas about the standard U.S. algorithm for multiplication (Figure 2.3).

1	Facilitator:	What do you think is the most sophisticated strategy that you saw?
2	Mr. M:	Probably using the algorithm.
3	Facilitator:	The algorithm? Do you all agree about that?
4	Teachers:	No.
5	Ms. N:	They don't know what they're doing [when they do the algorithm.]
6	Ms. K:	And you don't have to think about the problem when you're doing it.
7		Like you have to think about 40 as a unit in the other strategies.
8	Mr. M:	But you have to hold the value when you multiply.
9	Ms. K**:**	That's why I think it's –
10	Mr. M:	That's sophisticated in itself.
11	Ms. K:	But I think that's a memorized rule. I don't think kids think, "Oh, I'm
12		holding the 1s place here."
13	Ms. N:	It would be interesting to see if they could explain why they're
14		multiplying and what it means.

Figure 2.3. Excerpt from a conversation at Crestview Elementary School (transcript excerpt from Franke et al., 2005, pp. 215-216)

We see that the group openly challenged Mr. M's assertion that students' use of the standard U.S. algorithm for multiplication was the most sophisticated strategy they saw among students' work. The group wrestled together with what *is* sophisticated about the algorithm, what might not be (e.g., Ms. K's comments on lines 6-7; lines 11-12), and what they would look for in students' work as evidence of students' deep conceptual understanding of multiplication (lines 13-14). At this point in the community, there is evidence that the group could openly challenge and wrestle with ideas together.

The mathematics department at Railside High School provides another rich case through which to see the community's authentic engagement with one another's ideas. Consider the

example Horn (2007) details of a conversation in the Algebra Group about a problem of practice a teacher named Tina encountered. In Tina's telling of the problem, she contrasted "kids that know a lot" or "kids who are fast learners" and "kids that [...] feel like they're slow learners" (p. 51). The department chair Guillermo then challenged Tina's categorization of her students (Figure 2.4).

1	Guillermo:	Um. OK, I have a prediction. My prediction is that you won't be able
2		to do anything about it. But that, I think that's from, from thinking
3		about a group of kids as *slow* learners and that's, that's how we're,
4		we're *acclimatized* to, to *think* about learning. And, and I don't really,
5		what I find is that when I have *mindsets* like that that they get in *my*
6		way in terms of thinking about the curriculum. So it wasn't a real
7		prediction but I was just trying to be shocking. Um.
8	Tina:	It worked.
9	Judy, others:	(Laugh)
10	Guillermo:	(Laughs) I wasn't trying to be mean.
11	Tina:	(Shakes head) You weren't.

Figure 2.4. Excerpt from a conversation in the Algebra Group at Railside High School (transcript excerpt from Horn, 2007, pp. 54-55)

In this short exchange, Guillermo first challenged Tina's language of "slow" to describe a group of students by linking the language to widespread narratives and noting that these narratives have gotten in the way of his own teaching. Tina and Guillermo engaged in banter (line 7: "...I was just trying to be shocking;" line 8: "It worked."), and others laughed (line 9). The lighthearted response to Guillermo's "prediction" (lines 1, 7) suggests that the practice of challenging one another's ideas had become normative in the group. As the conversation continued beyond the excerpt depicted above, Guillermo posed an alternative way of thinking about "fast" students as students who could benefit from slowing down and thinking more deeply about problems. This exchange sparked the group's inquiry into and reconsideration of the labels of "slow" and "fast" for students' abilities in relation to mathematics. Further, it prompted Tina and Carrie's collaboration to pose a "problem of the week" in their classrooms, as a space

through which to support the students Tina had seen as "fast" to engage in unrushed, deep thinking and problem-solving.

Establishing such a normative practice in the community requires trust and a culture in which it is safe to be vulnerable. For example, in analyzing the same fast/slow episode from the Algebra Group at Railside, Little (2003) highlights the vulnerability required of Tina in making this problem of practice public for discussion and "the importance of establishing a sense of trust and safety within the group" (p. 929).

What Is the Role of Professional Learning Facilitators and School Administrators in Supporting An Inquiry-Oriented Professional Community?

Studies of three of the eight communities (Hilltop Elementary, Gibbons, Kazemi, & Lewis, 2016; Mapleton Elementary and Nile Middle school, van Es et al., 2014) focus on facilitation practice. I attended to findings from these studies in relation to the tasks that were visible in leaders' work in studies for which facilitation and administration were not an analytic focus. I identified three key leadership tasks which appeared across multiple communities: (1) ensuring teachers' agency in hiring and placement decisions; (2) organizing a professional learning system toward a vision; and (3) facilitating inquiry in discussions. Who enacted these tasks varied by community and their contextual features, including the experience and capacity of the individuals supporting the community. I also attended to the stance facilitators held toward teachers in the communities, based on their reflections in the studies they themselves authored.

Ensuring Teachers' Agency in Relation to Hiring and Placement Decisions

A key task that emerged in my analysis of author's descriptions and reflections on the context at Railside High School involved ensuring teachers' agency in relation to hiring and placement decisions. Critically, there is evidence at Railside that the community's work was

sustained (e.g., Nasir et al., 2014). Teachers' and researchers' reflections on the work at Railside suggest that sustainment was, in part, related to teachers' agency regarding *what* they taught and *who* they were in community with (e.g., Louie & Nasir, 2014).

Prior to the department's reform efforts, hiring had long been in the purview of school administrators. As a part of its early reforms, the mathematics department advocated that teachers play a central role in hiring new mathematics teachers (Tsu, 1998). In part, the mathematics department's agency over hiring decisions allowed them to hire teachers with a "strong preference to do the work of teaching in a highly collaborative way" (Cabana, Shreve, & Woodbury, 2014, p. 181).

In secondary schools, it is typical that courses are assigned based on seniority, with the newest and often most inexperienced teachers assigned to entry-level courses (cf. McLaughlin & Talbert, 2001). But, the Railside High School mathematics department had agency over teachers' placement and preparation to teach all levels of courses. This preparation involved pairing more novice teachers with more experienced teachers to observe and discuss their instruction, engage in mathematics tasks together, and lean on each other for advice and support (Cabana, Shreve, & Woodbury, 2014).

Organizing Professional Learning Events

Across all eight communities, leaders engaged in the task of organizing professional learning events. *How* the leaders organized professional learning events appears critical. In my analysis, I found that leaders: (1) designed events toward a vision; and (2) built events into teachers' work schedules.

Designing toward a vision for the community's work in relation to an explicit vision for mathematics instruction. As described above, all of the communities exhibited evidence of

working toward a shared vision for instruction and for the community's work. In my analysis, I found that a key way leaders might support shared vision among the community is by organizing professional learning efforts toward that vision. For example, early in the Railside mathematics department's efforts to develop meaningful community, they engaged in workgroup conversations, workshops focused on Complex Instruction facilitated by university-based mathematics educators, and observations of an 8th-grade course co-taught by the department chair and a university-based mathematics educator (Tsu, Lotan, & Cossey, 2014). Each of these events were organized toward the same, developing vision for mathematics instruction. In subsequent years of the department's work, teachers' ongoing workgroup meetings (e.g., the Algebra Group meetings), Complex Instruction professional development sessions, and observations of colleagues' instructions continued to be organized around shared (albeit evolving) vision of mathematics instruction and "principles of distributed leadership and seeing teachers as learners" (Cabana, Shreve, & Woodbury, 2014, p. 184).

Even Louie and Nasir's (2014) account of "derailment" at Railside suggests the importance of organizing professional learning toward a vision. In the later years of Railside's documented work, teachers' meetings became increasingly dictated by an agenda, which they felt was set by leaders who seemed "to prioritize compliance with the letter of state and federal laws, regardless of the effects on students and students' learning" (p. 201). That is, it became less centered around the vision the community had for mathematics instruction and for their own work together.

There was variation among the communities in *who* organized meetings toward a vision. In some communities, a school administrator with experience teaching mathematics or with time and space to dig deeply into issues of teaching and learning mathematics played a central role

(e.g., the principal at Hilltop Elementary School; the assistant principal at Magnolia Middle School). In other communities, the school administrators made space in the school schedule for the community to meet and talk, and a school-based instructional coach or university-based mathematics educator organized the meetings toward a vision for mathematics teaching and for the community's work (e.g., the Freshman Team at Septima Clark). Across the communities, it appeared important that meetings were organized by one or more people who (1) could bring in outside resources and research regarding mathematics teaching aligning with the community's developing vision for mathematics instruction; (2) shared the community's vision for its work; and (3) engaged in ongoing conversations and learning in relation to supporting the community's work.

Building time into the school schedule for professional learning events. Another subtask supporting leaders' organization of professional learning events involved *scheduling* these events such that they were sustainably built into the school calendar. How frequently and when in the school schedule communities met and how this time was arranged varied widely across communities. Common among the communities, however, was effort to ensure teachers saw the communities' meetings as minimally burdensome in adding to their workloads. For at least four[10] communities, arrangements were made to build time into teachers' current schedules for their work. For example, the Freshman Team at Septima Clark High School met daily to talk about their enactment of Complex Instruction. Researchers and school administrators at Septima Clark coordinated prior to the school year, arranging for teachers to have an additional planning period dedicated to their work together, and securing an additional teacher for the Freshman

[10] It is unclear how time was built into the school schedule at Western Elementary School, Magnolia Middle School, and Esperanza High School.

Team with a background in Complex Instruction to cover the courses left from teachers' lightened teaching load (Bannister, 2009). As another example, the community at Crestview Elementary met monthly after school to engage in workgroup meetings facilitated by Kazemi and Franke. Researchers and school administrators also coordinated in this case about the arrangement of these meetings, designating one of the already-scheduled faculty meetings each month for the community's work (Kazemi, 1999). Administrators appeared to play an integral role in structuring time into teachers' current schedules, as they often hold in their purview the arrangements of teachers and students in the school day and the focus and frequency of faculty meetings.

In two communities, teachers met outside of their typical schedule, and teachers' additional time was compensated (usually by the grant supporting researchers' efforts in the school). For example, a group of seven fourth- and fifth-grade teachers at Mapleton Elementary met monthly after school with researchers for a video club. The teachers had been asked to participate by their principal and "were paid a small stipend" from the grant funding the researchers' work with Mapleton for their participation (Sherin & van Es, 2009, p. 23).

In the same "derailment" account described above, Louie and Nasir (2014) note that building time into teachers' schedule for professional learning events requires that school administrators assess the degree to which new policies align with the community's vision. There were significant changes that shifted the student population (e.g., more transience), increased tracking, and discontinued block schedules (i.e., 90-minute classes). These changes led teachers to have less time devoted to working together toward a vision, which is a critical piece of the derailment story, because, as Louie and Nasir say:

> sustaining the kind of teaching in which they were engaged - even in the absence of external challenges - requires teamwork. As Railside teachers described, they were

> constantly innovating and problem-solving, often covering new and unfamiliar territory that required teachers' collective resources (p. 199)

That is, school administrators' direction and treatment of policies influenced the time teachers had to work together toward their vision.

Facilitating Inquiry in Conversations

The third task that emerged in my analysis of leaders' support of and influence on the communities' work regards their facilitation of inquiry in conversations. Leaders appeared to engage in three subtasks related to facilitating inquiry: (1) surfacing and maintaining a direction for conversations; (2) pressing for specificity; and (3) pressing on conceptions about students. While these subtasks were also enacted by teachers and other community members, the studies under review indicate that they are especially important in the practice of professional learning facilitators as the community develops.

Surfacing and maintaining a direction for conversations. Studies of the communities at Crestview, Mapleton, and Western Elementary Schools and Nile Middle School document the early stages of the communities' work together. In these communities, I found that the professional learning facilitator surfaced and maintained a direction for the community's conversations. An analysis squarely focused on the facilitation practice at Mapleton Elementary School and Nile Middle School indicates that facilitators maintained a direction for conversations that focused on *inquiry* into issues of mathematics teaching and learning (van Es, Tunney, Goldsmith, & Seago, 2014). Facilitators did so in part by orienting the group toward evidence from which to draw in their inquiry and in part by connecting the ideas teachers raised to issues of mathematics teaching and learning.

Murata oriented conversations among the lesson study group at Western Elementary School toward particular lines of inquiry depending on the nature of the meeting and part of the

lesson study cycle they were working on. Murata and colleagues' (2012) analysis of discussions among the group found that "teacher talk overall moved from discussing student learning of mathematics, to discussing content, to discussing teaching, and finally back to discussing student learning" (p. 628). The authors argue that it was both the structure of lesson study and the facilitation Murata did inside of that structure to maintain direction in conversations which allowed for meaningful inquiry.

Pressing for specificity. The body of literature reviewed also suggests the importance of professional learning facilitators pressing for specificity in community members' descriptions. As van Es and colleagues (2014) describe, in their analysis of the facilitators' practice in supporting the communities at Mapleton Elementary and Nile Middle:

> *Pressing* explicitly prompts teachers to expand on an idea or further explain their reasoning … in the form of questions such as "Can you tell me more about that?" or "I'm not sure I understand your idea. Can you explain what you mean?" (p. 346, emphasis in original)

Across various communities, facilitators asked for clarification and elaboration when needed, for example, in relation to the context of an interaction during instruction (e.g., "Did you intervene?" Horn, 2010, p. 247) or details of students' thinking and participation (e.g., "Could you give an example of what [a student] did…?" Kazemi, 1999, p. 76).

While the studies of the Algebra Group at Railside High School do not focus on facilitation, they give a detailed image of various community members' press for specificity and its connection to the quality of the community's conversations. In Horn's 2005, 2007, and 2010 studies, Guillermo, the department chair, plays a key role in teachers' learning together by pressing his colleagues for specificity about episodes of instruction they share. For example, in Horn's 2010 study of the teachers' learning together through teaching replays and rehearsals, Guillermo presses a colleague Belinda for elaboration on the episode of teaching she describes.

Her specificity allows Guillermo to then describe (or "rehearse") how she might support the development of norms of interaction among students in her classroom. Horn (2007) argues that the specificity of teachers' dialogue painted a rich picture of classroom interaction and provided the group with opportunity to engage in critical discussions of teaching and, as described in more detail below, of narratives about students' abilities.

Pressing on conceptions about students. A third subtask involved in facilitating inquiry involved facilitators pressing on the conceptions of students that were raised in conversations. For example, at Crestview Elementary School, the professional learning facilitators oriented the community toward what students *were* doing, rather than what they *were not* doing (e.g., Kazemi, 1999; Kazemi & Franke, 2004). They supported teachers' understanding of why students might have difficulty with the content, supported them to see what students did know, and supported them to think about how they could move forward with students, building on what students know. This work "deepened as well as challenged teachers' notions about their work as teachers" (Kazemi & Franke, 2004, p. 230).

As another example, Horn (2007) gives an illustration of the Algebra Group at Railside High School in which a teacher Tina gave a rich description of a particular episode of instruction, highlighting a gap between the "fast" and "slow" learners in her classroom. In the process of engaging in conversation with her colleagues, Tina's account became open and nuanced, and it surfaced language deeply embedded in U.S. mathematics classrooms regarding what it means to be capable of rigorous mathematics. The department then examined instructional decisions in relation to these narratives about students. Tina's colleagues, Guillermo (the department chair) and Carrie (a fellow teacher), challenged the categories of "fast" and

"slow" by connecting to a broader conversation about what it means to engage in the discipline of mathematics.

These examples suggest particular knowledge facilitators might need in order to be able to press on conceptions of students in a community. At Crestview Elementary School, facilitators spent regular time in teachers' classrooms getting to know students. Their knowledge of those students and their mathematical understanding supported them to orient the community toward what students *do* know by providing concrete examples of students' mathematical competencies (Kazemi & Franke, 2004). Horn's analyses of the Algebra Group at Railside High School suggest that facilitators need to have developed an understanding of the particular categories present in the community for students and their abilities. The categories "fast" and "slow" present in the Algebra Group were related to conceptions about the discipline of mathematics and to beliefs about students. Guillermo's and Carrie's knowledge of these categories allowed them to challenge them directly.

Orienting Toward Teachers as Knowledge-Generators

A set of the pieces reviewed here were written by facilitators of the communities' professional learning themselves (at least 16 of the 45 total pieces[11], from six communities). Often, these pieces provide insight into the stance of the author-facilitators toward the teachers in the communities. I found that across studies of the six communities, author-facilitators' language reflected an orientation toward teachers as knowledge generators in the community's work together.

[11] There were 16 studies in which it was clear that an author also facilitated.

Several author-facilitators described teachers in the community as sources of knowledge and expertise that would benefit the community's learning (e.g., Lewis, 2016; Franke et al., 2005). For example, the author-facilitators who worked with the community at Crestview Elementary School said, "we wanted [teachers] to see from the start that they were experts about both their own students and about ways to support the learning of their students" (p. 213). The Crestview author-facilitators described the importance of this orientation toward teachers in terms of the community's sustainment; teachers needed to see themselves and each other as valuable resources for each other's learning and ongoing work (Kazemi, 1999).

Across the communities, author-facilitators described the community's work together as involving joint knowledge generation among those participating in the professional learning events together. As Murata and colleagues (2012) described of the work at Western Elementary School they analyzed, the community's knowledge "was developed collaboratively, influenced by the varied interests and experiences of the individual teachers" (p. 642). In part, author-facilitators conveyed this stance by speaking about their own learning and knowledge generation alongside teachers. For example, as Franke and colleagues (2005) reflect, "we wanted the teachers to see us participating with them in learning about the development of students' mathematical thinking and ways to incorporate that knowledge into their classroom practice" (p. 213). The author-facilitators wanted teachers to see them as learning *with* the community about both the particular students in their classrooms and about the work of teaching those students. In the case of the video clubs at Mapleton Elementary School and Nile Middle School, the author-facilitators noted that as the community watched and responded to video of one another's teaching practice, the author-facilitators were not evaluating teachers' interpretations of the video or guiding teachers toward a particular interpretation. Rather, "both the facilitators and teachers

played important roles in shaping the discussions that ensued in the meetings" (van Es & Sherin, 2008, p. 247).

The stance described by these author-facilitators is in keeping with the one described in seminal work on the development of community. For example, Grossman, Wineburg, and Woolworth (2001) note that a critical starting point in the development of community involves a stance among all those involved (facilitators and researchers included) that "some people know things that others do not know and that the collective's knowledge exceeds that of any individual" (p. 973). That is, facilitators are not the keepers of all of the knowledge; rather, their role is to support the knowledge generation of the community. Little (1993) also writes that the most generative professional learning settings rest on "a view of teachers not only as classroom experts, but also as productive and responsible members of a broader professional community" (p. 133).

Discussion and Conclusions

In this paper, I have analyzed the existing literature to specify what we know in the field about how robust, inquiry-oriented professional communities of mathematics educators are established, sustained, and supported by leadership. Prior research has detailed the characteristics of communities associated with students' and teachers' learning (e.g., Jaworski, 2006; Kruse, Louis, & Marks, 1995), and there are empirical examples of communities with these characteristics in the literature. However, little research has examined the features and practice that support the development of such communities (cf. National Academies of Science, Engineering, and Medicine, 2020). In this paper, I examined 42 studies of eight inquiry-oriented professional communities focused on improving mathematics teaching and learning to answer the questions: (1) What is the focus of an inquiry-oriented professional community? (2) How are

inquiry-oriented communities established and sustained? and (3) What is the role of professional learning facilitators and school administrators in supporting an inquiry-oriented professional community?

Taken as a whole, this review highlights the foci of inquiry, aspects of vision, routine structures, normative practices, and leadership tasks that might contribute to the development and sustainment of such communities. Further, this analysis suggests a set of considerations for practitioners and researchers working to develop and understand the work of communities which result in meaningful aims for teachers and students. In what follows, I discuss these considerations. I conclude with questions raised by this analysis and potential directions for future research. Throughout, where possible, I connect to other seminal studies of mathematics departments and communities that did not meet the criteria for this review but provide insight into the focus, development, sustainment, and leadership of robust, generative groups of mathematics educators.

Key Considerations in Supporting the Development of Communities

One key consideration regards the *vision* orienting the community and the extent to which it is *shared* among teachers, leaders, and other stakeholders influencing the community. We saw above that each of the communities targeted an explicit vision for mathematics instruction, and this vision appeared to be shared by professional learning facilitators. Further, in communities where school administrators attended the community's meetings (i.e., Hilltop Elementary School, Magnolia Middle School, and Western Elementary School), the school administrators also appeared to share this vision. It is worth noting that the studies under review did not illuminate *how* this vision came to be shared, especially by school administrators. This is

not likely to be trivial work and warrants further study[12]. However, a key consideration in supporting the development of communities appears to be a vision for mathematics instruction that is shared among the leaders and teachers influencing the community.

Another related consideration regards ongoing opportunities for the community to *specify* and *refine* their vision. Certain shared, normative practices for engaging together appeared to support these efforts for specification and refinement in the communities under review. For example, we saw the Crestview community authentically engage with Mr. M's proposal that the multiplication algorithm was the most sophisticated strategy they saw students use on a problem. As Ms. N and Ms. K offered alternative viewpoints, it allowed the group to articulate what a teacher might want to know about a students' thinking as they are using the algorithm. In doing so, the group was further specifying their vision for teaching multiplication.

Building from this, what is *normative* and *routine* among the group in terms of its conversations and interactions with one another appears to be a critical consideration in the development of community. The findings of this review indicate that robust, generative communities are marked by vulnerability and willingness to inquire into authentic problems from teachers' own practice, rather than privacy; an orientation toward experimentation, rather than evaluation or performance; and authentic engagement with one another's ideas, rather than acting "*as if* we all agree" (Grossman, Wineburg, & Woolworth, 2001, p. 955, emphasis in original). Each of these ways of engaging together depends on meaningful relationships and trust among community members, including teachers, professional learning facilitators, school

[12] In Chapter 3, I begin to address this gap by providing an illustration of three leaders working to make decisions in relation to an evolving and ever-deepening vision for mathematics instruction and vision for the community's work together.

administrators, and researchers (Datnow & Park, 2019; Sztajn, Hackenberg, White, & Allexsaht-Snider, 2007). Further, literature suggests that these ways of conversing in a school setting likely require deliberate work to disrupt modal hierarchies of status between role groups and various positionalities in the community (cf. Lefstein, Louie, Segal, & Becher, 2017).

Another key consideration for the development of inquiry-oriented professional communities concerns the role of outside expertise. Of the eight communities under review, seven were engaged in professional learning facilitated by university-based mathematics educators. This could be explained in part by the fact that university-based mathematics educators are often the authors of these pieces, researching what is happening in their own research contexts. However, we also see the importance of outside expertise in the example of the sixth grade team at Magnolia Middle School, the one example of a community that was not facilitated by university-based educators. The instructional coach co-facilitating the sixth grade team meetings engaged in meetings with other instructional coaches in the district and members of the MIST team, to learn together about the launch or introduction to cognitively demanding tasks (Jackson, Garrison, Wilson, Gibbons, & Shahan, 2013). The instructional coach then oriented the sixth grade team toward the launch of tasks.

In relation to the considerations above, it appeared critical that the outside expertise did not dictate these communities' efforts; when researchers were directly involved in communities, they appeared to attend carefully (1) to when they brought research to bear on conversations (e.g., bringing research as it was relevant to the community's aims and conversations; Murata et al., 2012), (2) to being seen as learning alongside teachers and school leaders (e.g., Franke et al., 2005), and (3) to how to orient consistently toward teachers as knowledge-generators.

While the development of these communities appeared to depend on outside expertise, their sustainability also appeared contingent on supporting school-based leadership and facilitation. In the three communities for which we have evidence of the community's ongoing work over many years (Crestview and Hilltop Elementary Schools; Railside High School), the university-based mathematics educators supported a meaningful transition of facilitation responsibilities of the community's meetings to school-based staff. That is, facilitation was transferred gradually with support, and with attention to staff members' experiences, expertise, and capacity. For example, at Hilltop, the school-based instructional coach co-facilitated for several years, collaborating with university-based mathematics educators in design, planning, and facilitation decisions; she eventually took on sole facilitation responsibilities (Gibbons, Kazemi, & Lewis, 2017).

Reflections on Writing About Communities

This review highlights the power of producing a *set* of written accounts of a community. A set of studies allows the reader to see the nuance in, the nature and character of, and the various outcomes of the community's work together. Using the same pseudonym throughout the set allows the field to trace the story of the community's work. It appears generative that part of this set of writing include reflection on or analysis of the community's work over time, for example, after a research grant organizing professional learning efforts has ended. Such reflections on the communities at Crestview Elementary School (Franke et al., 2005) and Railside High School (Louie & Nasir, 2014) allowed me to begin to theorize in this review about what matters for *sustained* efforts.

It also appears important that part of a set of accounts about a community make plain the vision for teaching and learning guiding the community. This aligns with recent arguments to

analyze professional learning (cf. Kennedy, 2016) and practice (e.g., Janssen, Grossman, & Westbroek, 2015; Resnick & Kazemi, 2019) in light of the vision underpinning it. As Resnick and Kazemi (2019) argue, a careful description of vision "serves as a lens for interpreting identified components of practice and supporting incorporation into a 'whole' practice that is responsive to specific context and relationships" (Resnick & Kazemi, 2019, p. 12).

Relatedly, it appears generative (in relation to a vision *for the community's work*) to describe the community in terms of characteristics of inquiry-oriented professional community (Table 2.1). As a field, we know these characteristics matter for subject-specific groups; they are well-established in connection to outcomes for both students and teachers. However, in my review, evidence of each of the characteristics was often hard to find, and required looking across multiple studies (see Appendix A). Describing the vision for the community's work (held by teachers and/or by those designing and facilitating professional learning) could involve description in relation to these characteristics. Each of these reflections on writing about communities can support the field's work toward a set of shared language and practices.

Questions Raised, and Directions for Future Research

More work remains to be done if the field is to shape the organization of schools for teachers' and students' learning and wellbeing. It is clear in this review that the development of inquiry-oriented professional communities that shift the status quo and result in meaningful outcomes for students are challenging to develop. Further, they require particular organizational features and intentional work on the part of professional learning facilitators and school administrators. They appear to be fragile (e.g., the "derailment" at Railside, Louie & Nasir, 2014), not easily sustained even once they are developed. As a field, we need to know far more

about *how* such communities come to be developed, the factors and features that matter for their sustainment, and the specific role of leadership.

One critical implication for future research into the focus of communities' work regards inquiry into racialized discourses. This review has provided insight into productive lines of inquiry among mathematics teachers—it indicates that one important line of inquiry in generative communities includes regards discourses about students and their capabilities. Literature suggests that such discourses are critical to hold to the light and explore with colleagues (e.g., Jackson, Gibbons, & Sharpe, 2017). Literature also suggests that if teachers are to support students from communities historically marginalized and oppressed by schooling generally and mathematics in particular, the systemically-rooted racialized discourses that very often intersect with discourses about students' academic capabilities must be aired and disrupted (cf. Nazemi, 2017). There was no evidence in this body of literature that such discourses were a focus of conversation, which is perhaps because of the nature of the research questions asked of the communities (Appendix C).

It is crucial that research take up constructs and questions that highlight the ways that racialized discourses are raised and explored in communities of educators, and specifically in subject-specific inquiry-oriented professional communities, including mathematics departments. As Gutiérrez (2000) says, "when mathematics teachers acknowledge race and racism as a part of their students' everyday lives, they are able to support students in complex manners" (p. 103). We need images of how such discourses might show up and be shaped by communities' conversations and collective inquiry, and how they intersect with the lines of inquiry that emerged in this review (Joseph, Jett, & Leonard, 2018; van Es, Hand, & Mercado, 2017). Louie's (2015, 2016, 2017a, 2017b) studies of the mathematics department and Geometry Team

at Union High School in its first year of work together are an important start to this kind of work. Second, we need to understand how inquiry into racialized discourses might be supported in communities' work. As an example, Battey and colleagues (e.g., Battey & Chan, 2010; Battey & Franke, 2015) have begun to explore inquiry into racialized discourses in relation to the focus and facilitation of professional development. Open questions for the field include: What are the features (i.e., routines, normative practices) of communities in which racialized discourses are held to the light, challenged, and disrupted in conversations and in practice? What is the role of facilitators and school administrators in supporting such a focus in community?

In relation to how communities are established and sustained, a central implication for research raised by this review concerns understanding how community develops across multiple forms of professional learning (i.e., across a professional learning *system*; Cobb, Jackson, Henrick, Smith, et al., 2018). As an example of this, Lewis (2017) explored teachers' learning as they engaged together in Math Labs and in one-on-one classroom visits with the instructional coach. This study provides an image of how a set of professional learning structures might work together in support of teachers' learning and the development of a robust community. We need more studies of this nature in order to develop theory regarding *how* professional learning systems that support meaningful learning are developed and maintained. I begin to take this up in Chapter 3, where I explore school leaders' design and enactment of a professional learning system toward the development of an inquiry-oriented professional community among a middle school mathematics department.

In relation to the theoretical or analytical frame researchers take when analyzing the development and sustainment of communities, it appears valuable to consider what is *routine* or *normative* about communities' work. In this review, I drew on Feldman and Pentland's (2003)

definition of routines as "repetitive, recognizable pattern(s)" in the community's work (p. 311). I further specified routines as either *routine structures* or, following Coburn and Russell (2006), *routine interactions.* I also attended to the normative practices the communities appeared to engage in (Little, 1982; McLaughlin & Yee, 1988). These appear to be useful categories in specifying aspects of communities, in that they reveal what happens with regularity in a community. They also warrant further exploration, expansion, and refinement through analysis of other communities' work. In my analysis of the literature, I found routine structures to be readily visible, as they often aligned with professional learning events. Normative practices and routine interactions were more challenging to identify, in that they required attention to how community members engage together. Normative practices became visible when there were transcripts of conversations in which to see the community's responses to particular ways of engaging together, and thereby see what is accepted and celebrated, and what appears to be a breech in normative practice. Routine interactions require attention to what happens with regularity, and were challenging to identify in this corpus of literature except in the case of "teacher time out," in which the routine was itself the analytic focus of the study (Gibbons, Kazemi, Hintz, & Okun, under review). In Chapter 3, I take up the concepts of routine structures and routine interactions to shed light on the development and leadership practice supporting an inquiry-oriented community of middle grades mathematics educators. In Chapter 4, I take up the concepts of routine structures and normative practices to shed light on *how* the community's work allowed for teachers to air and navigate the tensions that emerged as they worked to enact their commitments to meaningful aims for students and instruction.

This review highlighted that there has been very little research on the role and practice of professional learning facilitators in the support of inquiry-oriented professional communities of

mathematics educators, and even less on the role and practice of school administrators. One key direction for future research is to focus analysis on the facilitation and administration practice supporting such communities. It appears generative to consider and attend to the *distribution* of leadership (e.g., Spillane, 2006). I began this analysis with two separate questions regarding the leadership influencing and supporting the communities, one focused on the work of professional learning facilitators, and one focused on the work of school administrators. In the process of analysis, I found that the practice of these individuals was intertwined and could not be easily parsed apart. A distributed leadership perspective treats leadership practice as a whole, shared set of tasks distributed across individuals and aspects of the context (Spillane, 2006). This lens appears useful in studying the leadership of communities, because it acknowledges that the experiences and expertise in a school, and the expectations for any given role vary greatly by context. We need to understand the role and practice of leaders in relation to communities at varying places in their maturity, including such questions as: What is the role and practice of professional learning and school administrators in the early development of a community? As it is more established? It is likely that their roles look different at different time points and in relation to various contextual features of the community (e.g., the experience of the teachers the community), and this warrants more study.

CHAPTER 3. AN ANALYSIS OF LEADERS' PRACTICE IN SUPPORTING INQUIRY-ORIENTED PROFESSIONAL COMMUNITY IN A MIDDLE SCHOOL MATH DEPARTMENT

Supporting students to engage in rigorous mathematical activity and to see themselves as mathematics learners with power and agency is challenging work. Teachers must surface and challenge discourses about what it means to do mathematics (e.g., Gutiérrez, 2012; Horn, 2007), what it means to teach mathematics (e.g., DiME, 2007; Munter, 2014), and who is capable of rigorous mathematical activity (e.g., Jackson, Gibbons, & Sharpe, 2017; Nazemi, 2017). They must also deepen their own mathematical knowledge for teaching (e.g., Hill, Ball, & Schilling, 2008; Shulman, 1986) and develop forms of teaching practice that build on students' thinking and experiences (e.g., Aguirre, Mayfield-Ingram, & Martin, 2013; Franke, Kazemi, & Battey, 2007; Wilson, Nazemi, Jackson, & Wilhelm, 2019). At the same time, teachers must be able to adapt their practice to support the individual students in their classrooms to thrive – particularly those from communities historically marginalized in and oppressed by mathematics and schooling (e.g., Gutiérrez, 2002; Joseph, Hailu, & Matthews, 2019).

This highly complex and challenging work requires the support of colleagues in *community* (e.g., Franke, Carpenter, Levi, & Fennema, 2001; Little, 2002; McLaughlin & Talbert, 2001; Nasir, Cabana, Shreve, Woodbury, & Louie, 2014). That is, these pursuits require ongoing space in which educators can collectively engage in the deeply vulnerable work of identifying and calling into question ideas that are often taken for granted concerning mathematics, teaching, learning, and students. Colleagues must help each other actively recognize assumptions that might otherwise remain tacit and press each other to question and explore ideas and their implications (e.g., Horn, 2007). Further, this enterprise requires a

collective understanding that wrestling with the dilemmas of teaching is part and parcel of the work of teaching (Little, 1982).

Robust examples can be found in the literature, pairing mathematics teachers who work together in inquiry-oriented professional communities with evidence of powerful changes in practice. For example, studies of the mathematics department at Railside High School have provided images of teachers engaging in authentic, collective inquiry into instructional practice oriented toward ambitious and equitable learning aims for students, accompanied by compelling evidence that students' learning and sense of themselves as mathematics learners improved (Boaler, 2002; Boaler & Staples, 2008; Nasir et al., 2014).

While the field knows the value of these kinds of authentic, inquiry-oriented communities, only minimal research has traced the development of these communities from their inception (see Chapter 2 for a discussion). The images of mathematics department communities that exist in the literature suggest that professional learning facilitators and school leaders play a critical role in creating the conditions in which robust communities can develop, but their work has been less specified (e.g., Battey & Franke, 2015; Horn, 2007; Lewis, 2016). In order to contribute to the field's understanding of the role and practice of leaders in this work, I report on a qualitative analysis of leaders' approach to supporting the development of an inquiry-oriented professional community of mathematics teachers at Forest Middle School in the northwestern U.S.

At the time of data collection, Forest Middle School had been a part of a research-practice partnership aiming to understand how district math leaders, coaches, and teachers can use data about instructional practice to support system-wide instructional improvement for several years. The mathematics department at Forest was comprised of teachers in their first two

years at this school and leaders in their first year of a coordinated effort to design and facilitate a connected set of professional learning experiences geared toward developing an inquiry-oriented community of teachers. As such, this school's circumstances provide an especially rich case in which to make sense of how inquiry-oriented professional community might be developed and supported. I focus particularly on the work of the school leader (in this case, the principal) and professional learning facilitators (in this case, the mathematics and English Language arts instructional coaches) who designed and enacted a set of professional learning experiences aiming to establish and sustain such a community. I asked the following question: "What is the practice of school administrators and professional learning facilitators in supporting an inquiry-oriented professional community?"

In what follows, I begin by reviewing what we know about the roles of school leaders and professional learning facilitators in supporting inquiry-oriented professional communities. On the basis of this, I propose a framework for analyzing the work of the leaders at Forest. I then describe the methods I employed in this analysis and present my findings, which focus on the routines and activities the leaders enacted in support of the community. Based on these findings, I outline considerations for leaders' practice in support of establishing inquiry-oriented professional communities. I conclude by discussing limitations and implications for future research.

Relevant Literature and Framing Concepts

Supporting Inquiry-Oriented Professional Community

As described in detail in Chapter 2, *inquiry-oriented professional community* brings together conceptions of professional community and inquiry community. It is characterized by the features of professional community, namely collaboration, deprivatized practice, reflective

dialogue, shared norms and values, and a focus on student learning (Kruse, Louis, & Bryk, 1995). Further, an inquiry-oriented professional community engages in ongoing inquiry together; inquiry is both a *tool* the community uses in its work together and a *stance* it maintains.

Inquiry-oriented professional community stands in direct contrast to what Grossman, Wineburg, and Woolworth (2001) describe as *pseudocommunity*:

> The imperative of pseudocommunity is to "behave as if we all agree." An interactional congeniality is maintained by a surface friendliness, hyper-vigilant never to intrude on issues of personal space. The maintenance of pseudocommunity pivots on the suppression of conflict. Groups regulate face-to-face interactions with the tacit understanding that it is against the rules to challenge others or press too hard for clarification. This understanding paves the way for the illusion of consensus. (p. 955)

By contrast, in an inquiry-oriented professional community, vulnerability proves essential as individuals open up authentic problems of practice for the group to wrestle with and engage together. Community members make specific ideas and concepts public so they become open to clarification, contradiction, refinement, and, perhaps eventually, some consensus. At the heart of inquiry-oriented professional community is the aim "of challenging the status quo, of questioning accepted ways of being and doing" (Goodchild, Fuglestad, & Jaworski, 2003, p. 396). Where pseudocommunity depends on the suppression of challenging and pressing on ideas, inquiry-oriented professional community depends on the presence of it.

An inquiry-oriented professional community presumes that each one of its members, regardless of title, role, or experience, is *learning*, and that all of its members also bring ideas, practices, and perspectives that are important to the group's work. That is, in these communities, modal hierarchies of status among leaders and teachers, or researchers and practitioners, are actively disrupted in service of a "spirit of mutual inquiry" (Jaworski, 2006, p. 205).

We know inquiry-oriented professional communities are neither easily nor routinely established. Their key characteristics – collaboration, deprivatized practice, reflective dialogue,

shared norms and values, focus on student learning, and ongoing inquiry into practice, students, and prevalent narratives about teaching, learning, and students – are all counternormative and require conditions at odds with those that prevail in typical U.S. schools. For example, in order for group members to collaborate regularly, they must have time in their workday to visit each other's classrooms as well as meet and talk, which runs counter to the traditional "egg crate" organization of schools (Lortie, 1975). Further, for this collaboration to be meaningful, teachers must see it as so, and not simply feel pressured or coerced to work collectively (Hargreaves, 1994). Opening their classrooms to colleagues and exposing their practice to critical, inquiry-oriented discussion requires vulnerability, respect, and trust among teachers that defy what Little (1990) and Lortie (1975) have described as well-established norms of privacy and isolation in schools. Engaging in meaningful inquiry also requires a culture in which people can question and explore each other's ideas about the discipline, teaching, and their students' capabilities, something not possible in the "pseudocommunities" described above, especially in such spaces as schools which follow typically white, middle-class norms to "behave *as if* we all agree" (Grossman, Wineburg, & Woolworth, 2001, emphasis in original, p. 955).

Developing an inquiry-oriented professional community requires more than teachers' will and agency; it requires changes in the organization of schooling (Bannister, 2018; Gutiérrez, 2000) and attention to the institutional context of the community (Cobb, McClain, de Silva Lamberg, & Dean, 2003). Research indicates that school administrators (e.g., principals and vice principals) and professional learning facilitators (e.g., instructional coaches) play an essential role in shaping schools to support community among subject-specific groups of teachers (e.g., Gutiérrez, 1998; Horn, Kane, & Garner, 2018).

School administrators hold in their purview, among other responsibilities, structuring the workday, hiring teachers, and communicating expectations to teachers. Literature suggests that the ways in which school administrators enact these operations can either support or hinder community. For example, Halverson (2003) has argued that in order to support professional community among teacher groups, school administrators must both create expectations and allot time in the workday for teachers to visit each other's rooms (deprivatizing practice) as well as meet and talk with their colleagues (time for reflective dialogue). In fact, Louis, Kruse, and Bryk (1995) have argued that the most critical role a school administrator plays is their creation of meaningful opportunities for teachers to collaborate on issues that matter to them and to student learning. Research also suggests that how school administrators organize their own time affects their success in establishing community, allotting time to work intentionally with the instructional coach (e.g., Cobb & Jackson, 2011; Gibbons, Kazemi, & Lewis, 2017); time in teachers' classrooms to provide meaningful feedback on instruction (e.g., Cobb & Jackson, 2015); and time in professional learning events with teachers (e.g., Jackson & Cobb, 2013).

Professional learning facilitators (e.g., instructional coaches, district content specialists) likewise play a critical role in fostering the conditions for meaningful community to form (Andrews-Larson, Wilson, & Larbi-Cherif, 2017). Such facilitators can foster a group culture conducive to inquiry, one in which group members feel safe enough to be vulnerable with their practice and press on each other's ideas (cf. Lefstein et al., 2019). For example, in a study of the facilitation of four different classroom-embedded professional development experiences, Gibbons, Lewis, Nieman, & Resnick (under review) found each facilitator worked to foster trust among the group, highlight the value of collaborative work, and orient the group toward experimentation with and curiosity about instructional practice. As another example, in a study

of the role of the facilitator in teacher workgroups, Kane (in press) found that the facilitator supported teachers' generalization from the specifics of practice to broader principles of teaching. Significantly, they can also orient the group productively toward students' capabilities (e.g., Battey & Franke, 2015; Hand, 2012).

While teachers undoubtedly play a central role in supporting inquiry-oriented community in their departments and collaboration at the grade-level, this chapter focuses primarily on *leaders* in order to begin to specify their distinctive and essential work. In this analysis, I asked the following question: "What is the practice of school administrators and professional learning facilitators in supporting an inquiry-oriented professional community?"

Understanding the Practice of Leaders in Supporting Community

To explore how inquiry-oriented professional community was supported by leaders, I used an approach influenced by a distributed leadership perspective. Distributed perspectives are useful in the study of professional communities in part because the characteristics of strong professional communities, as laid out above, assume that knowledge is shared among community members. This assumption comprises a central premise of distributed frameworks for analyzing cognition and leadership (Hutchins, 1995; Spillane & Diamond, 2007; Spillane, Halverson, & Diamond, 2001, 2004; Spillane, 2006, 2015). Distributed perspectives assume human activity to be "stretched over" individuals and aspects of their situation. In other words, individuals' noticings, interpretations, and negotiations of meaning are all a function of their interactions with others and with parts of the context in which they work (Spillane, 2015).

From a distributed perspective, leadership practice is not centralized in one individual. Rather, it consists of "the identification, acquisition, allocation, coordination, and use of the social, material, and cultural resources necessary to establish the conditions for the possibility of

teaching and learning" (Spillane et al., 2001, p. 24). According to this definition, leadership practice is not a mere set of actions taken by someone in a formal leadership role. Rather, it is the body of work that fosters the conditions for improving teaching and learning in schools – the interactions among individuals and aspects of the school situation that support these conditions. The unit of analysis becomes this interaction, rather than an individual or what an individual does (Spillane, 2015). From a distributed perspective leadership "involves the many, and not just the few. It is about leadership practice, not just roles and positions. And, leadership practice is about interactions, not just the actions of heroes" (Spillane, 2006, p. 4). One way leadership is distributed is over "the many" individuals involved in shaping, in this case, the school and department setting – those with and without formal leadership titles. With roots stretching back to the work of Leont'ev, the unit of analysis under a distributed leadership perspective is the collective rather than the individual.

In understanding leadership practice, attention to elements of the school's or department's *routine* is critical (Spillane, 2006), meaning the "repetitive, recognizable pattern(s)" in the school's or department's work (Feldman & Pentland, 2003, p. 311). I attended to both routine structures and routine ways of interacting inside those structures. A *routine structure* is a sequence of events that recurs regularly and both involves and is recognizable by multiple role groups as routine. As will become clear below, the mathematics department at Forest engaged in a set of routine structures including one called Math Labs (Kazemi et al., 2018). During Math Labs, leaders and teachers met to plan an episode of instruction, enacted instruction together in a colleague's classroom, and debriefed the enactment together. A Math Lab was a routine structure in that it involved a sequence of events that happened three times

during the school year and both involved and was recognizable as routine by teachers and leaders at Forest.

Within the routine structures, interactions between and among individuals can become routinized. Building on Coburn and Russell's (2008) analysis of how coaches and teachers work together in the context of mathematics education reform, I define routine interactions[13] as patterned ways of engaging together "intended to guide conversation between adults on matters of instruction" (p. 217). As one example, at Forest, the leaders aimed for teachers to routinely pause during instruction in each other's classrooms (e.g., during a Math Lab) to engage in inquiry together. These pauses were routine interactions in that they occurred regularly when teachers and leaders were enacting instruction together and made space for particular kinds of conversations about instruction.

Leadership practice includes the *tasks*, or activities, involved in establishing and executing routine structures and routine interactions (Spillane, 2006). For example, as I will explicate below, in order to support the mathematics department to routinely pause during instruction to engage in inquiry, an important leadership task involved framing teaching as requiring experimentation. Critical to analyzing tasks is naming the *functions* these tasks address. Spillane (2015) has argued that leadership practice and its purpose cannot be analyzed or taken up separately; aspects of practice are understood only in light of the functions they serve. The function of practice has often been left implicit in analyses of leadership and school reform, but actively grounding any specification of practice in the purpose it intends to serve is critical to maintaining the complexity and meaning of the work (Spillane, 2000). A function-centered

[13] I use the term "routine interactions" to mean the same as what Coburn and Russell (2008) call "routines *of* interaction."

approach to analysis allows researchers to "attend to the daily work of school leaders without losing sight of the big picture" (Spillane et al., 2001, p. 24).

Spillane's (2000) argument to attend to the function (rather than solely the form) of practice – the rationales that underpin decisions to act or organize in particular ways – is commensurate with recent arguments to attend to the *vision* underpinning practice. My analysis sits within a broader body of work aiming to specify the work of practitioners to inform improvement efforts (e.g., Grossman et al., 2009). One danger in specifying practice is divorcing it from context and the meaning of the practice. In response, an increasing body of literature advocates grounding specifications of practice in the vision underpinning it (e.g., Janssen, Grossman, & Westbroek, 2015; Resnick & Kazemi, 2019). I take up Hammerness's (2001) definition of vision as an image of ideal practice, serving as "a guide and a measure" for one's work (p. 146).

Specifying the vision underpinning practice "serves as a lens for interpreting identified components of practice and supporting incorporation into a 'whole' practice that is responsive to specific context and relationships" (Resnick & Kazemi, 2019, p. 12). The argument for attention to vision is echoed by scholars attending to the design of professional learning events. For example, in a recent review of the scholarship on professional learning, Kennedy (2016) argued that when analyzing professional learning designs, researchers should attend to the theory of action that undergirds it rather than solely to its features.

Literature suggests that we attend to various layers of the vision undergirding leaders' practice, including vision for supporting both students' and teachers' learning (e.g., Hubbard, Mehan, & Stein, 2006; Kazemi & Resnick, 2020). For example, in a compendium of research analyzing the work of teachers and experiences of students at Railside High School, the authors

articulated a descriptive set of principles comprising a vision for supporting students' and teachers' learning (Nasir et al., 2014). Components of this vision included the following: seeing all teachers and students as learners; working from strengths while making space for vulnerability; redefining "smart;" redefining what it means to do math in school; and recognizing the importance of relationships. The authors argued that these components of the vision were crucial to understanding the work of the professional community at Railside: "The aspects of teaching practice and professional community at Railside were only powerful when connected to important and meaningful overarching principles" (Nasir et al., 2014, p. 235). As we see in this example, vision for supporting students' learning and teachers' learning may be tightly intertwined.

This analysis is guided by a view of leadership practice as comprised of tasks underpinned by vision, which support the establishment and enactment of routine structures and routine interactions. My aim in this analysis is to specify leadership practice involved in supporting inquiry-oriented professional community, including deprivatization of practice, reflective dialogue, collective focus on student learning, shared norms and values, collaboration, engaging in inquiry as a tool, and developing inquiry as a stance.

Methods of Analysis

The following research question guided my analysis: "What is the role of school leaders and professional learning facilitators in supporting an inquiry-oriented community?" I employed a distributed perspective to engage in a qualitative case study of the school leader (hereafter, the principal, Jack) and professional learning facilitators (hereafter, instructional coaches Patty and Ada) in supporting an inquiry-oriented community in the mathematics department at Forest Middle School. A case study allowed me to generate a "thick description" of the role of these

individuals (Geertz, 1973). In what follows, I first justify my selection of Forest as a case, then describe the research context, my positionality in the research, data sources, and analytic process.

Research Context and Case Selection

I purposefully selected (Patton, 2003) the Forest Middle School mathematics department for this study as a case of school leaders and professional learning facilitators working intentionally to support an inquiry-oriented professional community during the year 2018–2019. Forest Middle School (grades 6-8) is an ethnically, racially, and linguistically diverse school in the Northwestern U.S. At the time of data collection, there were 580 students at Forest. District records classified students' racial and ethnic affiliation as follows: 0.2% American Indian/Alaskan Native; 13% Asian; 17.6% Black/African American; 26.3% Hispanic/Latinx; 5% Native Hawaiian; 12.5% two or more races; and 25.4% white. The district prided itself on the number of languages spoken by students and families, and Forest displayed a school district sign saying "120 languages spoken" at the front of the school. 16.3% of students at Forest were classified by the district as "English Language Learners." A majority of students (74%) received free or reduced-price lunch, and 17.4% of students were classified by the district as receiving services for disabilities.

The school had undergone significant changes in the two years prior to this analysis. It had "de-tracked" all of its mathematics classes, meaning that students were no longer assigned to mathematics classes based on presumed ability. All seven of the mathematics teachers, along with more than 75% of the teaching staff as a whole, were in their first two years of teaching at Forest (though some had taught elsewhere previously) (see Table 3.1).

Table 3.1. Mathematics teachers at Forest in 2018 – 2019.

Mathematics teacher	Grade level	Racial / ethnic self-identification	Years teaching experience (prior to 2018 – 2019)
Bea	Sixth	White	0
Mari	Sixth	White	1
Carol	Sixth	Black	19
Eric	Seventh	Black	7
Lynn	Seventh	Asian	2
Robin	Eighth	White	7
Dave	Eighth	White	16

All three leaders identified as white. Jack had been a principal for six years total, three of them at Forest Middle School and three at an elementary school. Prior to that, he had worked for many years as a secondary mathematics teacher. Jack expressed a strong commitment to equitable outcomes for students at Forest and to teacher and leader collaboration. In his previous principalship, he had participated in a district-supported professional development model called Math Labs (Kazemi et al., 2018), in which a member of our research team played an integral role in the design and facilitation. Patty and Ada were responsible for planning and facilitating professional learning events at Forest, working with Jack. Patty was in her first year as the mathematics instructional coach after having taught middle grades mathematics at Forest for 13 years, during which time she, too, had participated in Math Labs. Ada was in her eighth year as an instructional coach at Forest and her second year focused on English Language Arts. Several years prior to this study, Ada had collaborated with a member of our research team and three other instructional coaches to support teachers' implementation of rich tasks through their design and facilitation of Math Labs. Prior to coaching, she had taught middle grades English Language Arts for 13 years and upper elementary grades for 6 years.

Jack, Patty, and Ada were in their first year of a coordinated effort to design and facilitate a connected set of professional learning events, and their aims and design decisions aligned with

the conceptualization of inquiry-oriented professional community described in the sections above[14]. As such, the Forest Middle School mathematics department represents a rich case from which to study the role of school leaders and professional learning facilitators in supporting such a community.

Positionality

I first met Jack, Patty, and Ada as a research assistant on a project that was a research-practice partnership aiming to understand how district math leaders, coaches, and teachers can use data about instructional practice to support system-wide instructional improvement. Prior to my data collection for this study, I had spent two years attending professional learning at Forest in order to understand the school and district context and to build relationships with the current teachers and with Jack, Patty, and Ada. At the time of my data collection, our research team had been partnered with the school district and had worked closely with the mathematics department at Forest Middle School for three years.

Each of the research team members (myself included) were former secondary mathematics teachers and identified as mathematics teacher educators and researchers steeped in literature on mathematics education and teachers' learning. One research team member had a long history of work supporting middle school mathematics leaders and teachers in job-embedded professional learning, including Math Labs, aiming to "empower students to meaningfully engage in learning mathematics" (Kazemi et al., 2018, p. 23). She had collaborated closely with Ada and Jack in some of her prior work supporting Math Labs in the district. Another member of our research team had recently been a part of Middle School Mathematics in

[14] This will become evident in the first section of the findings, in which I describe the leaders' vision in detail.

the Institutional Setting of Teaching (MIST) project, which examined how district and school systems might be designed and organized to support ambitious and equitable mathematics instruction at scale (Cobb et al., 2018).

While the contributions and role of the research team are not central to this analysis, it is worth noting that, in keeping with Jaworski's (2006) conception of inquiry community, we researchers saw ourselves as co-learners alongside the teachers, principal, and instructional coaches at Forest. In order to continuously position ourselves as such, we carefully considered our role and contributions in planning meetings and professional learning events. Aware we might be viewed as experts in the room, both by the teachers and by the leaders, we came to discussions with an authentic orientation of inquiry. Drawing on our understanding of the rich bodies of research in mathematics education, teacher learning, and school improvement, we wondered, "How might we learn together to advance equity for the particular students at Forest, with the particular district resources and demands and the particular knowledge and experience at the table?" In many ways, our stance in these interactions confronted traditional modal hierarchies among researchers and practitioners. The leaders told us often and directly that they saw our team as adding value to their design, planning, and facilitation decision-making. As Jack articulated in my spring interview with him: "I think, powerful for all this has been the partnership. … I don't know that it could have happened without your presence."

Jack, Patty, Ada, and I were all white educators who had come into the teaching profession with commitments to justice and equity and whose commitments had been deepened, challenged, and refined over time. We each had a network of support to engage in ongoing work regarding what teaching – and teaching mathematics in particular – for justice looks like in

practice. We all saw (and continue to see) ourselves as having a lot to learn and to unlearn about what it means to be white and teach Black, Indigenous, and Brown students.

Data Sources

I designed data collection to provide insight into the tasks supporting inquiry-oriented professional community at Forest and the vision underpinning this work. Data was collected over the span of a nine-month period during the 2018–2019 school year. The resulting data sources included field notes and artifacts from our research team's participation in planning and professional learning events; semi-structured interviews with each instructional leader; and semi-structured interviews with each of the sixth-grade teachers.

Design meetings and professional learning events. Our team participated in 12 collaborative design meetings with Patty, Ada, and Jack throughout the year; the design meetings took place prior to and after key professional learning events. We offered ideas grounded in research on mathematics education and teacher learning, audio-recording and collecting field notes and documents at each meeting. Additionally, at least one member of our team attended, audio-recorded, and collected field notes and documents at all key professional learning events (13 total events, spanning a range of forms). A district mathematics leader participated in half of these design meetings and professional learning events.

Semi-structured interviews with leaders. I conducted semi-structured interviews with Patty, Ada, and Jack. Initial interviews in the fall included questions about their goals for students' and teachers' learning, and particular goals for each form of professional learning. My second semi-structured interview with each came after the final set of professional learning events and included questions about how they saw the community developing in relation to their goals and their rationales for specific planning decisions. I conducted one additional interview

with Patty (the primary facilitator of professional learning events specific to grade levels) in order to understand her in-the-moment facilitation decisions. Each interview lasted approximately 45-60 minutes, and all interviews were transcribed (5 hours, 51 minutes total of interview data).

Semi-structured interviews with the sixth-grade team. In order to follow leaders' work into their support of grade-level groups, I attended to their work with the sixth grade teachers at Forest in particular. This group was comprised of three teachers, all of whom were, like the rest of the mathematics department, in their first year at Forest: (1) Carol, a veteran teacher of 15 years who was new to the Forest staff; (2) Mari, a second-year teacher who started her teaching career at Forest; and (3) Bea, a first-year teacher who, prior to teaching, had had rich experiences working with middle and high school students through community organizations. I conducted semi-structured interviews with each teacher at three points in the school year. Pertinent to this analysis, these interviews included questions about their goals for teaching, goals for working with their colleagues, and impressions of the professional learning system. These data were used to triangulate with the primary data described above. Each interview lasted approximately 45 minutes, and all were transcribed (6 hours, 28 minutes total of interview data).

Attending to credibility in data collection. As noted above, prior to the 2018–2019 school year, I had spent two years attending professional learning events at Forest, building relationships with Jack, Patty, Ada, and the mathematics teachers in the department at the time, including Mari. This prolonged engagement in the field supported my understanding of key aspects of the professional learning events as well as the district and school context surrounding the roles of the leaders (Lincoln & Guba, 1985). These opportunities to build relationships with

participants also supported trust and rapport, both essential for collecting valid data from participants (Erickson, 1986). I collected data in a range of forms and across multiple timepoints in order to (1) support triangulation across sources (Lincoln & Guba, 1985) and (2) understand the context of the leaders' practice in supporting the community (Spillane, 2006; Westheimer, 1999).

Data Analysis

For this analysis, I employed a distributed leadership perspective to specify the leadership practice that supported an inquiry-oriented professional community within the Forest Middle School mathematics department. My analysis was informed by an understanding of *practice* as the interaction among people and their situation that supports conditions for improving teaching and learning in school. In the case of Forest, practice is constituted in the interaction among mathematics teachers; leaders, including the principal and instructional coaches; and the situation of the mathematics department. My unit of analysis was that interaction.

The following analytic questions guided my analysis: "What were the leadership routines employed to support inquiry-oriented professional community? What tasks were executed as a part of these routines? Who enacted these tasks, and how were they enacted? What was the vision that underpinned this work?" To answer these questions, I engaged in phases of analysis, including initial exploration of the data, specifying the routines and tasks involved in supporting inquiry-oriented professional community, and specifying the vision that underpinned the work.

Phase 1: Initial exploration of the data. During and after data collection, I engaged in an initial exploration of the data in relation to my overarching research question: "What is the role of school leaders and professional learning facilitators in supporting an inquiry-oriented community?"

Regularly throughout my data collection, I listened to audio clips from planning and professional learning events, read through field notes, and wrote analytic memos that touched on both written and visual reflections on themes I was noticing in the data. For example, in December 2018, I wrote a memo focused on what appeared to be “threads” through the professional learning events in which the mathematics teachers had engaged thus far. As another example, in March 2019, I wrote a memo attempting to visually represent the set of professional learning events in which mathematics teachers were engaging and the threads from my December 2018 memo. This set of memos written throughout the course of data collection captured the critical work of Jack, Ada, and Patty in supporting the Forest mathematics community, and supported me to clarify the focus of this analysis.

I engaged in open coding (Merriam, 2014) to begin to more systematically identifying themes across the data and, in particular, specifying routines employed in support of inquiry-oriented professional community. After completing data collection, I parsed a subset of the interview data (Jack’s fall interview; Patty’s winter interview), using codes from my emerging conceptual framework. These codes included the five characteristics of strong professional communities identified by Kruse, Louis, and colleagues (e.g., Kruse, Louis, & Bryk, 1995) and the types of inquiry in which a mathematics department might engage (see Table 3.2). The resulting excerpts of data ranged markedly in size – some spanned multiple turns of talk while others were short utterances. The excerpts occasionally overlapped. Consider, for example, this segment of Jack’s fall interview:

> I'm pushing [teachers] to have students grapple and talk with partners … I'll have conversations in the [class]room, for example, with Bea. Last week, she asked a question and we [paused in the lesson] and said, "How can we spread this to more students than just the teacher and the student?" And then we talked about those things.

In this excerpt, Jack refers to a visit to Bea's classroom in which he and Bea paused during the lesson to think together about how to support students to engage in conversation with each other. I applied the codes "Reflective dialogue," "Deprivatization of practice," and "Inquiry as a tool."

For each excerpt, I wrote a brief descriptive memo characterizing the activities department members appeared to engage in ("tasks"), specifying who was engaging in those activities, and noting with special care to any aspects of professional learning events at the fore ("routine structures" and "routine interactions"). For example, in the excerpt above, I described the visit Jack had made to Bea's classroom and identified the routine interactions at play, including pausing in the moment of instruction, and the tasks in which Jack and Bea engaged during the visit, including engaging in authentic inquiry together. I linked such excerpts to other data sources pointing to the same type of interaction. In this case, I was not in the room to observe the interaction, so I could not consult field notes. Instead, I turned to Bea's interviews to trace her experience of the same classroom visit in order to paint a more nuanced picture of the interaction in my memos while further specifying and identifying tasks in those interactions.

Table 3.2. Codes and definitions used to identify excerpts in interview data (all definitions from Kruse, Louis, & Bryk, 1995 unless otherwise noted)

Code	Definition *Members of the community...*
Collaboration	… work together to (a) develop shared understandings of students, curriculum, and instructional policy and/or (b) produce materials and activities that improve instruction, curriculum and assessment for students and improve their own development
Deprivatization of practice	… share, observe, and discuss each other's teaching practice, including the problems of practice they face
Reflective dialogue	… engage in critical conversations about teaching and learning

Shared norms and values	… affirm common commitments regarding critical educational issues
Focus on student learning	… are focused on student learning and assume that all students can learn at reasonably high levels and teachers can help them
Inquiry as a tool[15]	… wonder, ask questions, and seek to understand by collaborating with others in the attempt to make answers to them
Inquiry as a stance[3]	… express an ongoing posture of curiosity

Phase 2: Understanding the vision underpinning leadership practice. In this phase, I worked to understand the vision underpinning leaders' work, the image of ideal practice serving as "a guide and a measure" (Hammerness, 2001, p. 146). As suggested by the literature, I attended to visions for both students' learning and teachers' learning.

To analyze for vision of students' learning and how it is supported, I first attended to how each instructional leader described aims for students' mathematical understanding, participation, and identities in relation to mathematics. I then attended to how they imagined these goals might be supported through classroom instruction. To do this, I analyzed how each instructional leader described what they would look for in a classroom to determine whether the mathematics instruction was of high quality, in particular, their description of the task, role of the teacher, discussion, and launch of the task (Munter, 2014).

To analyze for vision of teachers' learning and how it is supported, I attended first to how each instructional leader described aims for the mathematics teachers in the department, individually and as a collective department. In a manner similar to that employed for analysis for vision of students' learning, I attended to goals for teachers' understandings (mathematical and

[15] Code and definition from Jaworski (2006)

pedagogical), participation in professional learning events, and identities as mathematics teachers. I also attended to how leaders imagined these aims might be supported through professional learning.

Phase 3: Specifying the routines supporting the community's development. In this phase, I worked to further specify the routine structures and interactions supporting the community's development, building on my initial exploration of the data described in Phase 1. I attended to both the regular events the community engaged in together (*routine structures*), and the regular ways the community came to engage together in those structures (*routine interactions*), in light of the purposes that literature suggests matter in the development of inquiry-oriented professional community. These include: deprivatization of practice, reflective dialogue, collective focus on student learning, shared norms and values, collaboration, engaging in inquiry as a tool, and developing inquiry as a stance. A key analytic question guiding this analysis asked the following: "What are the *routine structures* and *interactions* involved in supporting these functions?" As a result of this phase of analysis, I identified four routine structures and three routine interactions supporting the community's development, as depicted in Table 3.3.

Table 3.3. Routine structures and interactions used at Forest.

Routine structures	*Routine interactions*
Leaders' design meetings and informal conversations	Pausing in the moment of instruction to engage in inquiry ("teacher time out"; for more elaboration on this routine, see Gibbons et al., under review)
Math Labs	
Classroom visits	Orienting toward the value in students' thinking and participation
Grade-level time	
	Connecting evidence of students' thinking and participation to teaching

Phase 4: Understanding the tasks organizing leadership practice. Following Spillane (2006), I employed the following questions in making sense of the leadership routines at Forest Middle School: "What are the *tasks*, or activities, involved in the establishment and execution of the routine structures and interactions? Who executes the tasks? What resources are used?" Coburn (2006) has suggested that a key task leaders might employ is their *framing* of the routines people engage in together, "to shape others' meaning-making processes in order to mobilize them to take action" (pp. 346-7). Building on the work of Goffman (1974), she defined framing as constructing an understanding of a situation and conveying it strategically to others. In keeping with the distributed perspective, Coburn saw framing as occurring in interaction among multiple individuals and in relation to the situation of the school.

I started with the Phase 1 list of routines and tasks and, using the constant comparative method, added one interview at a time, refining and adding to the list of tasks and routines until I had worked through all seven leader interviews (Glaser, 1969). For each, I parsed the interview into excerpts using the codes in Table 1, "functions" aligned with inquiry-oriented professional community. In each excerpt, I noted the routines and tasks at play, adding to and refining the Phase 1 list.

I then organized the interview data by routine in order to further specify the tasks comprising those routines. As in Phase 1, whenever a set of data referred to a particular interaction, I linked the data to other sources describing the same interaction (i.e., other interviews with leaders or teachers, field notes, audio recordings). Looking across various forms of data allowed me to further define the tasks at play, who enacted those tasks, how they were enacted, and the function they appeared to serve. I attended carefully to the language used by

individuals in the task in order to identify patterns in how aspects of the department's work were *framed* or conveyed to the department (Coburn, 2006).

Wherever possible, I named tasks in terms of the function they serve. To do this, each task went through iterations of grouping more discrete activities (what have been called "subtasks;" Spillane, 2006). For example, "enacting instruction in a teacher's classroom" and "posing genuine questions about one's own instruction" combined to become "engaging in authentic inquiry with individual teachers." Most tasks are named at such a grain size that conveys their function. In the cases of hiring, placement, and scheduling routine structures, I named these tasks in a direct way, because they have each been shown in prior research to be critical leadership tasks in support of teachers' professional learning in community (e.g., scheduling time in the contractual work day for teachers to meet: Horn, Kane, & Garner, 2018)

Attending to credibility in analysis. Aiming to make a credible argument, I engaged in peer debriefing and member checks throughout analysis (Lincoln & Guba, 1985). I shared memos and drafts of findings at several points in my analytic process with two other members of the research team. The following questions guided our conversations: "Do we recognize these things as a part of the practice at Forest? What is not captured here?" I engaged in biweekly conversations with one of these members of the research team (the chair of this dissertation), in order to clarify and refine emergent findings. Further, I scheduled strategic discussions with several colleagues, one of whom is trained in education leadership and policy, one of whom was trained in mathematics education and currently studies the organization of schools for teacher and student learning, and one of whom studied teacher learning. This peer debriefing shaped my analytic processes, pointing me to engage in further analysis of particular routines and resulting in clarified ways of articulating the leadership routines and tasks enacted at Forest.

I engaged in two formal member checks with Jack, Patty, and Ada. In the first, audio-recorded member check in June of 2019, I met with each of the three leaders individually, shared a preliminary draft of the vision for students' and teachers' learning underpinning their work, and asked the leaders to respond to the draft vision. This member check was guided by questions such as, "Do you recognize these as goals you have for your work with teachers? How would you revise them? Where do you see these goals getting worked on?" I probed to understand planning and in-the-moment facilitation decisions that they saw as supporting this vision. The second member check in December of 2019 involved a collective discussion with the three leaders in relation to a preliminary set of routines and tasks underpinned by a vision for students' and teachers' learning. This conversation was guided by questions including, "Do you recognize [this routine or task] as a part of your practice? What is missing or not represented here?"

The Forest Leaders' Practice in Supporting the Mathematics Department

In what follows, I describe the tasks that emerged in my analysis of the role of the leaders as they supported the developing community of mathematics teachers at Forest Middle School. Throughout, these tasks are named in terms of the purpose they appeared to serve. First, I explicate the leaders' vision and the work they did to foster a shared vision among the community. Then, I describe the tasks leaders undertook prior to the school year to organize teams for community. In the final findings section, I give a nuanced description of the routine structures the community engaged in together and the tasks leaders undertook to foster an inquiry-oriented professional community in each of the structures.

Fostering a Shared Vision

The Forest Middle School leaders engaged a set of tasks with the function of fostering a shared vision among their leadership team and among the mathematics department. In this

section, I describe two key components of the vision they were aiming to foster as shared—a vision for mathematics instruction and a vision for the community's work—and begin to describe *how* the leaders worked to foster a shared vision (the tasks they engaged in). I only begin to describe the work involved in fostering a shared vision here, because in large part, this happened through the leaders' and teachers' work together in a system of professional learning events, throughout the school year. I describe this in more detail in the section that follows.

Fostering a shared vision for mathematics instruction. In my analysis of interviews and informal conversations with the leaders and leaders' planning sessions, I found that Patty, Ada, and Jack shared a vision for mathematics instruction including their aims for students and their ideas for how these aims could be supported by teachers' work in classrooms. Broadly, the leaders wanted the students at Forest to enjoy school, to feel known and cared for by their teachers and peers, and to develop rich mathematical knowledge and practices. For example, as evidenced in both interviews and observations of planning meetings, the leaders cared deeply about students' experiences in their mathematics classrooms; they wanted Forest students to feel "excitement about math" (Patty, fall interviews) and to have "a mathematical voice and agency" in their rooms (8/23/18 design meeting artifact). As Jack articulated, they wanted students to "feel competent and safe as mathematicians, as people who can mess up and solve things …[while being able] to collaborate, to feel safe enough to speak and share what they're thinking, and [to] value the diverse voices in the room" (fall interview). Each leader emphasized that students "see that they're valued" (Patty, fall interview) and "see themselves as mathematicians" (Ada, fall interview), placing special importance on students "whose communities are historically marginalized in math" (Jack, spring interview).

In relation to how these aims for students might be supported through classroom instruction, the leaders articulated a vision that involved supporting students to engage in rich conversations about their and others' mathematical ideas in order to develop meaningful mathematical understandings and come to see themselves and others as mathematicians – what scholars have called a dialogic vision of mathematics instruction (Munter, Stein, & Smith, 2015). Specifically, across interviews and conversations, all three expressed a vision of mathematics instruction in which students experience "open-ended tasks with multiple entry points" (Ada, fall interview), which "promote reasoning and problem solving" (8/23/18 design meeting artifact). They aimed for these tasks to be introduced or launched such that "everyone is ready … everyone can access [the task] … [students] understand what the task is asking of them" (Patty, fall interview). Students' dialogue with one another was central to the leaders' vision for instruction and a clear and explicit aim throughout the school year, showing up time and again in their conversations with teachers and each other and in documents used in professional learning. They saw discussion as key to supporting students' mathematical understandings and sense of themselves in the classroom. As Jack articulated:

> I want to see students owning learning, coming up with representations of the mathematics, trying multiple strategies, collaborating with their peers to make sense [of the task] and then to find solutions that they can communicate to others. I want to see the teacher facilitating these types of explorations and then connecting things … to solidify the learning and draw out the mathematics in the lesson. (Jack, fall interview)

The leaders envisioned that teachers would support students' "exploration" of meaningful tasks (Patty, Ada, and Jack, fall interviews) and support students' "sense-making of a variety of strategies and approaches" to those tasks (8/23/18 design meeting artifact), especially by "ask[ing] questions that probe and push thinking" (Ada, fall interview). Their ideal instructional practice involved teachers, as Jack said above, "drawing out the mathematics in the lesson" and,

at the same time, giving students mathematical authority, supporting them to "see each other as resources" (Ada, fall interview).

It is critical to note that this vision was not static. Leaders' aims for students and vision of mathematics instruction evolved in response to what they themselves were learning in collaboration with each other and the mathematics department. By the end of the school year, the leaders' vision for mathematics instruction more squarely and specifically focused on the ways that power and agency were playing out in classrooms. Leaders had worked in the years prior to 2018 – 2019 to detrack mathematics classes and to shift toward discourse-oriented instructional practice. As they supported the mathematics department during the 2018 – 2019 school year, and in response to their participation at the Teachers Development Group Leadership Seminar (2019), leaders recognized the intentional inquiry that now needed to happen in relation to "what is equitable or inequitable about what's happening in the classroom" (Jack, spring interview). For example, Ada expressed in the March Math Lab, "just because we're shifting our practice and how we're teaching, we won't change patterns [of marginalization] unless we're focusing on who we're including and who we're giving authority to in the classroom. This is an aha for me. I just kind of thought discussion would bring more students in, but we have to really be aware." They saw facilitation of discussions in a different light; a form of practice in which they must be attending to, for example, "who we're giving authority to." They puzzled with our research team about the kinds of data that would support robust conversations among the community in relation to issues of students' authority in mathematics classrooms (e.g., Whole Class Discussion Measure retrieved from pmr2.org/measures) and the complexities involved in disaggregating data along lines of race and gender. By the end of the school year, Jack described mathematics teaching at Forest directly "as a vehicle to be anti-racist" (Jack, spring interview).

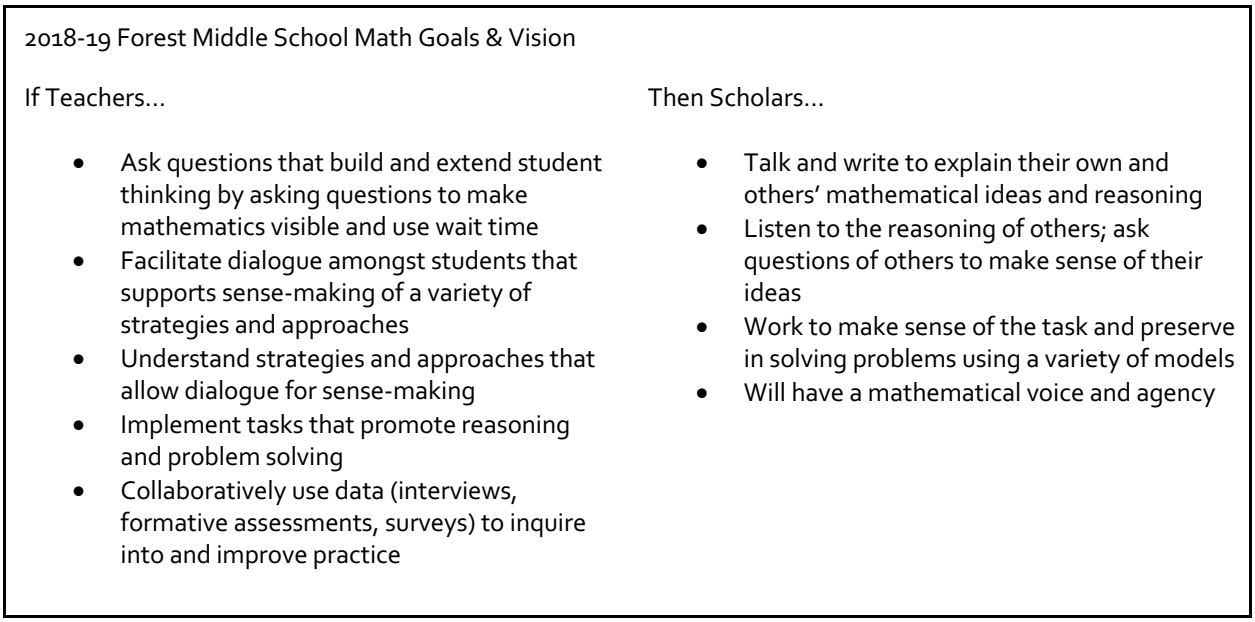
The leaders fostered a shared vision with the mathematics department, in part, through the tasks of setting goals with the department. Prior to the school year, the leaders, in partnership with our university-based research team and district mathematics leaders, engaged in the task of drafting a provisional set of goals for students and for teachers' instruction to bring to the department. These goals were generated in the conversation and informed by documents such as the National Council of Teachers of Mathematics' (2014) *Principles to Actions* (see Figure 3.1 below).

The leaders then engaged in the task of revising the goals alongside the mathematics department. In the first full-department meeting in September, the department read the Common Core State Standards for Mathematical Practice summary and, talking with a partner, "noting what resonate[d]" with them (Jack, 10/14/18 department meeting audio). They then read a draft of the set of goals for students created by Jack, Patty, and Ada, projected at the front of the room. Jack asked department members to talk with a partner: "How do these sit with you? … Is this what we want to focus on for kids this year?" (10/14/18 department meeting audio). Mari started the conversation with an excited, "Yes! If the question was, 'Do we want to focus on these?', yes! … These all focus on different aspects of students' collective ownership of the teaching, and really engaging in meaning-making."

Three teachers then posed questions to the group, resulting in revisions to the goals. For example, an 8th grade teacher asked, "How can we center writing in this set of goals? I think that's the missing piece here. We want them to be talking, yes, but also having space to reflect through writing" (10/14/18 department meeting audio). The department revised the first goal from "Explain their own and others' mathematical ideas and reasoning" to more explicitly foreground both talking and writing: "Talk, write and explain their own and others' mathematical

ideas and reasoning" (10/14/18 department meeting artifacts). The list of goals for students co-developed with the department also included listening to and making sense of the ideas and reasoning of others and seeing themselves has having a mathematical voice and agency in their classrooms.

After discussing their goals for students, the group turned to goals for instruction. Jack asked, "If we want students to do the things [the goals listed on the slide], are these the things we should be doing? Or are there things missing, or things we would want to change?" (Jack, 10/14/18 department meeting audio). The department engaged in a similar conversation of reflection and revision as they had with the student goals. The resulting goals for teachers' instruction included facilitating dialogue among students that supports sense-making of a variety of strategies and approaches.



2018-19 Forest Middle School Math Goals & Vision

If Teachers…

- Ask questions that build and extend student thinking by asking questions to make mathematics visible and use wait time
- Facilitate dialogue amongst students that supports sense-making of a variety of strategies and approaches
- Understand strategies and approaches that allow dialogue for sense-making
- Implement tasks that promote reasoning and problem solving
- Collaboratively use data (interviews, formative assessments, surveys) to inquire into and improve practice

Then Scholars…

- Talk and write to explain their own and others' mathematical ideas and reasoning
- Listen to the reasoning of others; ask questions of others to make sense of their ideas
- Work to make sense of the task and preserve in solving problems using a variety of models
- Will have a mathematical voice and agency

Figure 3.1. September 2018 draft of Forest math goals and vision document, after revisions with the mathematics department.

Leaders also engaged in the task of supporting the department to further specify the goals over time in response to the community's experiences together. For example, after attending an offsite conference focused on "awareness and action in service of equity in the day to day work

of math teaching, learning, and leading" (Teachers Development Group, 2019), the group spent time together in the March Math Lab specifying their aims for students' agency in relation to mathematics in their classrooms. For example, they engaged in discussion about the question, "What does mathematical agency look like?" (3/12/19 Math Lab artifact). This conversation led the group to wrestle with and come to a more shared understanding of what students' agency might look like in their classrooms. As another example, at the end of the school year, the leaders organized conversations revisiting the department's collective goals alongside their collective engagement in an online course, which centered on setting up mathematics classrooms to be productive spaces for high-quality discussions. In May and June of 2019, the department met three times outside of the school day to discuss the course and, in the process, revised and refined the goals from 2018–2019 in preparation for the 2019–2020 school year.

Fostering a shared vision for the community's work. In my analysis of interviews and informal conversations with the leaders and leaders' planning sessions, I also found that Patty, Ada, and Jack shared a vision for professional learning, including their aims for teachers and their ideas for how these aims could be supported. The leaders wanted teachers at Forest, like students, to feel known and cared for by their colleagues and to develop rich discipline-specific and pedagogical knowledge and practices. The leaders identified that if teachers were to facilitate meaningful discussions with students, then leaders and teachers would need to "deepen content knowledge," strengthen "conceptual understanding" of the content they were each teaching (Patty, fall interview), and "understand strategies and approaches" that students might bring to discussions (Figure 3.1). They saw professional learning as collective space in which teachers and leaders could provide one another with encouragement, challenge, and support in their shared aims to improve practice and the experiences of their students

The leaders shared a set of aims for teachers' participation in the department. First, they wanted teachers to experiment with instructional practice. This involved seeing teaching not as the transferal of a static set of knowledge, skills, and practices, but rather as a vital and dynamic process of ongoing learning and "trying different things out" (Patty, fall interview) in response to particular content, curricula, students, and in light of their evolving understanding of justice and equity. They described, for example, asking ongoing questions like, "What is equitable and inequitable about what's happening in [our classrooms]?" (Jack, fall interview), and investigating instructional decisions in response. Relatedly, they wanted teachers to see improvement of teaching practice as an ongoing task; that the work of teaching required that they "keep getting messy, keep moving forward" (Jack, spring interview). As Jack articulated:

> If I could do all of my professional development differently for my whole career, it would be supporting teachers just to be curious rather than 'I want to teach you to do this or that.' Just [supporting them to] be curious about why kids are learning or not learning … I think [teachers] know it's powerful when you don't know what to do. Maybe it's like, how can we convince ourselves that we all don't know what to do? (spring interview)

A central aim, exemplified above, was that the department develop a stance of curiosity in relation to teaching and learning. As Jack described, this curiosity involves authenticity and vulnerability, a stance that "we all don't know what to do," that each person in the community is learning about and from their students and each other.

Second and relatedly, the leaders wanted teachers and leaders to make their instructional practice public, positioning it as an object of inquiry for their own and others' analysis. In interviews, they each noted that they wanted "open doors" – teachers and leaders bringing authentic problems and artifacts of practice to their conversations and in classrooms authentically enacting instruction together (Ada, fall interview). Jack in particular noted that the act of laying bare instructional practice would demand that the department "lean in and be vulnerable" (Jack,

8/23/18 design meeting) and be "willing to screw up in front of [each other]" (Jack, 10/15/18 design meeting audio).

Third, the leaders wanted the community to consider each other as indispensable in the work of improving teaching. They wanted the department to see, as Grossman, Wineburg, and Woolworth (2001) say, that the "group's collective wisdom and knowledge exceed that of any one individual" (p. 46). They wanted teachers to see work with their colleagues both in and outside of structured professional learning events as fundamental to the work of improving teaching ("see that they need to collaborate, that it's better that way," Jack; "it's so powerful to be collaborating with other folks, and that's what really shifts practice;" Ada).

The leaders fostered a shared vision for the community's work with each other and with the mathematics department, in part, through the tasks they enacted in carefully organizing and facilitating a system of routine professional learning structures. As will become clear below, this system of routine structures involved space for the vision for the community's work to become further specified, refined, and revised in conversation and collaboration with our research team, district mathematics leaders, and the department mathematics teachers.

Organizing Teams for Community

The Forest Middle School leaders engaged in two tasks prior to the school year with the function of organizing teams for community. Hiring and placement are typically undertaken by school administrators in particular, and administration might have many considerations that inform *how* they hire and place teachers. At Forest, hiring and placement[16] were seen as integral to the development of the community, in that they determined which teachers would be working

16 This finding emerged from my analysis of interview data; I did not observe hiring or grade-level placement, as they had transpired prior to the start of the 2018–2019 school year.

closely together. Rather than being taken on solely by administration, Jack involved Patty, Ada, and a subset of the mathematics teachers in the department in the hiring and placement decisions.

Hiring teachers. As the leaders described in interviews, the task of hiring for the 2018–2019 school year first involved Jack, Patty, and Ada meeting to finalize a set of questions to ask the potential hires. Key categories of questions involved the prospective teacher's willingness to collaborate with colleagues and their commitment to justice and equity in relation to students' learning. For example, in meeting together, the three leaders drafted this interview question about collaboration at Forest: "We open our practice and learn from each other in many ways … Each of these experiences involves high levels of collaborative trust and commitment. What excites you about this work? What would be most important for you as you join a team committed to this work?" (Jack, spring interview).

The leaders then brought in the subset of teachers with whom the prospective teacher would work. For example, Mari and a sixth grade English Language Arts teacher joined the leaders for an interview with Bea, a prospective sixth grade math teacher. They conversed with Bea, first showing a video clip from a Math Lab in the 2017–2018 school year. The clip showed teachers engaging in a mathematics task together, and cut to the teachers enacting that task together with students in one of their classrooms. After sharing the clip with Bea, Jack, Patty, and Ada drew on the questions they drafted prior to the interview. Following the interview, the leaders met with Mari and the sixth grade English Language Arts teacher to discuss how Bea might contribute to their work and learning. Jack, Patty, and Ada later made the final joint decision to hire Bea in which they considered, in part, Bea's articulation of her commitment to students and to equity, her willingness to engage in collaboration with colleagues, and Mari's excitement to learn with Bea.

The leaders felt that teachers needed to come to the department with a set of commitments to collaboration with their colleagues and to justice and equity in relation to students' learning. They saw the ongoing work of the department as helping to shape teachers' visions of mathematics teaching and learning in relation to these broader commitments. As Ada articulated, "It's one thing to be committed and to say you're committed to [justice and equity], and it's another thing to see what that looks like and to experience what that looks like" (fall interview). In response, leaders provided ongoing opportunities for the department to engage in "connecting their ideas around social justice practices to the work that they're doing [in their classrooms]" (Jack, spring interview). Further, in relation to collaboration, the leaders noted that the mathematics teachers interviewed were "eager" but also oriented in different ways to collaboration. They saw a central part of their role as supporting the department toward a shared vision for their collective work.

Placing teachers in grade-level teams. Placement decisions for the 2018–2019 school year were made across a series of the leaders' design meetings from the spring of 2018 into summer, when hiring was finalized. In these meetings, the leaders carefully engaged in the task of constructing grade-level teams with the function of supporting meaningful connection and collaboration. One consideration guiding their placement was which teachers might best support one another in developing a shared vision for mathematics instruction and for the community's work.

For example, leaders reflected on placing Bea in the sixth grade team as someone "eager to get at the kids' understanding – conceptual understanding … [and] open to trying new things" (Patty, fall interview). This characterization was informed in part by observations Mari had shared with leaders after Bea's interview. As Ada recalled, Mari recognized that she and Bea

shared a common commitment to racial justice in mathematics education and a common background in working with middle school students through community organizations. She stated that talking with Bea had inspired her. The leaders thus saw immense potential in their work together. Because Bea and Mari were both new to teaching, the leaders also strategically placed a veteran teacher, Carol, on the sixth grade team. Jack noted the importance of Carol's placement "as the seasoned person on the team. If it were three newish teachers, they might not feel like their team is as powerful, because [Bea and Mari] feel like they can ask Carol content-related questions or just teaching-specific questions" (spring interview). The example of the configuration of the sixth-grade team illuminates leaders' recognition of the resources each team member brought to the department and consideration of who might support each other in grade-level teams.

Designing and Facilitating a Professional Learning System Toward a Vision

My analysis of planning, observation, and interview data suggests that the leaders organized a *system* of routine structures through which the community would engage in inquiry. This professional learning system (see Figure 3.2) involved a set of routine structures which leaders intended to "all mesh together and … all support each other" (Patty, spring interview) toward their vision for the community's work in relation to their vision for mathematics instruction. These structures were designed, planned for, and facilitated to support an inquiry-oriented community among the mathematics department.

The professional learning system involved (a) leaders' *design meetings*; b) the department's work in classrooms in *Math Labs*; (c) *one-on-one classroom visits* between Math Labs; and d) time for *grade-level teams* to meet outside of their classrooms. In what follows, for each of the routine structures, I describe how leaders built the structure into the school schedule,

the functions they intended it to serve, and the tasks they engaged in during and surrounding the structures to support their vision for mathematics instruction and for the community's work.

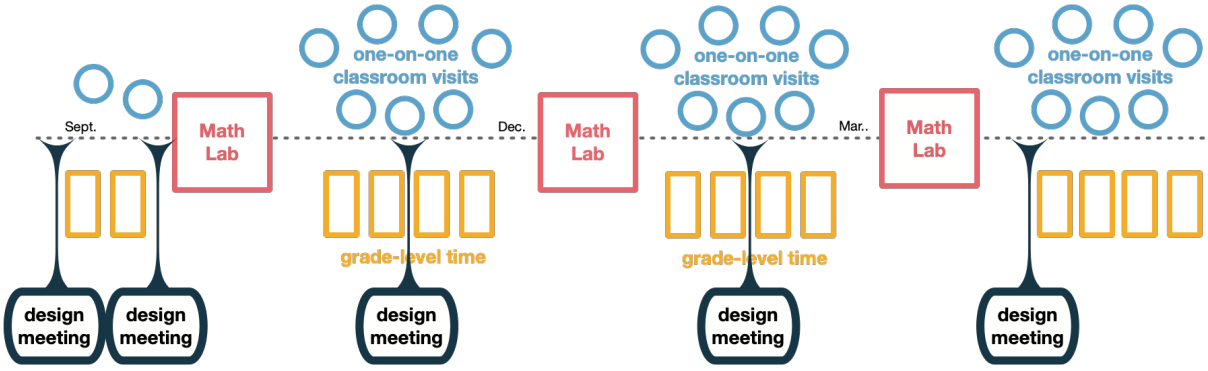


Figure 3.2. Professional learning system at Forest Middle School in 2018 – 2019

Leaders' design meetings and informal collaboration. The first routine structure in the professional learning system involved leaders' formal and informal meetings together and with our university team and district leaders. As evidenced in interviews, Patty, Ada and Jack saw these meetings as opportunities to debrief their experiences, plan for upcoming professional learning events, and confer about facilitation decisions. I found that the tasks undertaken by the leaders in their design meetings and informal collaboration to support inquiry-oriented professional community included: (1) organizing the physical space for "constant conversation" among the leaders; (2) scheduling regular design meetings; (3) engaging in authentic inquiry with other leaders and researchers; (4) considering decisions in light of teachers' and students' learning and wellbeing; and (5) attending to connections across the professional learning system.

Organizing the physical space for "constant conversation" among the leaders. Patty, Ada, and Jack's ongoing informal conversations allowed them to update each other on the experiences they were each having with teachers and students, informing the leaders' design and facilitation of the professional learning system. The task enacted by Jack to organize leaders' offices in proximity to each other appeared to serve the function of affording ongoing informal

interactions. In years prior, Ada's office had been on the second floor of the school, connected to the library, while the principal's office was part of the main office suite on the first floor. Jack described intentionally relocating the instructional coaches' office to the main office suite, near his office, so he and they could be in "constant conversation" about students, teachers, and their work in supporting them (Jack, 12/9/19 member check). He selected an office space large enough for two desks so Patty and Ada were seen as a team by teachers and other staff members, and so he could easily check in with the two of them.

Scheduling regular design meetings. Another key task enacted by all three leaders, involved building regular design meetings in the calendar, including meetings for the three leaders and meetings together with district mathematics leaders and our team of university-based partners. The leaders met at least once per week throughout the school year. They scheduled additional design meetings with our university team nine times throughout the school year. We met with all three leaders once prior to the school year, once prior to each of the three Math Labs, once at the end of the school year, and four times throughout the year with Patty (and often Ada) to think together about her work with grade-level teams and individual teachers.

Engaging in authentic inquiry with other leaders and researchers. During design meetings and informal conversations, leaders engaged in the task of inquiry with others in relation to an authentic problem of practice. For example, during a late-summer design meeting, the leaders raised the problem of practice of how to organize and facilitate "intervention time," 30 minutes built into teachers' common planning time with their grade-level teams. Jack preferred to "put intervention in quotes … because it's not about pulling kids out to fill gaps … it's about how we intervene through our instruction" (8/23/18 design meeting audio). During the

meeting, he asked our university team, “What do you think about “intervention” … and how to use that time?” (8/23/18 design meeting audio).

University team member:	What’s so wonderful about this is that you’re working to make mainstream instruction better. And, you’re acknowledging that there’s still going to be a little bit of extra stuff that has to happen for some students. But, you’re not just letting this *[gesturing to the left to indicate teaching]* be status quo, and then trying to fix it over here *[gesturing to the right to indicate intervention time]*.
Jack:	I’m glad you heard me say that. But, I don’t know how to communicate that to everybody.

The group considered together just how important Patty’s role would be as the facilitator during that 30-minute block to press teachers to consider how instructional decisions produced particular outcomes.

University team member:	That’s hard to do, because the tendency is to go to, “So and so just needs more __.” instead of going back to say, “Hm, outcomes are *produced*. *We* do that.”
Jack:	So, that’s why I’m thinking that these first two weeks are critical for it to be framed in a way that we’re not going in here to see what kids need, we’re going in here to see and align what high-quality math instruction looks like.

The group then inquired together about the role each leader could play in framing the grade-level time built into the school day.

In this example, we see that Jack’s questions and responses to ideas (e.g., “I don’t know how to communicate that…”) made space for authentic inquiry in the group, opening the conversation to an exploration of how to communicate the purpose of grade-level time with teachers. Across observations of design meetings and leaders’ reflections in interviews, leaders used this routine interaction—tentative language (“I’m wondering…,” “I’m not sure about…”)

and questions ("What do you think about the idea of…")—to open space for authentic exploration of ideas with others.

Considering decisions in light of students' and teachers' learning and wellbeing. The leaders also engaged in the critical task of considering students' and teachers' learning in their decision-making during their design meetings and informal conversations. It was clear in leaders' interactions together that evidence of students' and teachers' learning and wellbeing were central to their decision-making. As an example of attending to students' learning, during the same late-summer design meeting described above, we discussed what grade-level time might afford for teachers' learning and for community development that Math Labs could not. The group considered the affordances of grade-level time together in terms of deepening content knowledge in relation to the particular ideas getting developed in the grade-level and in the particular sequence of lessons in the district-supported curriculum. A university team member asked of the current opportunities teachers had together, "are we finding out what kids currently think? Are we pressing them to make sense of other students' ideas? … I wonder if it's getting kids' work on the table to start to see the range of students' ideas." As the group began to converge on centering students' current thinking during the first several weeks of the 30-minute grade-level time, another member of our university team suggested engaging in informational interviews with individual students. She explained her rationale:

> It just changes our eyes. We just see stuff differently. … They get such great insight into students' reasoning or thinking through stuff. Because what they write on paper can be pretty different from how they think through it. So, sometimes they're blown away … 'I had no idea that kid thought like that, because I'm not seeing it on paper.' (8/23/18 design meeting audio)

The group saw student interviews as an opportunity to center students' thinking and reasoning in the department's work, and to do so in a way that honored the value in students' understandings.

The leaders oriented toward teachers with the same care and humanity that they oriented toward students, making ongoing decisions in light of teachers' learning and wellbeing. As Ada described:

> We're [all three leaders] doing a lot of learning [in teachers' classrooms]... and then [we] come back and say, 'Okay, what did you see? What are some things that we could work on together?' You know, so that we're calibrating our thinking around supporting teachers. (fall interview)

In relation to teachers' wellbeing in particular, Ada articulated what appeared to be a shared stance among the leaders that one must feel cared for and "valued … in order to really shift your practice, in order to really hear [one another]" (spring interview). In design meetings, the leaders considered together how they were building trust and relationships with each of the teachers, positioning themselves as a part of the community, and learning and inquiring alongside teachers.

Sixth grade teacher Bea reflected that a sense of value was one of the common threads through her experiences at Forest Middle School, "every person has something they can contribute, and that collectively our wisdom is so much more, our knowledge and our capability is so much more than it would be as individuals" (spring interview). As they interacted with students and teachers, leaders made careful note of outcomes for students and teachers to bring back to the other leaders and participants in design meetings, to inform their planning and facilitation decisions.

Attending to connections across the professional learning system. In these meetings and conversations together, leaders also engaged in the important task of attending to connections across the professional learning system. For example, during the same late-summer design meeting described above, throughout the conversation, leaders engaged in the task of considering how this new structure would "connect to," "support," and "inform" Math Labs and teachers'

own work in their classrooms (8/23 design meeting audio). Jack emphasized that across these various experiences, he hoped to reinforce the value of engaging collectively in making sense of students' strategies, instructional decisions, and ideas about teaching and learning.

Math Labs. Math Labs were another routine structure in the professional learning system and involved both leaders and teachers in the mathematics department. Math Labs were intended as full- or half-day meetings providing opportunities for the group of teachers and leaders to enact instruction with each other's students and to inquire collaboratively into their instructional decisions in relation to students' thinking and participation. They followed a cycle adapted from the work of Kazemi and colleagues (2018) of unpacking new learning, collectively planning an episode of instruction, collectively enacting that episode in one of the teachers' classrooms, and, when debriefing the enactment, considering students' thinking and participation in response to instructional decisions (Figure 3.3). Built in to the Math Lab model are the assumptions that teaching involves experimentation with instructional practice, that everyone involved is learning and growing, and that teaching is a collective endeavor (Kazemi et al., 2018).

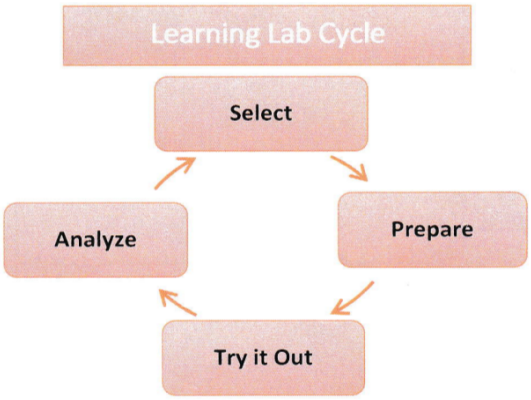


Figure 3.3. Cycle of professional learning in a Math Lab[17]

[17] This cycle image was used in the agenda for each of the three Math Labs at Forest and reflects the structure of Math Labs more generally as described by Kazemi and colleagues (2018).

As evidenced in interviews and design meetings, leaders had three key purposes for Math Labs. First, Math Labs were intended to provide structured means through which to deprivatize teaching practice, as the group enacted instruction together in a colleague's classroom and closely examined artifacts from that enactment, including students' work and observations about students' mathematical thinking. Second, leaders intended Math Labs to support them in fostering a shared vision of mathematics instruction, and to shape what teachers and leaders viewed as possible in classrooms at Forest. Jack voiced in an interview that during Math Labs, teachers and leaders alike were exploring and "*seeing* what could or should be done" in classrooms (fall interview). The leaders saw the shared instructional experience Math Labs afforded as providing rich space through which to foster a shared vision of teaching. Third, leaders viewed Math Labs as providing space for the department to engage in deep, meaningful inquiry, especially into particular instructional decisions and general principles of teaching and learning.

I found that the tasks undertaken by the leaders in Math Labs to support inquiry-oriented professional community included: (1) scheduling Math Labs as anchoring experiences in the school calendar; (2) selecting host classrooms in light of a vision; (3) selecting a focal instructional routine in light of a vision; (4) framing the work of teaching as experimental; and (5) engaging in authentic inquiry with mathematics department. In what follows, I describe the leaders' enactment of each of these tasks, using the representative example of the October Math Lab. I also highlight the routine interactions involved, and how the leaders worked to foster a shared vision for mathematics instruction and for the community's work in their planning and facilitation of Math Labs.

Scheduling Math Labs as anchoring experiences in the school calendar. A key task involved scheduling Math Labs into the school calendar, as anchoring experiences in the professional learning system. As described above, leaders scheduled three Math Labs in the 2018–2019 school calendar, in October, December, and March[18] (see Figure 3.2). Because Math Labs typically occupied a full day as department-wide professional learning events, Jack arranged for full-day substitute teachers for each of the seven mathematics teachers to cover each of the three Math Lab days. A shortage of substitute teachers in the district brought challenges in securing coverage for Math Lab days, but Jack worked creatively by asking other teachers in the building to step in during their planning blocks to cover for colleagues engaging in Labs. The teachers came to prioritize Labs, in spite of the challenges involved ("It's just what we do," Mari, spring interview; "It's a lot, and it's hard, but it's worth it to learn together," Bea, spring interview).

Selecting a host classroom in light of a vision. Another key task enacted by the three leaders prior to each Math Lab involved deciding in whose classroom the group would try out the lesson they would co-plan together. Critically, they did so in light of the vision they had for mathematics instruction and for the community's work together. Leaders' decision-making in selecting a host classroom for the Math Labs also served to emphasize "that this isn't a model classroom," but rather, that everyone – teachers and leaders alike – were experimenting with practice and learning together (Jack, 10/15/18 design meeting). They considered the extent to which the classroom would be a rich space in which to work on particular mathematical ideas and principles of teaching. Leaders anticipated that teachers might write off a classroom

[18] The February Math Lab was rescheduled twice due to snow and was ultimately held on March 12.

experience by thinking, “That's just a good group of kids” (Patty, fall interview). Such a dismissal would limit the individual’s opportunity to inquire into their own instructional practice in relation to the Lab. In an aim to avert these narratives, leaders “purposefully chose” classrooms that teachers were likely to view as “typical or even challenging” (Patty, fall interview).

For example, in a design meeting ahead of the October Math Lab, the leaders determined not to ask Mari to host because she had developed a culture in the room in which students felt willing to share in-process ideas and push back on each other’s thinking. As Jack explained, “there’s this dynamic that Mari’s class has the best kids. What people don’t realize is that … it’s what Mari does to create that culture in the classroom” (Jack, 10/15/18 design meeting audio). For the October Math Lab, they instead chose Bea’s room. As a novice teacher in her first months of teaching, Bea was early in the process of developing such a culture. Bea described to the leadership team in the days prior to their planning meeting, “if it would work for [this particular class], it would work for anybody” (Jack, 10/15/18 design meeting audio). Leaders saw Bea’s classroom as a rich space in which to experiment with and inquire into the facilitation of discussions together.

Selecting a focal instructional routine in light of a vision. A third key task enacted by the three leaders prior to each Math Lab selecting a particular instructional routine (e.g., Contemplate then Calculate; Kelemanik, Lucenta, & Creighton, 2016) for each Math Lab that would be conducive to working on the goals that they had co-developed with the mathematics department for students’ learning and teachers’ instruction. Instructional routines are “designs for interaction that organize classroom activities” (Lampert & Graziani, 2009); they are lesson structures intended to be used regularly to provide space for students to develop particular

disciplinary habits and teachers to develop particular forms of instructional practice. The focal instructional routines at Forest furnished a predictable structure through which teachers could work on broader principles and practices of teaching (e.g., supporting students' mathematical identity, voice, and agency).

The leaders were responsive to both students and teachers as they selected a focal instructional routine. For example, in a design meeting to prepare for the October Math Lab, the leaders chose the Contemplate then Calculate routine, which is organized so students "make sense of a mathematical object – a visual pattern, arithmetic operation, equation, or graph – and look for what is structurally significant about it" (fosteringmathpractices.com). The Forest leaders articulated two reasons for choosing the Contemplate then Calculate routine for the October Math Lab. First, the routine was designed to support students to engage in meaningful, structured discussion about mathematical ideas. In unpacking students' strategies through grade-level time, teachers and leaders across the grade-level groups were finding "kids are jumping to an algorithm all the time for a variety of different problems in math" (Jack, fall interview). Contemplate then Calculate would provide students space to look for and make use of the structure found in problems in order to reason about a strategy and solution. As Jack articulated, "we're not doing this because that's just the newest thing that we want to try it. It's because we're seeing … what kids are doing, how they're reasoning" (fall interview). As such, their selection of the Contemplate then Calculate involved the routine interaction of connecting evidence of students' thinking and participation to teaching. Second, Contemplate then Calculate provided space in which to support teachers' inquiry into "how to ask questions in their classroom and push kids a little deeper into understanding what they're saying" (Patty, fall interview). The

leaders saw questioning as a critical aspect of facilitating mathematics discussions that each of the seven teachers could benefit from exploring together.

Framing the work of teaching as experimental. During Math Labs, the leaders engaged in the task of framing the work of teaching as involving experimentation with practice. In their design meetings for each Math Lab, the leaders thought together about their roles in this framing. For example, in the design meeting ahead of the October Math Lab, they planned to explicitly convey to teachers in their introduction to the day that their primary aim was to learn together about supporting students' reasoning through discussion, rather than to perform or model instruction ("we really need to say it's about learning together … and when we're learning like this, learning together, it's messy, and it's also powerful." Jack, 10/15/18 design meeting audio).

At each Math Lab, the group met around a large table in the school's main office to start the meeting. The meeting's agenda was on the table as teachers arrived, with the first page depicting a cycle of planning, enacting, and debriefing an instructional routine (Figure 3.3). On the image of the Math Lab cycle, the lesson enactment phase was titled, "Try It Out." In his introduction to the October Math Lab, Jack emphasized the "Try It Out" part of the cycle, saying, "We get to experiment here. We're like a real lab, going out, trying things, and learning something new" (Jack, 10/16/18 Math Lab audio). The leaders emphasized that anyone at any time could pause ("time out") the teaching and pose a question to the group:

> I might wonder in the middle of teaching, "What kind of question can get at the student's thinking, reasoning?" … We want to make that public practice at Forest … that we'd feel comfortable [asking that to the group]. … Imagine I'm in front of the classroom, and I say "time out," and Ada is over here, and I might say, "Ada, what questions could I ask here?" and Ada could share. … It's a cool experience to be in a researchy think-tank in the classroom. (Jack, 10/16/18 Math Lab audio).

Here, we see Jack framing the group's collective instruction as experimental in his language choice ("like a real lab," "trying things," "research think-tank") and his introduction of the

routine interaction of teacher time out, which would allow the department to pause and pose genuine questions in the moment of instruction.

The group then read about and discussed Common Core State Standards Mathematical Practice 7, "look for and make use of structure" (CCSS-M). Patty then led the teachers in experiencing the Contemplate then Calculate instructional routine (Kelemanik, Lucenta, & Creighton, 2016) and making connections to Mathematical Practice 7. Here, they engaged in the routine interaction of connecting students' thinking and participation to teaching, as they considered their own strategies and engagement in the routine as learners in relation to Patty's instructional decisions. In light of this discussion, the group designed an observation template supporting them to attend to students looking for and making use of structure in their upcoming classroom visit. The department then co-planned the same instructional routine to try out in Bea's sixth grade classroom. As the department collectively planned an episode of instruction to enact in the classroom, the leaders used such language as "experiment," "try this out," and "I wonder what might happen" (10/16/18 Math Lab audio). Each member of the department (including Patty, Ada, and Jack) took on a different part of the lesson enactment. Immediately before moving into the classroom together for the October Math Lab, Patty noted that they could expect their collective practice not to be perfect or polished ("...it's not going to be perfect the first time and we have to stick with it…" 10/16/18 Math Lab audio).

Engaging in authentic inquiry with the mathematics department. Leaders also engaged in the task of genuine inquiry into teaching practice alongside the mathematics department. As Ada described, "we're asking the same [inquiry] of ourselves, and it's okay that I get messy" (spring interview). Often, this involved taking on parts of the collective instruction themselves and opening their own practice to the department's collective inquiry. For example, Jack and Ada

both made their teaching practice public and available for the group's inquiry during the October Math Lab. The group co-enacted the Contemplate then Calculate routine in Bea's classroom. Each of the seven mathematics teachers took on part of the routine, Jack led the discussion of students' strategies, and Ada wanted to "try out" recording students' reflections at the end of the routine.

During each Math Lab, after enacting the instructional routine, the department would return to the large office table to discuss their enactment, inquiring about notes they made on their observation templates regarding students' thinking and participation in relation to the instructional decisions they collectively made (i.e., the routine interaction of connecting students' thinking and participation to teaching). During the October Math Lab, Jack observed that when he asked a question to the class, "there were crickets. I'm wondering how I could have posed it differently so there would be meaningful discussion at that point in the lesson." The department then engaged in a line of investigation together in relation to the strategies students had posed and questions that might have been more generative and cause students to engage with in the moment to which Jack was referring, again engaging in the routine interaction of connecting students' thinking and participation to teaching. Patty noted the importance of Jack facilitating part of the instructional routine and reflecting with vulnerability and curiosity on what did not go as he had expected in his teaching: Jack "own[ed] it and was like, 'We're learning together'" (fall interview). Jack positioned his practice as an object of genuine inquiry, and not model instruction.

All three routine interactions of teacher time out, connecting students' thinking and participation to teaching, and orienting toward the value of students' thinking were used during the classroom instruction phase of each Math Lab, to support leaders' engagement in authentic

inquiry with the department. When leaders and teachers called a time out, pausing during the enactment, they oriented each other toward the mathematical value in particular students' strategies and they reasoned together about the next instructional decision they might make in light of students' thinking or participation at that moment. For example, in the October Math Lab, the group paused and huddled together as students were working on the mathematical task to talk about the mathematical value in the strategies they were seeing and consider how to proceed with the discussion. When leaders initiated pauses, they were not evaluative or in a spirit of feedback. Rather, they took the form of a question about how "we" (the leaders and teachers) might accomplish a particular goal, or a genuine curiosity about a student's thinking or participation. In the case of the time out and huddle during students' work on the task, these routine interactions allowed the group to inquire together about a particular instructional decision in relation to what they were seeing in students' work.

Classroom visits. Classroom visits were a third routine structure in the professional learning system, involving one of the leaders visiting one of the teachers' classrooms. The leaders recognized that it was crucial to structure routine opportunities to build on what was focused on in the Math Labs. As evidenced in interviews and design meetings, leaders had two purposes for classroom visits: (1) to connect to Math Labs and (2) to advance inquiry in the context of each teacher's own classroom and students. In terms of connecting with the Math Labs, leaders designed classroom visits to center the same instructional routine (e.g., Contemplate then Calculate in fall visits) and a focus on an aspect of instruction related to the department-wide focus of facilitating meaningful discussions. As Jack reflected:

> Patty coming in and co-teaching and practicing – that's been super powerful, so [Math Labs] are not just a one-and-done professional development thing. The linkage between her classroom visits and the Labs has been a way to help make something feel doable. (spring interview)

Classroom visits were intended, in part, to support teachers to see a discourse-oriented vision of mathematics instruction as possible with their own students.

In terms of advancing inquiry in relation to teachers' own contexts, the classroom visits were intended as space through which to investigate how the instructional routine used in the Math Lab might fit into or supplement the district-supported mathematics curriculum and be adapted to support a teacher's particular students. The leaders designed classroom visits to be co-planned with an individual teacher and to be responsive to both that teacher (e.g., their current instructional practice; narratives about teaching and learning) and to their students. I found that the tasks undertaken by the leaders in classroom visits to support inquiry-oriented professional community included: (1) scheduling "natural spots" for classroom visits within each unit; (2) building trust among leaders and teachers; and (3) engaging in authentic inquiry with individual teachers.

Scheduling "natural spot[s]" for classroom visits within each unit. A key leadership task involved scheduling classroom visits on days in which the instructional routine introduced in the Math Lab felt like an appropriate fit in the curriculum. The leaders reserved time at the end of Math Labs to schedule follow-up classroom visits with Patty (and occasionally Ada or Jack) for either co-teaching or strategic observation of the teacher's instruction. For example, in a design meeting ahead of the October Math Lab, the leaders reserved time at the end of the day for grade-level teams to meet and decide when to try the routine in their own classrooms. Jack rehearsed this, saying: "So, you'll look into your curriculum … and work with your [grade-level team] to find something in the next however many weeks, that we can do this [task] with you" (10/15/18 design meeting audio). Patty responded, "Right, I've already told sixth grade that this will just go into - I'll just co-teach with them - sometime in the next week. They'll just find in

their curriculum where it would be a natural spot" (10/15/18 design meeting audio). This became the rhythm as the year progressed. The department tried a lesson structure together in a Math Lab, the grade level team scheduled out "natural spot[s]" in the curriculum to try the lesson structure in their own classes, and Patty or another leader joined them for at least one class period on those dates.

Building trust among leaders and teachers. During classroom visits, leaders intentionally worked on the task of building trust among leaders and teachers, especially reinforcing that that leaders were not evaluating teachers' instructional practice. Rather, they were offering accountability and support, and they were learning alongside teachers about instruction and about their students. While leaders worked to build trust throughout the professional learning system and informal interactions with teachers, classroom visits offered especially generative space for this task in that they involved just one leader and teacher.

The leaders designed classroom visits to work "like a Lab" in that both the teacher and leader would be learning in and through the instruction (Jack, 10/2/18 design meeting field notes). Ada emphasized that this "way of being in the classroom together" differed from that of a more traditional coach engaging with a teacher in a classroom, in which a coach might be seen as supporting the teacher's learning but not as learning themselves (spring interview). In interviews with the sixth-grade teachers, they characterized their work with Patty during classroom visits as "co-facilitating" (Bea, spring) and "figuring things out together" (Mari, spring) rather than being shown what to do or how to do it. As Mari noted in her fall interview, "[Patty] has so much expertise, but she's not going to [say], 'I have so much expertise, learn from me.' … She's not going to be flaunting it around, but she delivers it in such a fun and inviting way."

While all three leaders worked to build trust, framing classroom visits as a space for co-inquiry and co-learning, this appeared to be especially important work for Jack to undertake. He described the particular challenge posed by his role as the school principal:

> I'm just grappling with like, how can I build trust? I think [I] don't have that with a certain amount of people. I've always felt like I think sometimes the coaches are seen [by teachers] as the ones that can build these relationships and improve practice, and principals are something different, but I've always felt that that's not what I think we should be able to do. I want teachers to feel like I am an instructional leader and can also work with them to provide feedback and move their practice forward. (spring interview)

Jack understood that his visits might be seen as evaluative by teachers given modal expectations for the role of school leaders in U.S. schools, and given prior experiences teachers had with their principals. He recognized that framing classroom visits offered space for "build[ing] trust," "building these relationships." By the end of the school year, Jack reflected that he had done so with some of the mathematics department but not all, and that it was challenging work.

Just as in Math Labs, the leaders used teacher time outs to pause instruction and engage in conversation. In the classroom visits, these were used in part to counter notions that the leader was evaluating teachers' instructional practice and to build trust with teachers. For example, Jack recalled a visit to Bea's room, in which Bea took the lead on instruction and paused herself in the moment of teaching. "[Bea] asked a question and we did a teacher time out right there. [I] said, 'How can we spread [the dialogue] to more students than just the teacher and the student?' (spring interview). In this case, Bea initiated the pause in instruction, and she and Jack discussed how they might engage more students in the room in dialogue. Jack saw this teacher-initiated pause as evidence that Bea saw his role in the classroom visit as a co-learner with whom to engage in collective inquiry and experimentation, rather than an evaluator for whom she had to perform.

Engaging in authentic inquiry with individual teachers. Like in Math Labs, leaders engaged in the task of genuine inquiry into teaching practice alongside teachers during classroom visits. We see in the example of Jack's visit to Bea's room above that the teacher time out also provided space through which to reason together about an instructional decision. The leaders also engaged in authentic inquiry with individual teachers about students' mathematical thinking and participation. We can see this in a representative classroom visit from Patty to Mari's room in December. Mari and Patty had co-planned the Contemplate then Calculate instructional routine that was introduced in the October Math Lab, embedding a mathematics problem from an upcoming lesson in the district-supported curriculum. Mari took the lead on facilitating the whole-class discussion of students' strategies. After one student shared his strategy for solving the task, Patty paused the instruction, asking, "How can we get students to really think about this idea? It's so cool!" (12/6/18 classroom visit field notes). Here we see all three routine interactions—teacher time out, orienting toward the value in students' mathematical thinking, and connecting students' thinking to teaching—as Patty oriented Mari to the "cool" idea a student had shared and initiated conversation about their next instructional decision in relation to that students' idea. Mari and Patty conferred together and decided to ask other students to repeat what the student had shared, using some of the sentence stems suggested in the Contemplate then Calculate routine (e.g., "They noticed … so they …"). Mari reflected that pausing during the lesson and orienting toward the mathematical value in a student's strategy both supported their instructional decision-making. In an interview after the classroom visit she noted, "Where I might be like, 'Oh, yeah, he's just sharing his ideas,' [Patty] was like, 'Wow, this is really cool, for a sixth grader to be thinking like this,'" allowing them to draw on the strategy in the discussion (winter interview).

We see in the example above that the routine interactions of pausing during instruction (teacher time out) and orienting toward the value in students' thinking provided space for Patty and Mari to attend to the mathematical value of the student's strategy and for them to make an instructional decision in the moment in response. Further, this pause and the tone it took ("How can we get students to really think about this idea? It's so cool!") signified that Patty was learning *with Mari* about the particular students and ideas in the room. More generally, leaders appeared to use the routine interaction of pausing during classroom visits to highlight that they too were learning how to enact their commitments to equity and justice in their own rooms with the particular content, students, and contextual features at play. Leaders positioned teaching as an object of inquiry for leaders and teachers alike, something worth collaborating on to learn more about.

Grade-level time. The fourth routine structure in the professional learning system at Forest Middle School was time for grade-level teams to meet. Leaders saw importance in grade-level teams of mathematics teachers meeting together regularly to plan and debrief upcoming lessons and think together about students' learning of particular mathematical ideas. As evidenced in interviews and design meetings, leaders had two purposes for grade-level time. First, they were intended to "connect" to and "support" Math Labs, by both informing the focus of the Math Labs and by providing space for grade-level teams to try out instructional routine introduced in the Math Lab with colleagues and with a particular curricular and mathematical focus (8/23/18 design meeting audio). Second, mathematics teachers' meetings in grade-level teams were designed to provide routine structure through which to inquire into: (1) the particulars of the mathematics content being worked on in a given unit or set of lessons; (2) how students develop particular mathematics understandings; and (3) how teachers might build on

students' current understandings during instruction. The leaders saw these grade-level meetings as offering a unique space to "help deepen content knowledge" (Patty, fall interview).

Grade-level time followed two different cycles. Several times during the school year (e.g., three times for the sixth grade team), grade-level teams engaged in the cycles of student interviews described in the sections above. During these cycles, they interviewed individual students about their mathematical thinking and collectively debriefed the interviews along with Patty using protocols adapted from the Mathematical Reasoning Inventory (Burns et al., 2012). As the school year progressed, the cycle evolved to include: collectively unpacking content for upcoming units, collectively developing interview questions to use with students, interviewing students, collectively using data from student interviews to plan for upcoming lessons, and collectively reflecting on how lessons went in various of their classes. Several times during the school year (e.g., four times for the sixth grade team), grade-level teams engaged in intervention cycles, in which they collectively developed common formative assessments, administered the assessments in their classes, collectively analyzed students' work, and collectively discussed instructional decisions the teachers would make based on their analysis, both in core instruction and during designated intervention time with small groups of students.

I found that the tasks undertaken by the leaders in grade-level time to support inquiry-oriented professional community included: (1) scheduling grade-level time into the calendar; (2) attending grade-level time to prioritize vision; and (3) engaging in authentic inquiry with grade-level teams.

Scheduling grade-level time into the calendar. The leaders engaged in the task of scheduling grade-level time into the contractual work schedule, both during the school day and during "early release days." Jack in particular organized the daily school schedule to provide

teachers in the same grade level a common planning period. He noted that collaboration among grade-level teams is "impossible outside of [structured common planning]" (spring interview).

> I think the best thing that we do is we provide time for teachers that teach the same thing to just run into each other around the building. The best teachers – the ones that are most successful and feel good about themselves teaching – are the ones that are collaborating and bouncing ideas off each other constantly. (Jack, spring interview)

Because the school had detracked its mathematics classes, subject-specific grade-level teams of teachers were all teaching the same curriculum and could work closely together to engage in unit- and lesson-planning, and to analyze student work after lessons.

Grade-level mathematics teams began the school year by meeting four days per week for 30 minutes of their 1.5-hour common planning period (using the fifth day to meet with their cross-content grade-level teams). The teachers could meet less frequently during their common planning period later in the year, as they were often called to cover a colleague's class because of the shortage of substitute teachers in the district. The leaders also carved grade-level time from each of the 18 district-mandated afternoons for school-wide professional development. Patty supported grade-level teams' work during these afternoon sessions, and Jack often attended to sit with teams and engage as a thought partner in the work with them. Grade-level teams used both the common planning and afternoon time to engage in either student interview or intervention cycles, as described above.

Attending grade-level time to prioritize vision. Grade-level time was a key space in which the day-to-day frustrations or logistical challenges of teaching surfaced, as teams, for example, calendared the lessons in an upcoming unit or created a common formative assessment for a particular mathematical idea. Patty's and Jack's task involved attending grade-level team meetings to emphasize that school leaders' and administrators' priorities in terms of day-to-day teaching aligned with their vision for mathematics instruction and for the community's work. For

example, during common planning time in October, the sixth grade team worked to schedule their first common assessment such that they could collectively analyze data from the assessment in their next afternoon meeting. Bea expressed that she was not at the same place as her colleagues in the curriculum:

> [Bea] teared up a bit as she spoke and said "I'm so behind." Jack was at the table briefly at this point and said, "You're going slow to go fast! The culture in your room is incredible, and you're building a solid foundation." (10/5/18 sixth grade time field notes)

Bea's expression likely reflected an internal pressure to keep pace with her colleagues and with the district recommendations. Jack's response reflected the department's goals for students and for their teaching (Figure 3.1). To support students to engage, for example, in meaningful discussions, requires intentional up-front work, a "solid foundation." Reflecting on this moment in her fall interview, Bea said: "I think [Jack] is part of the reason why Forest feels so different than any other school I've ever worked in, and it's because he takes a real ownership over the building of a strong community. I see him as a partner as much as I do as a supervisor. And so for that, I feel really lucky."

Engaging in authentic inquiry with grade-level teams. As in the other routine structures in the professional learning system, during grade-level time, leaders engaged in the task of authentic inquiry with the grade-level teams. The routine interaction of orienting toward the mathematical value in students' thinking appeared to be particularly generative in supporting this inquiry. Patty saw herself as deepening her own content knowledge alongside teachers, engaging in genuine inquiry into mathematical concepts and students' development of mathematical ideas, broadening what she might count as mathematically valuable in students' thinking. Prior to the sixth grade team's planning for a unit on ratios and proportional relationships, Patty met with our university team to "dig in" and "play with ideas" (10/1/18 design meeting audio). We each read a relevant chapter from *Teaching Student-Centered Mathematics: Developmentally Appropriate*

Instruction for Grades 6-8 (Van de Walle, Bay-Williams, Lovin, & Karp, 2019) and documentation of the progression of students' development of these ideas across sixth and seventh grades (Common Core State Standards Initiative, 2010). In our meeting, we puzzled together over the "key concepts (understandings) that students need to develop" and what it might "look like and sound like for kids to demonstrate understanding of these ideas" (10/1/18 design meeting agenda).

Patty brought her own learning and research-based resources to bear on grade-level conversations. However, the tone she took in these conversations conveyed that she was learning from teachers and from their students' strategies. For example, when the sixth grade team began to explore the content in their upcoming unit on ratios and proportional relationships, Patty suggested the teachers read the progression of students' development of these ideas across sixth and seventh grades prior to the meeting (Common Core State Standards Initiative, 2010). At the start of the meeting, Patty said, "We'll build out these ideas based on what we've seen our students saying and doing" (1/9/19 sixth grade time audio). As the teachers gave examples of language they had heard in prior units from students, or in the case of Mari and Carol, language they had heard when teaching these concepts in prior years, Patty kept careful record on a graphic organizer. In her responses, she used the routine interaction of orienting toward the mathematical value in students' thinking (e.g., "Oh that's a really great way of conveying a part-to-whole relationship!"; 1/9/19 sixth grade time audio). While Patty worked to orient and guide the conversation, she did so with a tone of genuine inquiry into mathematics content and students' thinking.

Discussion and Conclusions

This paper explores the practice of the three leaders supporting the Forest Middle School mathematics department in an aim to develop toward inquiry-oriented professional community. While prior research has detailed the characteristics of communities associated with students' and teachers' learning (e.g., Jaworski, 2006; Kruse, Louis, & Marks, 1995) and specified the nature of the work and conversation of such generative communities (e.g., Kazemi & Franke, 2004; Horn, 2010), little research has explored the role school administrators and facilitators play in supporting communities, particularly ones aiming to transform instructional practice. This study specifies the role of a principal and two school-based instructional coaches who together supported the mathematics department in their work.

Specifically, I identified the routine structures and routine interactions at play in the community's work, and I identified the tasks leaders enacted to cultivate an inquiry-oriented professional community among the mathematics department. The routine structures involved opportunities for the community to collectively investigate and enact key aspects of instructional practice, which literature suggests is important (e.g., Grossman et al., 2009). The routine interactions included pausing in the moment of instruction to engage in inquiry (teacher time out; Gibbons, Kazemi, et al., under review); orienting toward the value in students' thinking and participation; and connecting evidence of students' thinking and participation to teaching (e.g., Horn, Kane, & Wilson, 2015).

While Jack, Patty, and Ada's practice was specific to and responsive to the context at Forest, their practice has implications for other leaders supporting inquiry-oriented professional community among discipline-specific groups of teachers. In what follows, I recast the findings that emerged from the work of Jack, Patty, and Ada in more general terms, to both reflect and

add to what we know from the literature. I then discuss the important role Jack played to allow for the community's work. Finally, I consider the limitations of this study and implications for future research.

The Practice of Supporting Inquiry-Oriented Professional Communities

The work of the Forest leaders suggests implications for the practice of others aiming to support inquiry-oriented professional communities. As with the results of any qualitative case study, the components of leadership practice shared here are not intended to apply directly to other cases. Nonetheless, they are worth considering in relation to the research of other communities and in the practice of school leaders and facilitators of professional learning.

Foster a shared vision for the community's work in relation to a vision for instruction. While school reform, teacher learning, and school leadership literature have increasingly called for organizing professional learning (cf. Kennedy, 2016) and leaders' practice (e.g., Council of Chief State School Officers, 1996; Murphy, Elliott, Goldring, & Porter, 2007) around a shared *vision for instruction*, the findings of this study also implicate the importance of organizing around a shared *vision for community* in relation to a vision for instruction. The leaders at Forest shared a vision for mathematics instruction which they had cultivated over time, through open, authentic conversations with each other about teaching and learning, through shared experiences with researchers and other practitioners, and in relation to their own stance of curiosity and ongoing learning. They used this vision to guide their design and enactment of professional learning events, in keeping with Richmond and colleagues' (2019) argument in the context of pre-service teacher education that the design and enactment of professional learning be grounded in "a shared vision of good teaching, shared knowledge and beliefs about teaching

and learning, and use of common standards of practice that guide and assess [teachers' work]" (p. 189).

Less specified in the literature is the cultivation of a shared vision *for the community's work* among leaders and teachers. The Forest leaders shared a vision that the community would make their practice public and available for inquiry, experiment together with instructional practice, and see each other as indispensable in the work of improvement, all in service of their vision for instruction. This vision underpinned the leaders' practice, shaping the ongoing decisions leaders made, both in designing professional learning events (e.g., deciding how to structure "intervention") and in the moment of facilitation (e.g., using language like "let's try it out" in Math Labs).

A central contribution of this study is an image of *how* leaders can work to foster a vision for community in light of a vision for instruction. The next two sections describe critical work the leaders undertook in order to cultivate that vision.

Organize teams toward a vision. Existing literature has indicated the importance of hiring and placement, especially teachers' and professional learning facilitators' involvement and agency in these decisions which are traditionally in the purview of school administrators (see Chapter 2). This case adds to this literature by indicating that hiring and placement be enacted *toward* a vision for the community. For example, Jack, Patty, and Ada decided to hire Bea prior to the 2018 – 2019 school year because of (1) Bea's articulation of her commitment to students and to working toward justice in her instruction; (2) Bea's willingness to engage in collaboration with colleagues; and (3) Mari's excitement to learn with Bea. Their inclusion of teachers in decision-making reflected both a desire that teachers experience agency in placement decisions

and an attention to *how* teachers' experiences and commitments would complement and support each other in their work toward a clear vision.

Build professional learning into the school schedule. Protected time for authentic, meaningful work together is critical. We see in the case of Forest Middle School that Math Labs involved scheduling dates ahead of the school year and arranging substitutes for each of the mathematics teachers where needed. Grade-level time involved ensuring teachers had common planning with others teaching the same subject and grade-level, and dedicating this time for work that mattered to teachers. Jack considered collaboration as "impossible" without structured time devoted to inquiring into instructional practice together. This is echoed in literature that indicates just how important it is that time with colleagues is structured into teachers' schedules, in order for it to be sustained (e.g., Horn, Kane, & Garner, 2018). However the work at Forest suggests that time alone is not sufficient to foster an inquiry-oriented professional community; as Grossman and colleagues (2001) argue "…structural arrangements alone cannot teach people to interact differently" (p. 990). We see in this case that much of the meat of leaders' work to support the community happened in their ongoing planning and facilitation of professional learning events.

Design and enact a professional learning system toward a vision. This case highlights the value in leaders designing and enacting a professional learning system toward a vision. It appeared critical that the Forest leaders treated professional learning structures and events as part of a *system* of professional learning. In other words, they saw the structures and events as "connected and coordinated," each building on and elaborating on the others (Cobb, Jackson, Henrick, Smith, et al., 2018, p. 66). While the importance of attending to the connection and coordination of professional learning has been identified as important, we have few empirical

accounts of how such systems get designed and enacted. The case of Forest sheds light on this apparent gap.

In order to design professional learning as a system, the Forest leaders both attended to the unique affordances of each structure and links between structures. For example, the leaders used Math Labs to inquire into a shared instructional experience together as a department, while they used grade-level planning time to inquire into students' mathematical understandings in relation to particular content. Across the professional learning system, there was authentic inquiry into instructional practice by teachers and by leaders. We see this leaders' practice that across all four routine professional learning structures, they engaged in genuine inquiry into instructional practice—in Math Labs, with the whole mathematics department; in classroom visits, with individual teachers; in grade-level time with the grade-level team; even in design meetings, with each other, district leaders, and our university team.

Authentic inquiry required vulnerability. In each of these structures, leaders regularly asked questions that put their problems of practice and current thinking about instruction, mathematics, and students in the spotlight; they regularly enacted instruction with others present and posed questions about their instructional decisions for the group to explore together; they modeled making practice public and available for inquiry and an experimental stance toward teaching in their participation in professional learning events. These links across the professional learning system did not happen by chance. In design meetings and informal conversations, the leaders regularly attended to how teachers would experience various decisions as "connecting" or "supporting" each other.

The professional learning structures at Forest were also connected by the vision for the community's work. To illustrate this, when Bea was asked what seemed to connect the various

experiences she was engaged in with colleagues (Math Labs, classroom visits from leaders, grade-level time), she named several goals, including the department's work to support students' agency and identities in relation to mathematics, and "… this idea that collectively we're stronger than we are as individuals."

The Crucial Role of the School Administrator

In taking an approach influenced by a distributed leadership perspective, I have articulated leaders' practice as it was shared by Jack, Ada, and Patty. However, it is worth pausing and noting how counternormative Jack's role at Forest Middle School was, in light of broader patterns in how school administrators influence teachers' work together. First, that Ada and Patty were involved at all in hiring and placement decisions reflects Jack's commitment to an authentic partnership among the leaders in any decision-making that would impact the mathematics department's work.

Second, Jack prioritized the shared vision for the community, even in the midst of competing pressures and policies. Nasir and Louie's (2014) reflection on the "derailment" of the community at Railside High School, tells a very different story with a similar conclusion – school administrators' prioritization of a vision matters for community. With a change in school administration, the mathematics department at Railside no longer had space for inquiry, as their allocated time with colleagues became increasingly taken over by external agendas and a tone of evaluation of their teaching practice, rather than genuine curiosity about and inquiry into issues of teaching and learning. Nasir and Louie note that this was in part because the new administration did not share the same vision the department had for their work, and thus, that vision was not prioritized when there were competing demands. While little research has explicitly focused on shared vision and expectations among administrators and teacher

communities, studies suggest that administrators' expectations should not compete with a community's goals and vision (cf. Dunlap, ND).

Third, Jack attended professional learning events with great care for how he would be perceived by teachers and how he would influence the culture of the spaces. During Math Labs and classroom visits, he made an intentional effort to teach in front of the mathematics department and display vulnerability, asking authentic questions about his instructional practice in relation to students' thinking and participation. He worked deliberately to "build trust" with individual teachers, knowing teachers may be inclined to perform in front of him. In relation to the other leaders, Jack positioned himself as a co-learner and co-facilitator. This is commensurate with the argument that *how* a school administrator collaborates with an instructional coach matters in terms of supporting teachers' learning (e.g., Jackson, Cobb, Wilson, Webster, Dunlap, & Appelgate, 2015).

Limitations and Directions for Future Research

In this study, I have specified the role of a principal and two instructional coaches as they worked to foster an inquiry-oriented professional learning community. In doing so, I proposed a set of leadership tasks that have the potential to support school administrators and professional learning facilitators. Although I see this work as making a contribution, more work needs to be done to understand the conditions and leadership practice that support inquiry-oriented professional communities across disciplines.

One key implication for future research includes the need to understand the practice of leaders as they work with multiple departments or subject-specific teams. At Forest, I was only able to closely follow the work of the mathematics department, and not the work of other departments or the interactions between them. However, is clear in my data that the work of the

whole school matters for the kind of community that is possible within the mathematics department. In interviews with Patty, Ada, and Jack and observations of their planning, we can see that they give clear attention to teachers' learning and experiences in other content areas, in cross-subject grade-level teams, and in school-wide staff meetings. In other words, the work at Forest Middle School was a school-wide effort. This study has explored in particular how leaders might support inquiry-oriented professional community within a mathematics department and mathematics-specific teams, where inquiry in relation to mathematics and the practice of mathematics teaching was possible. One critical line of investigation concerns the relationship between the work of supporting individual departments toward inquiry-oriented professional community and the work of supporting the whole school.

Another critical implication for future research involves understanding the responsive and context-specific nature of leaders' practice. Developing an inquiry-oriented community at Forest appeared to be fragile work in part because the norms guiding this community stood at odds with normative expectations in the U.S. for teachers and leaders. While not an explicit focus of this paper, it appeared crucial that Jack, Patty, and Ada's decisions remained responsive to the current district initiatives; conditions of the school; practices, vision, and narratives of the Forest teachers; and needs of the students. For example, we saw the Forest leaders building relationships with teachers, spending time with them in their classrooms, and checking together in design meetings about individual teachers and grade-level teams, so they could make decisions with teachers in mind. How leaders might make decisions in support of community *and* in response to various aspects of the context is a critical space for future research. The sustainability of any community appears to depend in part on leaders' responsiveness to these

aspects of the context. How might the features of each professional learning event that leaders design and facilitate change as aspects of the department's context change?

I found that the community at Forest Middle School appeared to be contingent on the work of a school administrator who valued teachers' collaboration and created the conditions necessary to enact the principles named above. Can meaningful, inquiry-oriented teacher community form even in schools where the school leader does *not* privilege teachers' collaboration or play the central role Jack played at Forest? Relatedly, it appears critical to explore the role district leaders play in supporting inquiry-oriented professional community among departments and schools. In particular, what is their role in support of principals, teachers, and the organization of schools? What decisions might they make regarding curricula and district-supported professional learning efforts?

I chose in this analysis to attend to the distinctive and critical role of school administrators and professional learning facilitators in supporting inquiry-oriented professional community. Of course, teachers play a critical role in this development as well, and a limitation of this analysis is that I did not attend to teachers' roles in and experiences of the community. In the next paper of this dissertation, I investigate teachers' experiences of the professional learning system and, in particular, the tensions that emerge as they work toward inquiry-oriented professional community. Understanding the role and experiences of various community stakeholders is crucial in making sense of the development of an inquiry-oriented teacher community.

CHAPTER 4. AN ANALYSIS OF HOW TENSIONS ARE AIRED AND ADDRESSED IN AN INQUIRY-ORIENTED PROFESSIONAL COMMUNITY

Supporting students to engage in rigorous mathematical activity and to see themselves as mathematics learners with power and agency is challenging work. Teachers must surface and challenge discourses about what it means to do mathematics (e.g., Gutiérrez, 2012; Horn, 2007), what it means to teach mathematics (e.g., DiME, 2007; Munter, 2014), and who is capable of rigorous mathematical activity (e.g., Jackson, Gibbons, & Sharpe, 2017; Nazemi, 2017). They must also deepen their own mathematical knowledge for teaching (e.g., Hill, Ball, & Schilling, 2008; Shulman, 1986) and develop forms of teaching practice that build on students' thinking and experiences (e.g., Aguirre, Mayfield-Ingram, & Martin, 2013; Franke, Kazemi, & Battey, 2007; Wilson, Nazemi, Jackson, & Wilhelm, 2019). At the same time, teachers must be able to adapt their practice to support the individual students in their classrooms to thrive – particularly those from communities historically marginalized in and oppressed by mathematics and schooling (e.g., Gutiérrez, 2002; Joseph, Hailu, & Matthews, 2019).

Developing and enacting the commitments described above requires substantial shifts in the teaching and organization of most secondary schools (cf. National Academies of Sciences, Engineering, and Medicine, 2020). Given the radical nature of the shifts required, dissonance is bound to arise between mathematics teachers' commitments, their existing practice, and the institutional setting of their work (e.g., the adopted curriculum and expectations from school leaders). In other words, the challenging work of collectively shifting practice and discourses will likely evoke *tension* (e.g., Ball, 1987; Louie, 2015, 2016).

Empirical studies of both individual and organizational learning suggest that exposing tensions in a supportive community is necessary to transform entrenched ideas and ways of

working (e.g., Achinstein, 2002; Hebard, 2016; Lima, 2001; Louie, 2016; Westheimer, 1999). As a field, we are beginning to understand the kinds of tensions likely to emerge as mathematics educators work to enact their commitments to meaningful aims for students and ambitious, discourse-oriented instruction (e.g., Achinstein, 2002; Louie, 2016; Westheimer, 1999). We know it is critical that these tensions be engaged in community (cf. Westheimer, 2008).

Also critical is that we understand *how* tensions might be productively engaged to support the learning and wellbeing of community members. Teacher communities' responses to and navigation of such tensions have been examined in studies of their conversations (e.g., Brodie & Shalem, 2011; Louie, 2016). On the basis of such studies, the field has identified conversational features of a community's work (e.g., the way they engage in discussion together) that can serve as either resources or hinderances toward teachers' generative learning. Far less work has attended to the institutional setting in which these tensions arise (for exceptions, see Achinstein, 1998, 2002), which we know matters greatly (e.g., Cobb, McClain, de Silva Lamberg, & Dean, 2003). For example, in relation to the tensions that emerge in teachers' work, little research has attended to the structures that organize communities' work or the role and practice of district or school leadership.

In this paper, I report on a qualitative case study of the conversational and organizational features of a mathematics department at a school that supported productive engagement with tensions, referred to as Forest Middle School. As described in Chapter 3, during the 2018 – 2019 school year, the Forest Middle School mathematics department involved leaders in their first year of a coordinated effort to design and facilitate a connected system of professional learning experiences geared toward developing a robust community of teachers. The community, at its

core, was organized toward meaningful aims for students and an ambitious, discourse-oriented vision for mathematics instruction (see Chapter 3 for a detailed description).

I focus this analysis on tensions experienced by Mari and Bea, two of the teachers newest to the Forest Middle School mathematics department and to the teaching profession, Mari in her first of teaching and Bea in her second. Both were sixth-grade math teachers and white, middle-class women. As I will substantiate in the Methods and Findings sections, these teachers had been hired in the years prior to data collection expressly for their commitment to meaningful aims for students, discourse-oriented vision of instruction, and openness to learn with their colleagues. As such, analysis of this particular mathematics department and these particular teachers marks a rich case through which to explore generative responses to tensions. I asked the following questions:

1. What tensions between commitments and practice were aired and addressed by the two novice teachers?
2. How did the conversational and organizational features of the department support teachers to air and address these tensions?

In what follows, I begin with a review of extant literature on the importance of both airing and addressing tensions in teaching communities. I also identify key concepts that informed my analysis. I then describe the methods employed in this analysis and present my findings, which focus on the tensions Mari and Bea experienced in enacting their commitments and the conversational and organizational features of the community that supported them to air and address those tensions. I conclude by discussing the contributions of this analysis to the literature and implications for future research.

Relevant Literature and Framing Concepts

The work of teaching is rife with tension, so it is critical that the field understand these tensions and how they might be productively engaged. As Ball (1987) has described:

> I take schools, in common with virtually all other social organizations, to be arenas of struggle; to be riven with actual or potential conflict between members; to be poorly coordinated; to be ideologically diverse. I take it to be essential that if we are to understand the nature of schools as organizations, we must achieve some understanding of these conflicts. (p. 19)

In what follows, I review the literature related to tensions and conflicts in the work of teaching. First, I turn to the literature framing tension as generative for the learning of both individuals and organizations. Next, I describe the tensions the literature suggests teachers might experience as they work to enact ambitious, discourse-oriented forms of teaching. I end with a discussion of the literature on how tensions might be *productively* engaged in teachers' collective work.

Tensions as Generative for Learning

Robust sociocultural theories of learning suggest that tensions in and among such areas as ideology, policy, and practice can be generative for learning. As one example, cultural-historical activity theorists have argued the centrality of contradictions—tensions within and between activity systems—in the transformation of those activity systems (e.g., Engeström, 2001). Engeström (2001) has described such contradictions as generating "collaborative envisioning and a deliberate collective change effort" (p. 137). In other words, navigating tensions can lead to *learning* in the organization. As another example, Wenger (e.g., 1998) has theorized the importance of engaging tension in relation to communities of practice. He argues that tension is endemic to work in communities, especially in relation to the various and often conflicting sets of expectations community members bring to their work. It is through the process of reconciling these tensions that individuals' identities and ways of engaging in the community shift; that is, engaging with these tensions generates *learning*.

Much of the scholarship that builds on these theories attends to the ways in which organizations and individuals learn as tensions are surfaced and engaged. Empirical studies situated in schools have shown that tensions can also support organizational learning, the shifting and adapting of the institutional setting of schools. As Westheimer (2008) has argued, reform efforts that "do not shy away from" tensions that emerge for teachers appear to be "far more likely to succeed in fostering authentic cultures of intellectual inquiry and learning among teachers" (p. 762). For example, Achinstein's (1998, 2002) analysis of two school-wide communities of middle school teachers has revealed the potential for tension to spur organizational change. Washington and Chavez Middle Schools were California schools in adjacent districts, and in each, over 75% of students identified as Black, Filipino, Indigenous, or Latinx. Tension arose in both communities, as each worked to implement collaborative reform efforts. Achinstein found "an embracing stance towards conflict" among the community at Chavez Middle School related to changes in structures, approaches to reform, and normative practices among teachers and leaders at the school. In contrast, she found that the community at Washington Middle School "tended to minimize dissent or divergent perspectives" (p. 446), especially by locating the source of tensions in "problem students" (p. 443). Whereas significant change unfolded in the organization of Chavez, Washington's organization saw little progress. On the basis of these findings, Achinstein (2002) argued that "different stances [toward tension] provide different opportunities for organizational learning" (p. 450). Engaging tensions as they emerge appears to be a primary means through which organizations learn and develop (e.g., Achinstein, 2002; Lima, 2001).

Empirical studies have further underscored the utility of surfacing and working with tensions for individuals' learning, especially learning that reshapes and shifts the status quo (e.g.,

Hebard, 2016, Lord, 1994; Louie, 2016). For example, drawing from cultural-historical activity theory, Hebard (2016) contrasted novice teachers' learning in two methods courses which took different approaches to the tensions emerging for the novice teachers. In one methods course, the activities focused solely on the tools and tasks of the university course, providing no opportunities for novice teachers to explore the tensions they were experiencing across the course and their field placements. In the second methods course, the instructor expressly attended to the tensions emerging for novice teachers in and across the course and field placement settings, providing opportunities for them to bring these tensions to light and explore them collectively. Hebard found that, more than those in the first course, novice teachers in the second course came to develop new, productive ways of thinking and acting. On the basis of these findings, Hebard argued for the generative role of airing and addressing tension in teachers' learning.

Tensions that Arise in Teaching

In this analysis, I focus especially on tensions that emerged as two novice teachers worked and were supported to enact their commitments to meaningful aims for students and to ambitious, discourse-oriented instruction. "Predicaments" or "problems" are endemic to the challenging work of teaching in ways that privilege student discussion of meaningful disciplinary ideas (Cohen, 2011; Lampert, 2001). These ways of teaching often run counter to what teachers themselves experienced as students (Lortie, 1975). Even teachers deeply committed to discourse-oriented instruction may rely or fall back on familiar practices, employing, for example, "instruments of control" even as they are committed to employing "those of trust" (Virkkunen, Newnham, Nleya, & Engeström, 2012, p. 187). Literature suggests a range of tensions are likely

to emerge, especially when teachers aim to teach in ways that confront and reshape the status quo.

Discourse-oriented instruction requires responsiveness to students and their ideas as well as the capacity to orient students toward the disciplinary value in their own and other's ideas (cf. Franke, Battey, & Kazemi, 2007). A persistent tension concerns how to prioritize this responsiveness to students within the guidelines (or confines) of a given curriculum. This tension is not unique to the current era of teaching and learning; as far back as Dewey (e.g., 1897), questions have arisen regarding whether and how to address curriculum in relation to students' ideas.

Another source of tension involves discourses about the mathematical competence of students (e.g., Bannister, 2009, 2015; Horn, 2007; Jackson, Gibbons, & Sharpe, 2017; Louie, 2015, 2016). Tensions arise as teachers elect to try out particular instructional practices (e.g., discourse- or reform-oriented practices) without being entirely sure they are appropriate for their students. For example, Horn (2007) explored the ways this kind of tension emerged for the Algebra Team at East High School (called Railside High School elsewhere; Nasir et al., 2014). In an analysis of teachers' conversations, she found tensions among discourses which characterized mathematical competence as related to speed ("fast"), and those attending to students' deep, conceptual understanding of mathematical ideas. Louie (2016) found a similar tension among the Geometry Team at Union High School. Sometimes, the teachers described mathematical competence of students as "inclusive" of many different forms of activity and practices; other times, their discourse was more "restrictive," defining mathematical competence as primarily a matter of memorization and computation.

Tensions involving curriculum or who is and what it means to be mathematically competent may not come up for every teacher; literature suggests that the kind of tension individual teachers experience depends on their own unique commitments (or "ideologies"). For example, in studies of professional communities among middle school teaching staffs, Achinstein (1998, 2002) and Westheimer (1999) found that different ideologies gave rise to different sorts of tensions. These studies underscore the need to analyze tensions alongside the associated perspectives and commitments of the community members experiencing them.

Productive Engagement with Tensions in Community

As detailed above, tensions can be generative for learning and for reshaping and shifting modal practices and systems. Achinstein (2002) writes, "to engage in conflict and question one's beliefs with the possibility of deep change is fundamentally a positive and hopeful act rather than a problematic one within community" (p. 450). However, surfacing tensions is not necessarily generative; a number of studies have detailed the unproductive ways tensions might be engaged to further entrench harmful ways of working (e.g., Achinstein, 2002; Louie, 2016; Westheimer, 1999). For example, Achinstein (2002) found that when tensions emerged at Washington Middle School related to students' learning, the community used exclusionary language to identify "problem students" who were "infecting" the student population and "[didn't] belong here" (p. 443). Rather than inquiring into their own instructional practices or discourses, they ascribed the source of tension to their students, perpetuating problematic ways of constructing students. Achinstein argued that this kind of engagement with tension limits opportunities for the learning of both individual teachers and the organization of the school community.

Research has detailed characteristics of inquiry-oriented professional communities in which tensions can be productively aired and addressed. Inquiry-oriented professional

community stands in direct contrast to what Grossman, Wineburg, and Woolworth (2001) describe as *pseudocommunity*:

> The imperative of pseudocommunity is to "behave as if we all agree." An interactional congeniality is maintained by a surface friendliness, hyper-vigilant never to intrude on issues of personal space. The maintenance of pseudocommunity pivots on the suppression of conflict. Groups regulate face-to-face interactions with the tacit understanding that it is against the rules to challenge others or press too hard for clarification. This understanding paves the way for the illusion of consensus. (p. 955)

By contrast, in an inquiry-oriented professional community, vulnerability proves essential as individuals open up authentic problems of practice for the group to wrestle with and engage together. Community members make specific ideas and concepts public so they become open to clarification, contradiction, refinement, and, perhaps eventually, some consensus. At the heart of inquiry-oriented professional community is the aim "of challenging the status quo, of questioning accepted ways of being and doing" (Goodchild, Fuglestad, & Jaworski, 2003, p. 396). Where pseudocommunity depends on the suppression of challenging and pressing on ideas, inquiry-oriented professional community depends on the presence of it.

In other terms, an inquiry-oriented professional community is characterized by identifying and exploring tensions. Jaworski (2006) has described such engagement as *critical alignment.* As she explained, "rather than providing solutions to problematic issues in practice, … critical alignment creates the clarity and strength of purpose to recognize issues, and, moreover, to tackle the issues consciously and collaboratively" (p. 204). This concept built from Wenger's (1998) notion that a key form of participation in any community is alignment*,* the process of coordinating perspectives and actions toward particular aims. But, alignment can explicitly or implicitly perpetuate harmful norms, practices, and discourses, depending on that with which community members align. As Jaworski (2006) argued, a critical approach to the process of alignment is crucial if the status quo is to be challenged and shifted.

Critical alignment involves *airing* and *addressing* the tensions individuals experience as they work to enact their commitments in practice. Airing tensions may involve, for example, articulating and putting forth an authentic, even vulnerable, problem of practice or idea to be "consciously and collaboratively" considered by the community (Jaworski, 2006, p. 204). Addressing tensions can then take many forms, whether community members examine an idea or problem together or analyze a community member's practice, including their own. As Achinstein (2002) has said, addressing tensions involves "challenging the taken-for-granted assumptions of teaching and schooling practices and imagining alternatives" (p. 425).

A body of literature has examined the conversational features of communities in which productive engagement with tensions transpires. One important conversational feature concerns the manner in which community members engage one another's ideas in dialogue. For example, Brodie and Shalem (2011) analyzed the conversations among a group of elementary and secondary mathematics educators engaging in professional development together. They found that community members balanced the practice of challenging one another's ideas with expressions of camaraderie and connection ("solidarity"). Based on these findings, they argued that such conversational features of the community's work "provide conditions of possibility for and are the consequences of teachers' accountability to each other, their learners, and their teaching" (p. 428).

Another conversational feature that studies highlight concerns how the community *frames* problems, especially those related to student learning. As Goffman's (1974) seminal work described, framing creates an interpretive context that communicates to participants an answer (or answers) to the question, "What is it that is going on here?" Tension can emerge in and among the frames teachers choose for the pervasive problem of students not learning as expected

(Bannister 2009, 2015; Horn, 2007; Jackson, Gibbons, and Sharpe, 2017; Louie, 2015, 2016; Windschitl, Thompson, & Braaten, 2011). Following a number of scholars, I attend both to *diagnostic* and *prognostic* frames in relation to the problems of practice related to student learning (Bannister, 2009, 2015; Jackson, Gibbons, & Sharpe, 2017). Diagnostic frames involve teachers' "identification of a problem and the attribution of blame" (Snow & Benford, 1988, p. 200). For example, as Bannister (2015) found, diagnostic frames for the problem of student learning might involve "fixed attributes of students" or their "personal and systemic circumstances" (p. 357). Prognostic frames, by contrast, involve "a proposed solution to the diagnosed problem that specifies what needs to be done" (Snow & Benford, 1988, p. 199). For example, in the same study, Bannister found prognostic some frames focused on what students should do while others focused on what teachers should do.

Far less research has focused on the organizational features of communities that might support tensions being aired and addressed. Some studies point to the importance of attending to, for example, the professional learning structures the community engages in together and school leaders' expectations for teachers and for the community's work (e.g., Cobb et al., 2003). Broadly, these studies emphasize features of the community's context which support or hinder "teachers' access to particular forms of pedagogical reasoning" (Cobb et al., 2003, p. 23). That is, they highlight the importance of attending to organizational features which support inquiry related to the tensions emerging for teachers.

In the studies focused on conversational features, quality, and nature of communities' conversations about tensions in relation to teachers' learning and growth, the focus has been on teachers' conversations in particular professional learning structures (e.g., Brodie & Shalem, 2011; Dooner, Mandzuk, & Clifton, 2008; Lord, 1994; Louie, 2016; Westheimer, 1999). Little

work has traced conversations about tension across the various settings in which teachers participate with their colleagues. Further, scant research has attended to the organizational features of communities' work in relation to the productive engagement of tensions. In this paper, I report on an analysis of both the conversational and organizational features of a department that has structured ways for teachers to air and address tensions across different professional learning structures.

Methods of Analysis

I engaged in a qualitative case study of the tensions emerging for two teachers, Mari and Bea, and the ways in which their work in the mathematics department at Forest Middle School supported them to air and address those tensions. A case study allowed me to gather "thick description" of the tensions experienced by these individuals and the community's responses to those tensions (Geertz, 1973). In what follows, I first justify my selection of the Forest mathematics department and especially the focus on Mari and Bea. I then describe the research context, my positionality in the research, the data sources, and my analytic process.

Department Context and Case Selection

I purposefully selected (Patton, 2003) the Forest Middle School mathematics department for this study as a case of a department in which there was intentional support in developing inquiry-oriented professional community toward a discourse-oriented vision for teaching and learning during the academic year 2018 – 2019. The robust professional learning system, ambitious aims for the community's work, and intentional work on the part of school leaders all make the department a rich case through which to explore generative responses to the tensions that arise in teachers' enactment to commitments.

Forest Middle School (grades 6-8) is an ethnically, racially, and linguistically diverse school in the northwestern U.S. At the time of data collection, there were 580 students at Forest. District records classified students' racial and ethnic affiliation as follows: 0.2% American Indian/Alaskan Native; 13% Asian; 17.6% Black/African American; 26.3% Hispanic/Latinx; 5% Native Hawaiian; 12.5% two or more races; and 25.4% white. The district prided itself on the number of languages spoken by students and families, and Forest displayed a school district sign saying "120 languages spoken" at the front of the school. 16.3% of students at Forest were classified by the district as "English Language Learners." A large majority of students (74%) received free or reduced-price lunch, and 17.4% of students were classified by the district as receiving services for disabilities.

The school had undergone significant changes in the two years prior to this analysis. It had "de-tracked" all of its mathematics classes, meaning that students were no longer assigned to mathematics classes based on presumed ability. All seven of the mathematics teachers, along with more than three-fourths of the teaching staff as a whole, were in their first two years of teaching at Forest (though some had taught elsewhere previously) (see Table 4.1 for more details about the mathematics teachers at Forest).

Table 4.1. Mathematics teachers at Forest in 2018 – 2019.

Mathematics teacher	Grade level	Racial / ethnic self-identification	Prior years teaching
Bea	Sixth	White	0
Mari	Sixth	White	1
Carol	Sixth	Black	19
Eric	Seventh	Black	7
Lynn	Seventh	Asian	2
Robin	Eighth	White	7
Dave	Eighth	White	16

All three leaders identified as white. The principal (hereafter, Jack) had been a principal for six years total, three of them at Forest Middle School and three at an elementary school. Prior to that, he had worked for many years as a secondary mathematics teacher. Jack expressed a strong commitment to equitable outcomes for students at Forest and to teacher and leader collaboration. In his previous principalship, he had participated in a district-supported professional development model called Math Labs (Kazemi et al., 2018). The instructional coaches (hereafter, Patty and Ada) were responsible for planning and facilitating professional learning events at Forest, working with Jack. Patty was in her first year as the mathematics instructional coach after having taught middle grades mathematics at Forest for 13 years, during which time she, too, had participated in Math Labs. Ada was in her eighth year as an instructional coach at Forest and her second year focused on English Language Arts (ELA). Several years prior to this study, Ada had collaborated with a member of our research team and three other instructional coaches to support teachers' implementation of rich tasks through their design and facilitation of Math Labs. Prior to coaching, she had taught middle grades ELA for 13 years and upper elementary grades for 6 years.

Jack, Patty, and Ada were in their first year of a coordinated effort to design and facilitate a connected set of professional learning events aimed toward developing an inquiry-oriented community of teachers. That is, they designed and facilitated these events such that the department would begin to develop the characteristics of inquiry-oriented professional community: collaboration, deprivatized practice, reflective dialogue, shared norms and values, a focus on student learning, inquiry as an activity, and inquiry as a way of being. The set of professional learning events at Forest included (1) Math Labs, (2) one-on-one classroom visits

with leaders, and (3) grade-level collaborative time. For a more detailed description of the professional learning system, see Chapter 3.

Further, the district-supported middle grades mathematics curriculum was in its first year of systematic use across the district. The curriculum used Engage New York as its basis and incorporated tasks from other curricula including, for example, Open Up and Illustrative Mathematics. The Forest mathematics department had piloted the curriculum in the year prior to data collection and provided feedback, which was taken up by a set of curriculum guide writers, middle grades mathematics teachers, district leaders, and university-based mathematics educators who collaborated to put the curriculum together.

Participant Selection

I narrowed my focus to the sixth grade team, which included two of the most novice teachers in the mathematics department at Forest Middle School. This group was comprised of three teachers, all of whom were, like the rest of the mathematics department, relatively new to Forest: (1) Carol, a veteran teacher of 15 years who was new to the Forest staff; (2) Mari, a second-year teacher who started her teaching career at Forest; and (3) Bea, a first-year teacher.

I focused in particular on Mari and Bea, because they are novice teachers and because they held arguably strong commitments to meaningful aims for students and ambitious, discourse-oriented instruction. As I will substantiate in the Findings, Mari and Bea held strong commitments; they were hired for their commitments to racial justice and mathematics education as a way to work toward equity and for their willingness to collaborate with colleagues. Teachers (and especially novice teachers) with such commitments are often seen as more readily able to enact them. However, as we will see in what follows, Mari and Bea experience tensions as they work to enact their commitments in practice. Their commitments, their strong working

relationships with each other and leaders, and the robust support of the mathematics department and leadership make Mari and Bea a productive case through which to explore productive responses to the tensions that arise when working to enact commitments.

Positionality

This analysis is part of a larger research-practice partnership which aims to understand how district math leaders, coaches, and teachers can use data about instructional practice to support system-wide instructional improvement. At the time of the data collection, our research team had been partnering with the school district and had worked closely with the mathematics department at Forest Middle School for three years. Prior to my data collection for this study, I spent two years attending professional learning at Forest in order to understand the school and district context and to build relationships with the teachers and leaders.

I attended Math Labs, classroom visits, and grade-level collaborative time with the sixth grade team. During these meetings, I (and any other research team members present) listened carefully and contributed resources and experiences as they were relevant. We regularly offered support as the group was planning ahead. For example, Mari and I made plans during the October Math Lab to co-enact the task introduced in the Lab during her first block class a few days later; we wanted to "try it out, to feel a little more agile" with the structure of the task (10/14/18 Math Lab memo). As another example, when I joined in on Patty's visit to Bea's room in March, I took careful notes of students' contributions in the discussion, so Patty and Bea could focus on other aspects of instruction and use my notes in their meeting after the lesson. Mari and Bea both appeared to see my presence in their professional learning events as supportive.

Mari, Bea, and I were all white women educators who had come into the teaching profession with commitments to justice and equity; we also critically each had a network of

support to engage in ongoing learning regarding what teaching mathematics for justice might look like in practice. Both Mari and Bea sought out the support of other teachers who were particularly expert and adept at building relationships with students and a culture in their classroom in which students were valued and supported to engage in meaningful activity. For example, Bea regularly observed Eric's teaching, because of "the amount of care" he had both for students "as a person" and for their mathematics learning (Bea, spring interview). Mari, Bea, and I also approach teaching with humility and a great deal of listening; we each see ourselves as having a lot to learn and to unlearn about what it means to be white and teach Black, Indigenous, and Brown students.

Because Mari was teaching at Forest the year prior to data collection, I began to form a relationship with her in the 2017 – 2018 school year. By the spring of 2018, we had become trusted colleagues, and our collegiality deepened through the year of data collection. We had lighthearted conversations about food and brought each other's favorite fruit and candies to share in meetings. We had more serious conversations about our commitments to students and about various challenges happening in our lives. Bea was a new teacher in the 2018 – 2019 school year, but we connected quickly. Because we lived in the same neighborhood at the time, we talked frequently about neighborhood haunts and met for interviews at a shared favorite coffee shop. My interviews with both Mari and Bea began and ended with off-the-record, candid conversation about life. Mari and Bea both became close colleagues through our team's partnership with Forest and through my individual interactions with them.

Data Sources

I designed data collection to provide insight into teachers' experiences of the development of the community. Data was collected over the span of a 9-month period, the 2018

– 2019 school year. Relevant data sources to this analysis are field notes and artifacts from our research team's participation in professional learning events, and semi-structured individual interviews with Mari and Bea.

Professional learning events. I attended, audio-recorded, and collect field notes and artifacts at key professional learning events, including three Math Labs, six classroom visits after Math Labs, and 10 sixth grade meetings.

Math Labs served as anchoring experiences for the Forest Middle School mathematics department. They were intended as full- or half-day meetings providing opportunities for the group of teachers and leaders to enact instruction with each other's students and to inquire collaboratively into their instructional decisions in relation to students' thinking and participation. They followed a cycle adapted from the work of Kazemi and colleagues (2018) of unpacking new learning, collectively planning an episode of instruction, collectively enacting that episode in one of the teachers' classrooms, and, when debriefing the enactment, considering students' thinking and participation in response to instructional decisions. Three Math Labs took place in the 2018–2019 school calendar, in October, December, and March. I audio-recorded the department's conversations during all three Math Labs, collected artifacts, and took field notes in which I, in part, attended to the problems of practice raised and how they were taken up in conversation.

At the end of each Math Lab, teachers scheduled follow-up classroom visits with Patty (and occasionally Ada or Jack) for either co-teaching or strategic observation of the teacher's instruction. I attended one of Patty's classroom visits to Mari's and Bea's rooms after each of the three Math Labs (six total). During these visits, I collected artifacts (e.g., a copy of the task, student work, representations of students' strategies) and generated field notes that focused on a

narrative description of the teachers' and Patty's instructional decisions and the nature of their conversation following the lesson.

Grade-level mathematics teams began the school year by meeting four days per week for 30 minutes of their 1.5-hour common planning period (using the fifth day to meet with their cross-content grade-level teams). The teachers met less frequently during their common planning period later in the year, as they were often called to cover a colleague's class given the shortage of substitute teachers in the district. The leaders also carved grade-level time from each of the 18 district-mandated early-release afternoons for school-wide professional development. Patty supported grade-level teams' work, and Jack often attended to sit with teams and engage as a thought partner in the work with them. Grade-level teams used both the common planning and early-release time for activities such as unpacking content for upcoming units, making sense of student work and strategies, and discussing instructional decisions they would make. I attended 10 of the sixth grade team's meetings, where I audio-recorded when possible, collected artifacts, and took field notes in which I, in part, attended to the problems of practice raised and how they were taken up in conversation.

Semi-structured interviews with Mari and Bea. I conducted semi-structured individual interviews with Mari and Bea at three time points throughout the school year. Pertinent to this analysis, these interviews included questions aimed at understanding their goals for their teaching, their goals for work with their colleagues, and how they were experiencing the professional learning system. Each interview was approximately 45 minutes in length, and all interviews were transcribed (4 hours, 32 minutes total of interview data).

Semi-structured interviews with leaders. In order to provide an additional vantage point on the tensions emerging for teachers and the community's responses to tensions, I

conducted semi-structured individual interviews with the leaders at Forest. I conducted five interviews total, three with Patty and two with Ada and Jack. I conducted interviews with all three leaders in October, which, pertinent to this analysis, aimed to understand their goals for the professional learning system and rationale for particular decisions related to the first Math Lab. I also conducted interviews with all three leaders in June, after the final set of professional learning events. This set of interviews included questions aimed at understanding their enactment of the professional learning system in relation to goals, and further rationale for decisions they had made throughout the year. I conducted one additional interview with Patty (the primary facilitator of professional learning events specific to grade levels) in December in order to further understand decisions she was making in relation to professional learning. These data were used for triangulation with the primary data described above. Each interview was approximately 45-60 minutes in length, and all interviews were transcribed (a total of 5 hours, 51 minutes of interview data).

Attending to credibility in data collection. As noted above, prior to the 2018 – 2019 school year, I spent two years attending professional learning events at Forest Middle School, building relationships with Jack, Patty, Ada, and the mathematics teachers in the department at the time, including Mari. This prolonged engagement in the field supported my understanding of key aspects of the professional learning events and the district and school context surrounding teachers' experiences (Lincoln & Guba, 1985). These opportunities to build relationships with participants also supported trust and rapport, which are essential for collecting valid data from participants (Erickson, 1986).

I also collected data in a range of forms and across multiple timepoints in order to support triangulation across sources (Lincoln & Guba, 1985). My aim was to be able to support any

claim with a range of data points, and I built this aim into my data collection strategy. Because attention to context is central to any analysis guided by cultural-historical activity theory (Engeström, 2001) and to understanding the development of professional community in particular (Westheimer, 1999), I collected a range of forms of data that supported my understanding of the context of the mathematics department, especially the professional learning events in which members of the department engaged, including observation notes, audio recordings when possible, and documents related to these events.

Data Analysis

My aim was to specify the tensions emerging for teachers and to attend to the conversational and organizational features of the community's work that supported them to air and address the tensions. I engaged in three phases of analysis: (1) an initial exploration of the data in relation to my research questions; (2) identification of the tensions that emerged for Mari and Bea; and (3) tracing each tension through the school year; and (4) an examination of the conversational and organizational features that supported Mari and Bea to air and address the tensions.

Phase 1: Initial exploration of the data. During and after data collection, I engaged in initial exploration of the data, attending to the tensions that emerged for Mari and Bea and tracing what happened with them. Regularly throughout my data collection, I listened to audio clips from planning and professional learning events, read through field notes, and wrote analytic memos that involved both written and visual reflections on themes I was noticing in the data. For example, in October 2018, I wrote a memo that focused on varying conceptions of "equity" raised in a sixth grade team meeting. As another example, in January 2019, I wrote a memo focused on how Mari's talk about challenges with particular students and her goals for her

instruction had shifted and evolved from my fall interview with her to my mid-year interview with her. The set of memos written throughout the course of data collection illuminated tensions teachers were experiencing and supported me to clarify the focus of this analysis.

Phase 2: Identifying tensions. As described above, my analysis focused especially on tensions individuals experienced, related to their development of ideas, knowledge, and practice embedded in the work of teaching mathematics. I engaged in open coding the data (Merriam, 2014) to more systematically identify themes across the data and, in particular, to identify the tensions emerging for Mari and Bea as they were supported and working to develop inquiry-oriented professional community. *How* I noticed tensions in the data was both deductively and inductively shaped (see Table 4.2). As a result, I identified the tensions that emerged for Mari and Bea as they worked to enact their commitments in practice, which will be elaborated in the findings.

Table 4.2. Approach to noticing tensions in the data.

Signal for a tension in the data	Description *Community member(s)…*
Naming a problem of practice	Identifies a dilemma experienced in their instructional practice (suggested by e.g., Lampert, 2001; Horn & Little, 2010)
Giving multiple frames for a particular problem of practice	Proposes the cause of (diagnostic frame) or a solution to (prognostic frame) a problem of practice (e.g., Bannister, 2015; Jackson, Gibbons, & Sharpe, 2017; Louie, 2016)
Naming expectations perceived to be at odds	Identifies policies, resources, or directives (e.g., adherence to curriculum) that appear to be contradictory or incompatible, especially in relation to commitments (Wenger, 1998)

Phase 3: Tracing tensions. In this phase, for each of the tensions that emerged, I wrote a narrative memo detailing each tension's emergence in interviews and professional learning events (the tension being *aired*), and its pathway through professional learning events in the 2018 – 2019 school year. Following Wenger (1998), this approach assumes that tensions are not

discrete events; rather they are important throughlines of learning that are always present, whether implicit as community members seek to reconcile them individually, or explicit, as they are addressed in the community's work. I narrowed my focus to tensions which were *addressed* in the community's work. See Table 4.3 for the landscape of these tensions.

Phase 4: Making sense of how the community supported tensions to be aired and addressed. In the final phase of analysis, I made sense of the organizational and conversational features at play in supporting Mari's and Bea's tensions to be aired and addressed among the Forest Middle School community. To attend to organizational features, I attended to elements of the Forest mathematics department's *routine* in relation to the tensions raised, meaning the "repetitive, recognizable pattern(s)" in the department's work (Feldman & Pentland, 2003, p. 311). I attended to both routine structures and routine ways of interacting inside those structures. A *routine structure* is a sequence of events that recurs regularly and both involves and is recognizable by multiple role groups as routine. As illustrated in Chapter 3, the mathematics department at Forest engaged in a set of routine structures including one called Math Labs (Kazemi et al., 2018). During Math Labs, leaders and teachers met to plan an episode of instruction, enacted instruction together in a colleague's classroom, and debriefed the enactment together. A Math Lab was a routine structure in that it involved a sequence of events that happened three times during the school year and both involved and was recognizable as routine by teachers and leaders at Forest.

Within the routine structures at Forest, there were particular ways of engaging in conversation, or discourse practices, that appeared to support Mari and Bea to air and address tensions. I attend in particular to the practices that surfaced in Lefstein, Louie, Segal, and Becher's (2019) review of research on conversations among groups of teachers in relation to

teachers' learning. These include: revealing and probing problems of practice; providing evidence or reasoning; making connections to general principles; building on others' ideas, and offering different perspectives. I attended to these five practices in relation to Mari's and Bea's initial airing of tensions and the pathways tensions took through conversations in professional learning events.

Some of these ways of conversing became routinized, in patterned ways of engaging together "intended to guide conversation between adults on matters of instruction" (Coburn & Russell, 2008, p. 217). For example, at Forest, community members routinely paused during instruction in each other's classrooms (i.e., during classroom visits and Math Labs) to engage in inquiry together ("teacher time out;" for more elaboration on this routine, see Gibbons, Kazemi, et al., under review). These pauses were routine in that they occurred regularly when teachers and leaders were in classrooms together and made space for particular kinds of conversations about instruction.

How Tensions Enacting Commitments Are Aired and Addressed At Forest

In what follows, I provide evidence of the tensions that emerged for Mari and Bea in relation to enacting their commitments with a particular emphasis on the conversational and organizational features that appeared to support the tensions to be both aired and addressed. First, I provide a detailed introduction to Mari and Bea, especially elaborating their commitments. Second, I detail two vignettes which illustrate two persistent tensions in enacting their commitments and provide an analysis of what supported Mari and Bea to air and address these tensions.

Mari's and Bea's Commitments

In what follows, I introduce Mari and Bea. I draw on data from my fall interviews with them, triangulated with data from observations of fall professional learning events and interviews with their colleagues.

Mari. Mari was a second-year teacher who had taught at Forest Middle School the year prior. In 2017, Mari met principal Jack "at a youth action team meeting, talking about how to reduce or eliminate the school-to-prison pipeline" (Jack, fall interview) where he encouraged her to apply to teach mathematics at Forest Middle. Prior to that, she worked in a number of roles working with youth, including as a residential counselor in a mental health and addiction recovery facility for youth; a support specialist in a mental health agency supporting youth in schools; and a behavioral specialist in a local Indigenous tribe's youth recovery home.

Mari expressed a deep commitment to her students' sense that they were valued and cared for in her classroom, both by Mari and by other students. She noted in my December interview with her that a key priority in the fall had been building "relationships with … the kids" and "increase[ing] student status" by supporting her students to see the value in one another's contributions. She described several instances of her careful work to support each of her students to treat one another's ideas with respect.

Mari also voiced a commitment to students finding meaning in their work in her room. She wanted the tasks students engaged with to be "real life problems that are affecting our world now [and] connected to things that are relevant to [students'] lives" (fall interview). In considering her own work in her classroom, Mari said: "we're using that math to work on problems or solve problems that are related to bigger issues" (fall interview). She wanted her

students to be able to use mathematics to engage critically in the world around them, and to experience agency in relation to problems they and their communities were facing.

Mari also expressed a vision for and commitment to discourse-oriented instruction, in which students were engaging in conversations to deepen their understandings of mathematics. She wanted to hear students "build off of each other's ideas or respectfully say, 'I disagree with you'" (fall interview). She highlighted the important role a teacher plays in supporting rich conversation among students, especially to productively challenge and press one another's ideas. For example, she described the teacher in an ideal classroom saying, "Let's talk about what happens when we have differing ideas." and "Hey, let's talk, but let's not talk over each other."

Mari was committed to working with her colleagues in the mathematics department and especially the sixth grade team. She viewed Bea, Carol, and Patty, who she collaborated most closely with, as working toward "the same goal," in that they were all aiming to support students sense of themselves as mathematicians. She emphasized that the value in their work together was that each of them brought "a unique background" and set of ideas in relation to that goal.

Bea. Bea was a first-year teacher with express commitments to justice and equity in teaching. Prior to teaching, Bea had rich experiences working with middle and high school students through community organizations. Immediately prior to her work at Forest, Bea had worked for a local university for three years, teaching an undergraduate course about working with youth, and running programming for a local middle school focused on doing mathematics. Prior to her local work, Bea had worked for a university in a large midwestern city and had supported programming with three high schools in a poverty-impacted sector of the city. There, the programming supported freshmen and seniors in thinking about transitions from middle to high school, and from high school into college and the workforce, respectively.

Bea had moved from community organizing efforts into teaching because she saw the potential of supporting justice through students' experiences in their mathematics classrooms. She wanted to create "an atmosphere where students can connect with the content in a way that's more meaningful than just seeing numbers on a page" (Bea, fall interview). Further, she was wholeheartedly convinced of the capabilities of her students: "I think my students are incredibly capable and they're already very resilient problem solvers." She noted that this commitment was a result of the "deep relationship with kids and with middle schoolers" she had developed in her prior work, "especially with students who don't look like me and don't identify as I identify." She emphasized that the narrative "that our kids aren't resilient … they need to be more resilient" was one that she was actively working against in her own practice (Bea, fall interview).

Bea held a strong commitment to students from communities typically marginalized and oppressed by schooling. For example, in my fall interview with Bea, she spoke about the challenge of creating a culture where students felt valued: "I think fundamentally … schools were not designed with many of our students in mind. I think schools operate in a system that supports white supremacy" (fall interview). Bea wrestled in this interview and in conversations with colleagues (e.g., 10/17/18 sixth grade meeting field notes) with how "my students of color … and my low income students are adjusting to the norms and values that schools perpetuate" (fall interview) and the ways that she could teach and set up counternormative ways of interacting in her classroom in response.

Coach Patty noted that Bea was "eager to get at the kids' understanding – conceptual understanding" (Patty, fall interview). In grade-level team meetings, for example, Bea often pressed her colleagues to "draw a model for the way this works" (Bea, fall interview). She wanted students to understand "the theoretical underpinning [of mathematical strategies]" (Bea,

fall interview). For example, in relation to multiplying by ten, rather than just executing a shortcut, she wanted students to understand "the reason *why* the shortcut is just move the decimal one place to the right" (Bea, fall interview).

Bea saw her aims for students' sense of themselves as mathematicians and conceptual understanding of mathematical ideas as connected to and shaped by the kind of conversations she was supporting in her classroom. She was committed "to have more student talk … to be doing less talking [her]self," and for this talk to involve "really meaningful conversations about strategies" (Bea, fall interview). She wanted discussions to allow students to see and make sense of one another's thinking: "where one student's perspective is valued as much as the others' because they see it in different ways, and that brings more wholeness to our overall understanding" (Bea, fall interview). Bea's commitment to discourse-oriented instruction was rooted in the purposes it could serve in terms of students' sense of themselves and mathematical understandings.

Bea saw teaching as involving ongoing learning. A stance of curiosity came through in Bea's interviews, as she posed questions in relation to her practice and her students. Bea saw value in and was "open to trying new things" (Patty, fall interview). In this ongoing learning, Bea was deeply committed to working with her colleagues. Jack, Patty, and Ada described the "energy" Bea brought to the department in its collective work. Bea jubilantly said during my fall interview with her, in reference to the department's and sixth grade team's work: "this is the *first* professional learning community I've been a part of as a teacher, it's really exciting!" She saw the department, including Jack, Patty, and Ada, as "teammates" and "partners" (fall interview).

Airing and Addressing Tensions in the Forest Community

In the data corpus, I identified the tensions Mari and Bea experienced in enacting the commitments described above. I traced the paths these tensions took in the community's work and discussions together, noting when they were aired, and tracing how they were addressed. Table 4.3 summarizes the tensions Bea and Mari experienced in enacting their commitments. For each tension, the table details the community members involved in airing and navigating the tension (bolded name indicates who initially raised the tension), in which professional learning event the tension was aired in the community's conversations, and whether and in which professional learning event(s) it was navigated.

Table 4.3. Landscape of tensions Bea and Mari experienced in enacting their commitments.

Who was involved	Brief description of tension	Aired in community	Navigated in community?
Bea, Mari, Carol, Patty, Jack	Focusing on classroom culture; "Going slow to go fast"	10/5/18 6th grade collaborative time	Yes: December Math Labs; 6th grade collaborative time; department planning for 2019-2020 year
Mari, Bea, Carol, Patty	What "fits" with the curriculum	October Math Lab	Yes: classroom visits; 6th grade collaborative time; all three Math Labs; department planning for 2019-2020 year
Mari, mathematics department	Centering students' work in discussions and "pacing"	October Math Lab	Yes: 6th grade collaborative time; classroom visits; Math Labs
Mari, Patty	Attending carefully to the value in students' thinking (amidst the other things to attend to during a discussion)	12/6/18 classroom visit	Yes: classroom visits
Mari, Carol, Bea	Building relationships and holding students accountable	12/7/18 6th grade collaborative time	Yes: 6th grade collaborative time
Mari, mathematics department	The role of relationship-building in students' participation	12/7/18 6th grade collaborative time	Yes: department planning for 2019-2020 year

Bea, mathematics department	Staying "honest to good teaching" that is discourse-oriented and supports the participation of a wide range of students	December Math Lab	No
Mari, Patty	Centering students' work and attending to their sense of value	1/7/19 classroom visit	Yes: classroom visits
Mari, Patty, Bea, Carol	The content knowledge needed to successfully facilitate mathematics discussions	1/8/19 6th grade collaborative time	Yes: 6th grade collaborative time
Mari, Bea, Carol, Patty	Supporting an individual student's participation and learning and supporting the whole group's participation and learning during discussion	2/22/19 6th grade collaborative time	Yes: 6th grade collaborative time; classroom visits; Math Labs
Bea, Carol, Mari, Lynn, Patty, Ada	The "unlearning" needed in teaching, related to students' academic identities	March Math Lab	Yes: March Math Lab; department planning for 2019-2020 year

I then attended carefully to the routines and normative practices that appeared to support tensions to be aired and addressed, especially in ways that appeared generative for the community's work and learning. Given space limitations, I have organized the findings around two illustrative vignettes (see the gray rows in Table 4.3). Both vignettes involve Mari or Bea airing a tension in a group conversation, and both cases are illustrative in terms of routines and normative practices that supported the tension to be aired and addressed. Further, both vignettes provide evidence that the tensions did not cleanly resolve but rather continued to be engaged throughout the 2018 – 2019 school year, and beyond. While there are many commonalities, the two vignettes are quite different in terms of timescale and, therefore, the number of routine

structures they span. The first unfolds over the span of many months, while the second unfolds in a single conversation during a Math Lab.

Tension 1: Navigating what "fits" with the curriculum.

Vignette. The morning of the first Math Lab of the year, the department sat around a large office table, exploring and discussing Common Core State Standards Mathematical Practice 7, "look for and make use of structure" (CCSS-M) and the Contemplate then Calculate instructional routine (Kelemanik, Lucenta, & Creighton, 2016). Instructional routines are "designs for interaction that organize classroom activities" (Lampert & Graziani, 2009); they are lesson structures intended to be used regularly to provide space for students to develop particular disciplinary habits and teachers to develop particular forms of instructional practice. The Contemplate then Calculate instructional routine in particular is organized so students "make sense of a mathematical object – a visual pattern, arithmetic operation, equation, or graph – and look for what is structurally significant about it" (fosteringmathpractices.com).

The department co-planned the Contemplate then Calculate instructional routine to try out in Bea's sixth grade classroom. Each member of the department (including Patty, Ada, and Jack) took on a different part of the lesson enactment in Bea's room. During the enactment, the department paused several times to consider the next instructional decision they might make ("teacher time outs," Gibbons, Kazemi, et al., under review). The department then returned to the large office table to discuss their enactment, inquiring about students' thinking and participation in relation to the instructional decisions they collectively made. For example, the department engaged in a line of investigation together in relation to the strategies students had posed and questions that might have been even more generative than the ones posed.

In the afternoon, the department broke out into grade-level teams in order to plan together to try Contemplate then Calculate as a part of an upcoming lesson in their curriculum. The sixth grade team (Mari, Bea, and Carol) sat together around a small round table in Jack's office, a room directly adjacent to the room where the rest of the department was planning. I joined them at the table as they each opened a laptop and pulled up the district-developed scope and sequence for the upcoming unit they would be teaching. Mari said in a quiet voice, "I don't know how we're going to fit this in" (10/14/18 Math Lab field notes). Bea and Carol nodded in agreement, as Jack entered the room and joined us at the table. As he sat down, Mari asked in a bit louder voice, "What is the purpose of all of this, again? Doing [the Contemplate then Calculate routine] in our rooms?" (10/14/18 Math Lab field notes). Both Mari's hushed expression of frustration and vocal questioning of the purpose of the task at hand were ways of surfacing a tension she was experiencing.

Jack responded to Mari's question, restating what had been said earlier in the Math Lab that morning. "The [Contemplate Then Calculate] routine is a container for working on talk in our rooms and student engagement." That is, enacting the routine was intended space through which to work toward the goals the department had set for students - that they would see themselves as mathematicians and engage in meaningful discussion together. Mari then responded by validating that she did indeed want those things for her students, but that students also "are going to have to take a test at the end of all this, and there's just a lot we have to manage" (10/14/18 Math Lab field notes). In Mari's statement, the tension has come fully into the light. What was hinted at in her prior turns of talk, through hushed frustration and through a question about the purpose of their work, had now been laid bare. This is a key aim in an inquiry-oriented professional community: that tensions would be openly raised in order to then

be explored and supported. Jack did not press further in this particular moment. He nodded, agreed that there is a lot to manage, and sat with the sixth grade team as they looked together at the upcoming unit.

Mari restated this tension in my interview with her several days after the October Math Lab, including the pull she felt to enact the district-supported curriculum as it was written. She found that the district-supported curriculum would require adaptations to support the meaningful conversation and critical use of mathematics which she "believe[d] would just revolutionize math" (fall interview). However, Mari also described her students' success as hinging on being able to move through the given curriculum:

> I think it's hard because … I feel like I have that, "Oh, this is a perfect vision of math." But then feeling tied to a curriculum which is aiming for [the same vision], I think, but it's still a curriculum that you're tied to. I would think that all of us, we have this ideal view but then also we need to *do* this.

She noted that "in a perfect world" she would move through the curriculum *and* support students to engage in meaningful conversations together, but "sometimes it's not realistic" (fall interview).

After closing out the Math Lab and saying goodbyes to the teachers as they left to support extracurricular activities, meet students in their classrooms, or leave the building for the day, Jack huddled briefly with coaches Patty and Ada. "It was real in there," he noted, as he recalled the tension Mari had raised, "and we don't want teachers doing this because they feel like they have to" (10/14/18 Math Lab field notes). Through their conversation together, Patty, Ada, and Jack wondered together about whether their visits to Mari's, Bea's, and Carol's classrooms in the coming week might be an important space through which to support them as they made further sense of and began to move through this tension. "I want them to see [Contemplate then

Calculate] as a useful container to work on their discussions," Ada noted, "which is part of want they want [in their instructional practice]" (10/14/18 Math Lab field notes).

In this conversation, the leaders began to specify the aims that they (and Patty in particular) would work toward in classroom visits with Mari and the mathematics department in light of the tension raised. As Patty noted several days later (10/19/18) in an interview, these aims included (1) co-planning with the teacher so the routine fits into the curriculum and uses a task already embedded in the curriculum; (2) working on pacing to give teachers a vision for how efficiently the routine can move in their room (countering ideas about routines hindering "moving through" the curriculum); and (3) supporting teachers in-the-moment to see the value in what is coming up in students' strategies.

As Patty described, in planning with Jack and Ada ahead of the October Math Lab: "I'll just co-teach with them—sometime in the next week. They'll just find in their curriculum where it would be a natural spot" (10/2/18 design meeting audio). In the week following the October Math Lab and every 1-2 weeks after that, the sixth grade team worked together with Patty to co-plan a Contemplate then Calculate routine, embedding mathematics problems from upcoming lessons in the district-supported curriculum. Patty planned with individual teachers before visiting their classrooms to co-enact or observe on the day of the lesson.

For example, in a representative classroom visit from Patty to Mari's room in December, the two co-planned before Mari's first-block class. During the lesson, Mari took the lead on facilitating the whole-class discussion of students' strategies. After one student shared his strategy for solving the task, Patty paused the instruction, asking, "How can we get students to really think about this idea? It's so cool!" (12/6/18 classroom visit field notes). Mari and Patty conferred together and decided to ask other students to repeat what the student had shared, using

some of the sentence stems suggested in the Contemplate then Calculate routine (e.g., "They noticed … so they …"). Mari reflected that pausing during the lesson and orienting toward the mathematical value in a student's strategy both supported their instructional decision making. In an interview after the classroom visit she noted, "Where I might be like, 'Oh, yeah, he's just sharing his ideas,' [Patty] was like, 'Wow, this is really cool, for a sixth grader to be thinking like this,'" allowing them to draw on the strategy in the discussion (winter interview). Patty and Mari met briefly after the lesson and celebrated the time the routine took: "17 minutes. That's a record!" (Mari; 12/6/18 classroom visit field notes). They then reflected on particular decisions they had made in relation to students' thinking and participation.

Analysis of what supported Mari to air and address the tension. As described above, I traced the pathway of this tension from the October Math Lab through the leaders' debrief meeting following the Math Lab and subsequent grade-level meeting and classroom visits. In what follows, I reflect on the routine structures, routine interactions, and discourse practices that appeared to support the airing and addressing of this tension.

Three routine structures appear in this vignette: (1) the Math Lab, including built-in grade-level planning time; (2) the leaders' meeting after the Math Lab; and (3) Patty's visits to Mari's classroom. The very fact that Mari aired the tension during the grade-level debrief of the Math Lab points to notable aspects of this routine Math Lab structure. Breakout groups by grade-level integrated at the end of the Math Lab gave teachers opportunity to process the day's experiences with their closest colleagues, those with whom they met several times per week during grade-level time. Tensions are most likely to be aired when those in the room have built relationships characterized by trust. Including time for these close groups of colleagues to meet as part of the routine structure made opportune space for tensions to emerge.

Further, the fact that this grade-level time was focused on concretely planning together for an upcoming lesson was by nature likely to raise tensions related to enactment. The hypothetical and exploratory use of the Contemplate then Calculate routine met the reality of the curriculum and teachers' individual classes. During grade-level time, the teachers were able to consider the relevance of the instructional routine to a particular class or group of students. Grade-level time, as deliberately connected to the Math Lab, also allowed teachers to consider their own capacity and resources to enact a focal instructional routine with their classes and at a given point in the curriculum.

A third key routine structure highlighted in this vignette were classroom visits. The routine structure of classroom visits was designed to connect to Math Labs, providing a throughline between these anchoring experiences in the professional learning system. They emerged as an important routine structure through which to work on tensions related to enactment. They offered especially generative space for leaders to provide both accountability and support and to build trust with teachers, in that they involved just one leader and teacher. The leaders' aims for the classroom visits between the October and December Math Labs were in response to the tension Mari had raised. Patty's December visit to Mari's room reflected these aims. We see for example that Patty, Mari, and the sixth grade team co-planned so the routine fit into the curriculum and used a task already embedded in the curriculum. Further, Patty and Mari were attending carefully to the pacing of the routine, to highlight the efficiency ("a record!") with which the routine could move in Mari's room. That is, these visits supported a view that the instructional routine was not at odds with "moving through" the curriculum.

This vignette also sheds light on the affordances of the routine structure of leaders' debrief conversations after professional learning events. Jack, Patty, and Ada's meeting after the

October Math Lab provided space through which Jack could share Mari's tension and the group could collectively consider planning and design decisions in relation to it. That is, Jack did not see Mari's airing of the tension as an end goal; airing the tension was a step along the way to engaging it and addressing it as a community. The leaders considered in their design meetings how to provide support as various community members were navigating tensions, like they considered in this case how to support Mari and the sixth grade team. Leaders regularly engaged in inquiry into their own problems of practice, related to the community's development and teachers' and students' learning.

This vignette also highlights important conversational features: pausing during the lesson to engage in inquiry, orienting toward the value in students' mathematical thinking, and connecting students' thinking to teaching. During Patty's December visit to Mari's classroom, we see all three conversational features at play. Patty paused the lesson and posed a genuine question to Mari, which oriented Mari to the "cool" idea a student had shared and initiated conversation about their next instructional decision in relation to that students' idea. In tandem, these conversational features appeared to support Mari to see the affordances of their instructional decisions (linked to the Contemplate then Calculate routine), in terms of students' learning and participation. In other words, they supported Mari to see her commitments to meaningful aims for students and ambitious, discourse-oriented instruction, for example, in how she and Patty were supporting students to see the value in their own and one another's ideas.

Throughout, this vignette points clearly to the important role of trusting, authentic relationships among community members and especially between leaders and teachers. That Jack was in the room when Mari aired the tension indicates that she felt safe to share vulnerably even

with her principal (who also served as her supervisor and evaluator) in the room.[19] This vignette also suggests the difficult work on the part of leaders to facilitate in such a way as to both foster trust and support learning and growth (Gibbons, Lewis, Nieman, & Resnick, under review). In response to Mari's tension, Jack struck a delicate balance between challenge and emphasizing his support, understanding, and care for Mari's concerns. He posed food for thought, reminding Mari and the group that the instructional routine was intended to serve as "a container for working on talk in our rooms and student engagement," two goals that reflected Mari's commitments to discourse-oriented teaching. However, he did not propose a solution or attempt to quell the tension as it emerged (which is common in "pseudocommunities," Grossman, Wineburg, & Woolworth, 2001). Rather, the grade-level time ended with open questions about the feasibility and value of embedding the Contemplate then Calculate routine in the curriculum.

Tracing the tension beyond this vignette. As noted above, by December, the sixth grade team was using the Contemplate then Calculate routine in their rooms at least once per week and co-planning the routine with Patty. There was momentum that appeared to have been generated between the group's planning and reflections, and what was happening with the routine in their classrooms especially in terms of students' talk and engagement. In an interview with Mari in December, when asked what, if any, value she saw in the Contemplate then Calculate routine, she said:

> Contemplate [then] Calculate really lends itself to creating access [for students] to the content … and everyone has an ability to contribute. It just provides this culture of, "Wow, cool," … "You're valued. Your experiences and your insights are worthy enough of being put on the board and talked about."

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[19] While the role of the researcher is not a focus of this analysis, it is worth noting that my position and relationships with those in the group also appear important, in that if a researcher is seen as evaluating, monitoring, etc., tensions like these may not be as likely to be aired in conversations.

By December, Mari saw the routine as providing space through which to move toward the goals she had for students in relation to her commitments to meaningful aims for students and ambitious, discourse-oriented instruction.

Mari also had begun to see how her work toward meaningful aims for students, and a responsive approach to teaching could coexist with the current district-supported curriculum:

> So I think that's really helped … a realization that Contemplate [then] Calculate could be used like that with the curriculum. I think I knew, but I just was like, "We have curriculum, and then, we also have this Contemplate then Calculate [routine]. How are we going to use it?" I think, [I'm] now, at the point [where I'm] seeing how they mesh together, and that it can make it a lot easier ... and a lot less like, "We're by the book," for myself, as well as the students. I think that that really helps.

Mari saw the curriculum as able to "mesh" with her use of the Contemplate then Calculate routine, to work to improve her facilitation of discourse-oriented instruction.

In my spring interview with Mari, when asked about her instructional focus with a new group of students in the fall, she responded that she would continue to focus on "student talk … access points so students feel that they can engage … setting the precedent early that everyone participates and everyone *can* participate." She emphasized how formative instructional routines had been in supporting her practice and her students' learning that school year, her increased comfortability adapting the curriculum to be responsive to her students, and her commitments to discourse-oriented instruction.

While Mari was regularly engaging students in discussions in her classroom, the tension she raised did not resolve. It became further nuanced and complicated across the school year, as the community addressed it directly in their work together. My narrative analysis of the tension Mari raised in October showed up in the data corpus through the end of the school year in June. For example, after reflecting positively on the discourse-oriented instruction she had been

engaging students in all year, in which she was supporting students to "think about things in a different way," she reflected:

> Yes, it's good, but that's not what's expected of them. They're expected to perform in this other way [on state standardized tests]. … Sometimes I still struggle with that because they are expected to perform in this computation-only kind of way, and [there is a] fine balance of utilizing those instructional routines while living in the expectation or the reality of a testing environment … They're at battle with each other for sure. Testing is not how we can determine these kids' levels of thinking, or the math that we actually need moving forward …, but that doesn't get changed overnight.

There was more to figure out and inquire about, and Mari clearly was practiced and able to engage in such inquiry and conversation alongside her colleagues in the Forest Middle School mathematics department.

Tension 2: Navigating the "unlearning" needed in teaching.

Vignette. In the weeks prior to the March Math Lab, the mathematics department had attended an offsite conference focused on "awareness and action in service of equity in the day-to-day work of math teaching, learning, and leading" (Teachers Development Group, 2019). In informal conversations with teachers and leaders, they expressed excitement and a new sense of energy and momentum, sparked by conference sessions and rich discussions together between sessions and over meals in the evenings. Several teachers for example mentioned how powerful it had been to hear the president of the National Council of Teachers of Mathematics, Robert Berry III, give an opening keynote entitled: *Catalyzing Change: Identity, Agency, Positionality and Equitable Instructional Practices*. In the March Math Lab scheduled just a week after the conference, Patty and Ada centered the definitions of identity and agency that had been proposed in Berry's keynote session and discussed over the course of the conference.

The March Math Lab had been rescheduled due to a snow day, and with other constraints in the calendar, a full-day session was not possible at the time. To work around this, a subset of the department met for a half-day Math Lab in the morning, and another subset met in the

afternoon. The morning session involved the sixth grade team (Carol, Bea, and Mari), one seventh grade teacher (Lynn), and instructional coaches Patty and Ada. When the group arrived in the morning, they sat around a large table together. Patty projected the definition of identity that had been proposed at the conference on the screen at the front of the room:

> Identity is a person's changing view of him/herself in a given social context, influenced by their experiences, personal history, and other events. Students' mathematical identity is how and who they see themselves as in the mathematics classroom, in their relationship with the subject of mathematics and mathematical activities.

Patty read the definition aloud, and then asked individuals to think to themselves about what resonated with them about the definition, and what they were wondering about in relation to it. After several minutes, she prompted the group to reflect aloud together.

1 2 3 4 5	Mari:	I'm thinking about the part that says "*changing* view of him or herself" … I really resonate with how [a student's identity] can fluctuate, even day to day, in seeing themselves as a math person or not. It reminds me of my role in empowering them that they are mathematicians. … how we are a part of that identity formation
6 7 8 9	Carol:	Trying to change the kids' views, because they come to us and are like, "I'm not good at math." and we're like, "You're good at math! You just have to practice." … they come to us with some kind of math knowledge; they know something about math.
10 11	Bea:	We do as a team a really good job of having that mindset ourselves about our students.

Mari began by raising a problem of practice: the problem of students "seeing themselves as a math person or not" (line 3). In this initial turn, she framed the problem of practice as something she can (and has a role to) shape. Carol emphasized the problem, stating a common refrain heard in their classrooms ("I'm not good at math," lines 6-7) and her own belief that the refrain is not true ("they come to us with some kind of math knowledge; they know something about math," lines 7-8). Bea then acknowledged this commitment to (or "mindset … about", line

10) students' capabilities as shared among the team. Thus far, the tone of the conversation was pragmatic. The turns of talk by the sixth grade team (1) established a problem of practice related to students' challenges, in particular how they see themselves in relation to mathematics; (2) grounded the group in their shared view of students' capabilities in relation to mathematics; and (3) began to establish that working on this problem involves intentional work on the part of teachers, "empowering [students] that they are mathematicians" (line 4), "trying to change the kids' views [of their own capabilities]" (line 6).

Bea's next turn of talk began to add more nuance to the problem, and her voice became filled with emotion and animation as she described her frustration in relation to the problem of students' negative identification with math.

12 Bea: The challenging piece is that, as sixth graders, our students have six years of
13 prior experiences with mathematics that are really influencing the way they
14 show up in the classroom and their mathematical identity. There's a lot of
15 frustration that I feel about the identity they have in regards to mathematics—
16 that they've already decided, not just that they're not a math person but they've
17 decided maybe that school isn't their thing. … [audible affirmation from others]
18 Just how much unlearning we have to do to really, really believe that not just
19 about our students but for them to believe it about themselves.

Bea tried on a diagnostic frame for the problem of students' mathematical (and academic) identities; perhaps it is a decision students have made as a result of years of being socialized into seeing mathematics in particular ways and seeing themselves in particular ways (lines 12-14). The group re-established their commitment to students in the earlier turns of talk in this episode. There was a shared commitment among the teachers in the room to seeing their students as mathematically capable, coming with "some kind of math knowledge" (line 8). Yet, in this turn of talk, Bea stated a realization that enacting that commitment required ongoing work; it wasn't enough to hold this commitment. She emphasized "how much unlearning" there is to do, in order to "really, really believe" in students' mathematical brilliance and capability and in order to

support students to believe the same (lines 18-19). In this turn, she broached the ongoing nature of the problem of practice and began a turn toward a prognostic frame for the problem (line 18).

Coach Ada: Piggy-backing on that, the need for it to be deliberate. [audible agreement] It won't happen by chance.

Lynn: … at five years old, they're deciding who the smart kids are, and like Bea said, we have 7 or 8 years to counteract, and it's a challenge, but it's one that is worth taking on.

Bea: And *we* have a bunch of learning to do. I have been conditioning myself about what it looks like to be smart, what it sounds like to be smart, what it means to be a math person.

Mari: There was a study done that if mothers didn't think they were good at math or had anxiety about it, the percent was crazy large about girls themselves having that idea themselves that they aren't math people. It makes me think about even parents who thought they were good mathematicians, now with the Common Core, the messages we get are, "I don't know how to do it." I wonder if that plays into things even more, if our parents are communicating that to students.

Bea: Yeah, it's just so rampant. Everywhere you look, every experience people have with school qualifies you either as smart and capable or as someone who is not able to.

Thus far in the conversation, the group had focused on diagnostic frames for the problem of practice, but as Bea alluded to a prognostic frame in noting the "unlearning" needed, Ada inserted a frame into the conversation that continued the focus on teachers' responses to the problem in their instructional practice, highlighting the need for teachers' "deliberate" work (line 20). Bea built on this, adding emphasizing that "*we*," the educators at Forest, "have a bunch of unlearning to do" (line 25). She then elaborates on *what* the community needs to unlearn and learn: "what it looks like to be smart, what it sounds like to be smart, what it means to be a math person" (lines 26-27).

Mari expanded on the pervasiveness of discourses about smartness in mathematics and its impact on students' senses of themselves in relation to mathematics (lines 28-34). She wondered briefly about the connection between *parents'* identities in relation to mathematics and *students'*. Bea echoed the "rampant" (line 35) nature of these discourses, turning again toward school and its impact on students' identities in relation to mathematics. She returns to a diagnostic frame for the problem at hand, students "seeing themselves as a math person or not" (line 3), noting that schooling plays a fundamental role: "every experience people have with school qualifies you either as smart and capable or as someone who is not able to" (lines 35-37).

We see over the span of the group's conversation several questions emerging: Is the problem of students' identities in relation to math something teachers can shift? Is it something students have resolutely decided? What work ("unlearning") does it take on the part of teachers to see mathematics differently and to see their students as capable and brilliant? What work does it take to support students to see themselves in these ways, as well? The group layered on both diagnostic and prognostic frames to try to make sense of the problem, its origins, and its solutions, and Bea concluded the discussion with a statement of culpability and responsibility of schools. The tension has not been resolved, but the stage has been set to explore more deeply together how they might work in their classrooms to "qualif[y their students] as smart and capable" (line 36).

Analysis of what supported teachers to air and address the tension. Again, we see that the routine structure of the Math Lab played an integral role in making space for this tension to emerge. The first phase of each Math Lab involved time for the group to unpack and specify ideas, grounding themselves in research-based artifacts and resources. In the October Math Lab, for example, the group read and discussed what it meant to engage in Common Core State

Standards Mathematical Practice 7, “look for and make use of structure” (CCSS-M). In the March Math Lab, the group explored the concept of students’ mathematical identity development (and, later in the morning, students’ agency). They centered their own notes and artifacts from a recent conference, and they projected a definition to explore and discuss.

Several discourse practices also appeared to be integral in how the tension was aired and addressed in the Math Lab. First, the practice of sharing exploratory, tentative thinking (or, “rough-draft” thinking, Jansen, 2020), allowed the group to try on diagnostic and prognostic frames for the problem of practice at hand, putting forth ideas and questions regarding the roots of and potential solutions to the tension, that others could add on to, refine, or challenge. More usual in professional settings is the practice of sharing fully-formed or polished ideas (e.g., Grossman, Wineburg, & Woolworth, 2001); such a discussion practice would limit and even preclude the kind of inquiry Bea, Mari, and their colleagues engaged in together.

The practice of posing alternative viewpoints also appeared to support the tension to be aired and addressed. The diagnostic and prognostic frames posed built from one another but did not necessarily all agree; some (e.g., parents communicating, “I don’t know how to do it,” line 32; students’ “six years of prior experiences with math” in school, lines 12-13) could even be at odds. The group’s practice of putting forth alternatives gave them a rich territory from which to explore the problem of practice at hand. It is worth noting that at no point in the conversation did there appear to be *conflict*. Rather, the group tried out various frames for the problem, adding dimension and nuance to the problem and its possible solutions as they posed alternative viewpoints.

As with the first, this vignette highlights the importance of authentic relationships among community members, characterized by trust and rapport. Bea’s expression of what was

"challenging" and "frustrat[ing]" with leaders and researchers present indicates the level of trust she appeared to feel. This vignette also suggests the careful work on the part of leaders to facilitate in such a way as to both foster trust and support learning and growth (Gibbons, Lewis, Nieman, & Resnick, under review). The coach, Ada, inserted a frame midway through the conversation that continued the focus on teachers' responses to the problem in their instructional practice, highlighting the need for teachers' intentional work in relation to supporting students' senses of themselves as mathematicians. The frame did not shut down conversation or impose a false sense of resolution; rather, it amplified Bea's frame and encouraged further conversation regarding the role and responsibility of teachers. This appears to be delicate and challenging work on the part of facilitators and leaders.

Tracing the tension beyond this vignette. The tension did not end with the March Math Lab. Teachers were given opportunities to continue to surface and navigate the tension. For example, stemming from the conversations in the March Math Lab and in preparation for the 2019 – 2020 school year, the department participated in an online professional development course focused on supporting students' senses of themselves in relation to mathematics. They met twice as a department, once while teachers were individually completing the course, and once afterward, to continue to think together about their work in relation to students' mathematical identities. In relation to their course experience, they wondered especially about how to foster a classroom environment "from the start" that would support students' senses of themselves, as seventh grade teacher Eric summed up, "really emphasizing and focusing on culture" (6/13/19 department meeting field notes).

They continued, also, to try on new diagnostic frames for students' identification with mathematics:

1 Bea: What's the disconnect between sports and music, and academics? They want to
2 *try* things in those places. They know they won't be perfect right away.

3 Eric: It's *shame*. Mathematicians say [shame] is what limits their progress.

4 Mari: We present things as though they're facts. We present mathematical ideas as
5 though they're facts, when they took years to come up with and tons of
6 creativity. But, we take that part out, and we take out all of the discovery and
7 creativity that went into it, the struggle that happened.

8 Bea: In science, you learn more from not proving your hypothesis than proving it.

The group considered the role of "shame" (line 3) and stripping mathematics of the "discovery and creativity" (lines 6-7) involved in its development over time and space.

As their own ideas and definitions of mathematics competence were being shaped and broadened, they hoped to support the same for their students. For example, they wanted students to understand that "speed is not important" (Bea, 6/6/19 department meeting field notes) and "mistakes are good [for learning]" (seventh grade teacher Eric, 6/13/19 department meeting field notes). As they conversed in these meetings about their goals regarding the environment of their classrooms and what they might do as a department and as individual teachers to develop such an environment, they returned often to the question of *how* (e.g., "I'm not sure *how* to set that up, that math isn't the enemy," eighth grade teacher Robin, 6/13/19 department meeting field notes).

Following these conversations, Jack, Patty, and Ada worked to arrange for themselves and several members of the mathematics department (including Bea) to attend a week-long conference focused especially on the initial development of a classroom environment prioritizing the building of a community of students and broadening both teachers' and students' views of mathematical competence. That is, another set of opportunities were planned for the department

to continue to navigate and explore the tensions emerging as they were working to enact their commitments.

Discussion and Conclusions

While prior research has suggested the kinds of tensions that might emerge as teachers work to enact ambitious, discourse-oriented instruction (e.g., Brodie & Shalem, 2011; Louie, 2016) and underscored the importance of tensions being aired and addressed in communities for both organizational and individual learning (e.g., Engeström, 2001; Wenger, 1998), little research has explored the *features* of communities in which tensions are productively engaged, especially in relation to the organization of the community. This is critical to understand because, as Cohen (2011) argues, "ambitious teaching is difficult in any circumstances, but it is especially difficult if schools lack the common knowledge, organization, and occupational culture that can support it" (p. 193). A central contribution of the analysis I report on in this paper concerns *how* a community might support tensions to be aired and addressed. I attended to the conversational and organizational features of the Forest Middle School mathematics department that supported Mari and Bea to surface and navigate the tensions that emerged as they were working to enact their commitments in practice.

Specifically, I identified routine structures and discourse practices that appeared to support Mari and Bea to both surface and navigate tensions. Routine structures included Math Labs, grade-level time and classroom visits connected to the Math Labs, and leaders' conversations following professional learning events. Discourse practices included pausing during the lesson to engage in inquiry, orienting toward the value in students' mathematical thinking, connecting students' thinking to teaching, sharing exploratory and tentative thinking, and posing alternative viewpoints.

Implications for Research and Practice

The findings of this study begin to shed light on facilitation and leadership *toward critical alignment*, or the airing and addressing of tensions in a community to support the community's generative learning. In particular, this study suggests the importance of carefully designing and facilitating communities' work together, attending to both their organizational and conversational features.

This study demonstrates the importance of a *system* of professional learning as it relates to surfacing and navigating tensions in community. For example, in the first vignette, we saw that the organization of the Math Lab brought a tension to light for Mari; that she and her sixth grade colleagues were tasked with embedding the instructional routine into an upcoming lesson raised the problem of whether and how it would "fit." She then had multiple opportunities to navigate the tension with many different colleagues, through grade-level time and through her time with Patty, to try the routine in her own classroom. In particular, it appeared that structured opportunities to plan, enact, and debrief instruction as a part of the professional learning system (i.e., pedagogies of enactment, Grossman et al., 2009) were critical in supporting Mari's navigation of the tension. For example, Patty and Mari's enactment of the instructional routine in her classroom supported Mari to recognize related changes in her students' mathematical thinking and participation, especially in relation to her commitments to meaningful aims for her students and to ambitious, discourse-oriented instruction. This opportunity appeared to be critical in her sensemaking about and productive navigation of the tension.

It appears critical the design and facilitation of the professional learning system treat tensions as ongoing and worth navigating together, rather than aiming to build pseudocommunities' "illusion of consensus" (Grossman, Wineburg, & Woolworth, 2001, p.

955). The tensions that emerged for Mari and Bea did not resolve or disappear. Rather, what appeared generative for their learning was the very fact that the tensions were maintained and addressed ongoing in the community's work. This is commensurate with the argument Hebard (2016) makes in relation to her analysis of novice teachers' learning in two methods courses. She argues that the tensions novice teachers experience can (and should) be reconsidered "from pitfalls into opportunities for expansive learning" (p. 35). As Borko (2004) states, "meaningful learning is a slow and uncertain process for teachers, just as it is for students" (p. 6). That is, the aim of those supporting teachers, much like the work of teachers in supporting students, should be to make space for the *navigation* of tensions, conflicts, and struggle.

While an analysis of the practice of the professional learning facilitators and administrators at Forest Middle School is beyond the scope of this study, Jack, Ada, and Patty's role in the vignettes above underscores the importance of their role, especially in developing a culture in which community members can share and explore authentic problems of practice. We see in the work of Patty, Ada, and Jack that such facilitation and leadership is delicate and complex. They appeared to work carefully in their facilitation to strike a balance between accountability and support, and between caring for the teachers in the department as humans and as ongoing learners. In particular, their work suggests the importance of *trust* among leaders and teachers. This is commensurate with studies emphasizing the importance of leaders building authentic, meaningful relationships with community members, characterized by vulnerability and trust (Sztajn, Hackenberg, White, & Allexsaht-Snider, 2007). In the first case, Jack could easily have responded to Mari's concern that students "are going to have to take a test at the end of all this, and there's just a lot we have to manage" with a directive or statement that would silence the tension. In support of the community's learning, he instead responded such that the tension

remained alive and well in Mari's talk (e.g., the October interview) and continued to be navigated and explored in the community's work. The findings of this analysis echo myriad others in highlighting the critical need to further understand the art and practice of facilitation and leadership (cf. Borko, 2004; Robutti et al., 2016).

For the sake of this analysis, I have focused on tensions that arise when working to enact commitments to meaningful aims for students and ambitious, discourse-oriented instruction. However, there is wide range of other tensions that are important to attend to as communities work together to shape and shift the status quo. For example, commitments to ongoing learning and collaboration with colleagues can give rise to *social tensions*, issues that arise interpersonally and, for example, promote inequitable hierarchies of status among teachers, between teachers and leaders, or between educators and the researchers supporting improvement efforts (e.g., Datnow & Park, 2019; Grossman, Wineburg, & Woolworth, 2001). It is critical that future studies attend to the *social tensions* that emerge in communities' work together, especially in relation to enacting commitments to collective work and collaboration.

Further, future research should attend to the features of communities that support the navigation of these and other tensions. The findings of this study are not meant to encompass an exhaustive list of the tensions that might emerge between teachers' commitments and practice. In fact, because I'm only looking at the experiences of two teachers, these findings are limited to their experiences. We need many more studies of this type that inquire into the experiences and tensions emerging for teachers with different positionalities, and the conversational and organizational features that support communities to navigate these tensions.

The conversational and organizational features identified in the findings of this study appeared to strike a delicate balance in being generative for learning *and* furthering Mari and

Bea's sense of being cared for and supported as a part of the community. This is critical because when tensions or conflict are engaged without attention to the wellbeing of teachers, it can lead to teacher attrition (e.g., Achinstein, 1998, 2002; Westheimer, 1999). While Achinstein (2002) described important organizational learning arising from the Chavez community's engagement with tensions, she also issued a warning:

> Many teachers [at Chavez] were frustrated with repeated conflicts, with not getting to solve the problems. Stress, burnout, and teacher turnover may have been high prices to pay for such an openness to conflict. Further, a lack of attention to the ties of the community, to that which is shared, may create fragmentation as individual and subgroups form islands onto themselves— thus contributing to, rather than countering, the isolation that collaborative reforms were initiated to address. (p. 449)

Attending to the balance between teachers' *learning* and *wellbeing* appears critical both in this case and in the literature more broadly (e.g., Grossman, Wineburg, & Woolworth, 2001). It resonates with Brodie and Shalem's (2011) findings that teachers' learning in their professional development setting was supported by a balance between challenging one another's ideas and offering camaraderie and connection ("solidarity").

In the need for reform and significant shifts in teachers' practice, the focus is often centered on teachers' learning. But, identifying how to also attend to teachers' wellbeing in this work is especially vital as we are working as a field to understand how to reduce teacher burnout and attrition (Santoro, 2018). It appears from the work of Jack, Patty, and Ada in this case that the leaders who are organizing improvement efforts in schools must share a conviction that teachers are human, with their own motivations and commitments for the work they do (e.g., Santoro, 2018), that the work of teaching involves tension in ideas that are deeply vulnerable and personal (e.g., Achinstein, 2002), and that the "unlearning" (Bea, 3/12 Math Lab audio recording) required in the work of teaching is the work of a career and even a lifetime (e.g.,

Little, 1982). That is, it is important that this work is done among communities that care about one another and are committed to ongoing learning and professional growth.

CHAPTER 5. CONCLUSION

In the three papers comprising this dissertation, I have aimed to contribute to the knowledge base regarding what makes for robust communities for generative learning. In Chapter 2, I put forth a framework for school-based subject-specific communities working to shape and shift the status quo. To do so, I drew from a range of studies of teacher communities and the professional learning of subject-specific groups of teachers. Building on a rich history of work, I call these communities *inquiry-oriented professional communities.* In light of that framework, I then reviewed the literature on eight inquiry-oriented professional communities of mathematics educators, to establish what is known about such communities, especially the focus of their work, how they are established, and the role of facilitators and school administrators in supporting them.

In Chapters 3 and 4, I took up two of the empirical gaps (among many) in the field's knowledge base that emerged in the review. Specifically, the review highlighted how little is known about the practice of school leaders (e.g., professional learning facilitators and school administrators) in relation to the development of inquiry-oriented professional communities. In response, in Chapter 3, I investigated the work of school leaders in supporting the mathematics department at Forest Middle School. Further, the review highlighted that little research has explored the features of communities that support meaningful inquiry into the tensions that arise for teachers when they are working toward meaningful aims for students and ambitious, discourse-oriented instruction. In Chapter 4, I analyzed teachers' experiences of tension and the organizational and conversational features of the community that appeared to support generative engagement with these tensions, in terms of the community's development and teachers' learning and growth.

In this chapter, I highlight the contribution these papers make as a body of work. I consider first the use of *inquiry-oriented professional community* as a lens through which to look at subject-specific communities. Then, I discuss the utility of attending to the institutional setting of communities' work, especially the role and practice of school leaders, including professional learning facilitators and school administrators.

In this dissertation, I proposed and made use of a framework for discipline-specific communities – *inquiry-oriented professional community* (see Figure 5.1). An inquiry-oriented professional community engages in ongoing exploration together in relation to, for example, community members' instructional practice, students' mathematical thinking, and underlying narratives about who is capable of engaging in rigorous mathematical activity. Inquiry is both a *tool* the community uses in its work together and a *stance* it maintains. Inquiry-oriented professional communities treat the tensions teachers experience in their work as vital sources of learning and growth. Community members open up authentic problems of practice for the group to wrestle with, making specific and often personal ideas and concepts public so they are open for clarification, disagreement, refinement, and, perhaps eventually, some consensus. At the heart of inquiry-oriented professional community is the aim "of challenging the status quo, of questioning accepted ways of being and doing" (Goodchild, Fuglestad, & Jaworski, 2003, p. 396). Inquiry-oriented professional community depends upon its members challenging and pressing on one another's ideas.

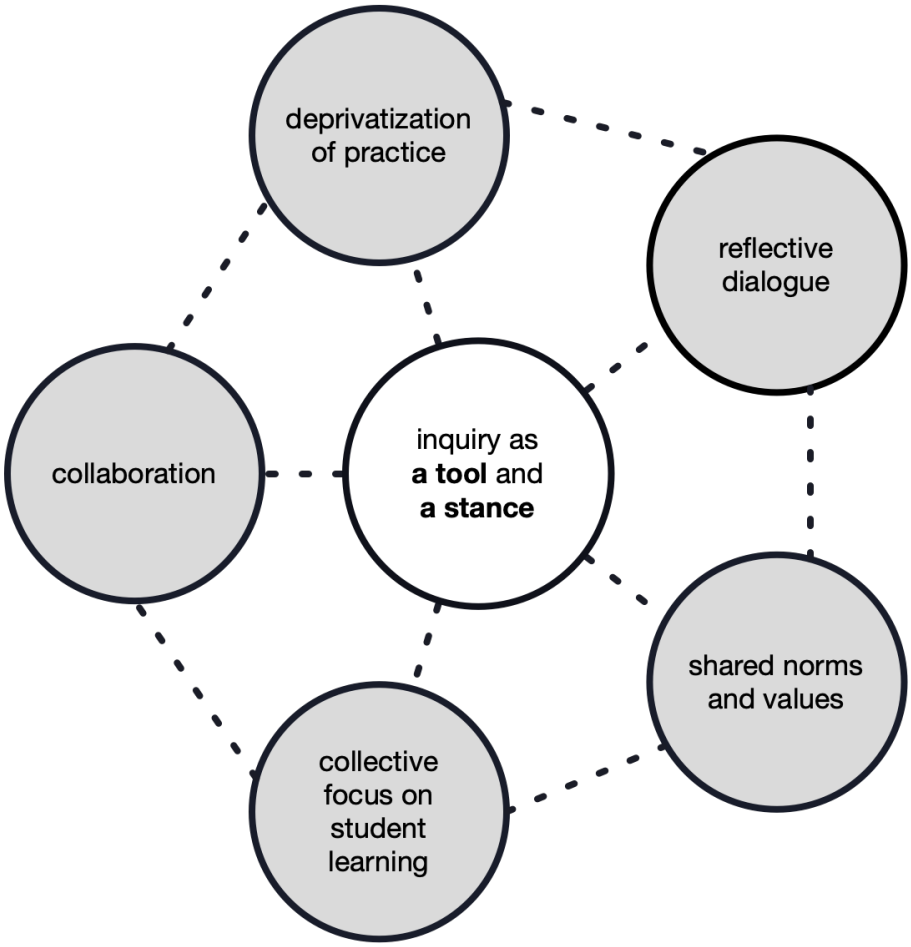

Figure 5.1. Characteristics of inquiry-oriented professional community, building on the work of Kruse, Louis, & Bryk (e.g., 1995) and Jaworski (e.g., 2006)

I found this framework to be useful both as a lens for my review of robust, generative mathematics communities and for my empirical analyses of the mathematics department at Forest Middle School. This framework builds from a rich body of work on school-wide professional community (e.g., Kruse, Louis, & Bryk, 1995), teachers' professional learning in subject-specific groups (e.g., Borko, 2004, Kennedy, 2016), and the importance of centering

inquiry in community (e.g., Jaworski, 2006). Even so, this framework is a starting point. Future research should continue to examine its utility, adding further nuance and complexity.

One area for future research regards understanding the relationship between the characteristics of inquiry-oriented professional community (see Figure 5.1). There are a number of questions that are worth exploring. Are there characteristics that precede others and therefore are important to attend to in the very earliest stages of the community's development? For example, do shared norms and values need to develop before the community can engage in inquiry together, or do they develop mutually through the community's work together? How do practitioners themselves experience the relationships between these characteristics? Understanding professional learning facilitators' current priorities in terms of supporting communities is critical to designing supports for facilitators' learning and practice as they work to develop robust, generative communities.

The body of work comprising this dissertation highlights the value of attending to the institutional setting surrounding communities' work. Principally, these studies underscore the importance of *systems* of professional learning, both as a lens for research and for the practice of supporting communities. Both Chapter 2 (e.g., the community at Hilltop Elementary School, Lewis, 2016) and studies of the mathematics department at Forest Middle School in Chapters 3 and 4 illustrate the importance of teachers' work in and across professional learning structures. In particular, attending to professional learning as a system allows us to see discussion practices that have become normative and ways of interacting that have become routine. For example, at Forest, attending to the community's work across Math Labs, grade-level time, classroom visits, and leaders' design meetings, we could see *how* the vision for instruction and for the community's work were designed and facilitated for, and specified throughout the system.

Further, with the system as a lens, it becomes clear that the work of school leaders is critical, if communities are to develop in such a way as to shape and shift the status quo.

In relation to school leadership, across the set of studies, professional learning facilitators and school administrators engaged in critical work in terms of (1) making structural and temporal space for teachers' work together; (2) supporting a climate in which teachers were valued and felt safe to engage in inquiry into authentic problems of practice; and (3) making both design and in-the-moment facilitation decisions in support of a robust vision for instruction and for the community's collective work. These studies also highlight the *distribution* of leaders' work (Spillane, 2006), as leaders and teachers shared this work in different ways, depending on, for example, the expertise and experiences of individuals in the community and the kinds of tensions that community members were experiencing in their work.

Across the three studies, it was apparent the importance that leaders orient toward teachers in particular, humanizing ways. Teachers' prior experiences were valued and built upon, the tensions they experienced were seen as important foundations for the community's learning, and their frustrations were heard and responded to. It appears critical that if communities are to be sustained in their efforts and engage the kinds of tensions that are generative in terms of shaping and shifting the status quo, school leaders must engage as learners and work to support others' learning. This kind of stance is based on a particular orientation toward teaching as responsive to context and students and, therefore, requiring ongoing learning and growth. Relatedly, it involves a particular orientation toward professional learning as responsive to teachers, to their students, and to the tensions that are emerging for teachers in their work.

In looking across these studies, it is important to note that the empirical analyses focused on just one small part of the school's journey. In the year after my data collection at Forest

Middle School, the school administration and budgets changed. There were no longer enough funds for Patty to work full-time as an instructional coach. The funds that had been earmarked for substitute teachers to cover community members' rooms on Math Lab days in the years prior had stiff competition. The school administrators came in with different priorities, and they appeared to be less aligned with the aims of inquiry-oriented professional community. Patty and Ada had less time to do their work and felt more isolated in it. It could be that in several years I and my colleagues are writing a piece similar to Louie and Nasir's (2014) reflection on the "derailment" at Railside High School. Regardless, what is clear is that inquiry-oriented professional communities are fragile. They take intention, heart, and a multitude of individuals working against the grain in order to get off the ground, and they take even more effort to be sustained. This begs several questions, zooming out even further into the institutional setting of these communities: How are inquiry-oriented professional communities sustained over time, even in the changing landscape of schools and districts? What conditions, supported by districts and by education policies, give rise to inquiry-oriented professional communities? What conditions preclude them? And, on a personal note, what is the role and responsibility of researchers in these efforts?

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APPENDIX A. EVIDENCE OF INCLUSION CRITERIA

School site of the community	Deprivatized practice	Collaboration	Reflective dialogue	Shared norms and values	Focus on student learning	Inquiry as a tool	Inquiry as a way of being	Evidence of learning
Elementary								
Crestview	Franke & Kazemi (2001b) Franke, Kazemi, Shih, Biagetti, & Battey (2005) Kazemi (1999)	Kazemi (1999) Kazemi & Franke (2004) Franke et al. (2005)	Franke et al. (2005) Kazemi (1999) Kazemi (1999)	Franke, Kazemi, Shih, Biagetti, & Battey (2005)	Franke & Kazemi (2001a, 2001b) Franke et al. (2005) Kazemi (1999) Kazemi & Franke (2004)	Franke & Kazemi (2001b) Franke et al. (2005) Kazemi (1999) Kazemi & Franke (2004)	Franke & Kazemi (2001b) Franke et al. (2005) Kazemi (1999)	Kazemi (1999); Kazemi & Franke (2004), teacher learning
Hilltop	Gibbons, Kazemi, & Lewis (2017) Gibbons, Kazemi, Hintz, & Okun (under review) Lewis (2017)	Gibbons, Kazemi, & Lewis (2017) Gibbons, et al. (under review) Lewis (2017)	Gibbons, Kazemi, & Lewis (2017) Gibbons et al. (under review) Lewis (2017)	Gibbons, Kazemi, & Lewis (2017) Gibbons et al. (under review) Lewis (2017)	Gibbons, Kazemi, & Lewis (2017) Gibbons et al. (under review) Lewis (2017)	Gibbons, Kazemi, & Lewis (2017 Gibbons, et al. (under review) Lewis (2017)	Lewis (2017)	Lewis (2017), both teacher and student learning
Mapleton	Sherin & van Es (2009) van Es & Sherin (2008) van Es et al. (2014)	Sherin & van Es (2009) van Es & Sherin (2008)	Sherin & van Es (2009) van Es & Sherin (2008)	Sherin & van Es (2009) van Es & Sherin (2008)	Sherin & Han (2004) Sherin & van Es (2009) van Es et al. (2014)	Sherin & van Es (2009) van Es & Sherin (2008)	van Es et al. (2014)	Sherin & van Es (2009) van Es & Sherin (2008),

								teacher learning
Western	Murata (2012)	Murata (2012)	Murata (2012)	Murata (2012)	Murata (2012)	Murata (2012)	Murata (2012)	Murata (2012), teacher learning
Middle								
Magnolia	Garner & Horn (2018) Horn, Kane, & Garner (2018) Horn, Kane, Wilson, & Brasel (2017)	Garner & Horn (2018) Horn, Garner, Chen, & Frank (2020) Horn, Kane, & Garner (2018) Horn, Kane, & Wilson (2015)	Garner & Horn (2018) Horn et al. (2017)	Horn et al. (2020)	Garner & Horn (2018) Horn et al. (2017) Horn, Kane, & Garner (2018) Horn et al. (2020)	Garner & Horn (2018) Horn et al. (2017) Horn, Kane, & Wilson (2015)	Horn et al. (2020)	Horn et al. (2020), teacher learning Horn, Kane, & Wilson (2015), opportunities for teacher learning
Nile	Sherin & Han (2004) Sherin & van Es (2009) van Es et al. (2014)	Sherin & Han (2004) Sherin & van Es (2009)	Sherin & Han (2004) Sherin & van Es (2009)	Sherin & Han (2004) Sherin & van Es (2009)	Sherin & Han (2004) Sherin & van Es (2009) van Es et al. (2014)	Sherin & Han (2004) Sherin & van Es (2009)	Sherin & Han (2004)	Sherin & Han (2004) Sherin & van Es (2009), teacher learning
High								
Railside	Lieberman (1997) Little & Horn (2007)	Lieberman (1997) Nasir et al. (2014)	Horn (2005, 2007, 2010) Horn & Little (2010, 2014)	Boaler & Staples, (2008) Little (2002)	Nasir et al. (2014) Tsu (1998)	Horn (2005, 2007, 2010) Little & Horn (2007)	Little (2002)	Boaler & Staples (2008), student

	Horn (2005, 2007, 2010) Horn & Little (2010, 2014)	Tsu (1998)	Little & Horn (2007)	Nasir et al. (2014) Tsu (1998)				Horn (2005, 2007, 2010), opportunities for teacher learning
Septima Clark	Bannister (2009, 2015) Horn & Kane (2015)	Bannister (2009, 2015) Horn & Kane (2015)	Bannister (2009, 2015) Horn & Kane (2015)	Bannister (2009, 2015)	Bannister (2009, 2015) Hall & Horn (2012)	Bannister (2009, 2015)	Hall & Horn (2012)	Bannister (2009, 2015) Horn & Kane, (2015), opportunities for teacher learning

APPENDIX B. STUDIES REVIEWED IN CHAPTER 2

Communities in Elementary Schools:

1. Crestview Elementary School teaching staff (Franke & Kazemi, 2001a; Franke & Kazemi, 2001b; Franke, Kazemi, Shih, Biagetti, & Battey, 2005; Kazemi, 1999; Kazemi & Franke, 2004; Kazemi & Hubbard, 2008)
2. Hilltop Elementary School teaching staff (Gibbons, Kazemi, & Lewis, 2017; Gibbons, Kazemi, Hintz, & Okun, under review; Kazemi & Resnick, 2020; Lewis, 2016)
3. Mapleton Elementary School video club (Sherin & van Es, 2009; van es et al., 2014; van es & Sherin, 2008)
4. Western Elementary School lesson study group (Murata et al., 2012)

Communities in Middle Schools:

5. Magnolia Middle School sixth grade team (Garner & Horn, 2018; Horn, Garner, Chen, & Frank, 2020; Horn, Garner, Kane, & Brasel, 2017; Horn, Kane, & Wilson, 2015; Horn, Kane, & Garner, 2018)
6. Nile Middle School video club (Sherin & Han, 2004; Sherin & van Es, 2009)

Communities in High Schools:

7. Railside High School math department and Algebra Team (Cabana, Shreve, & Woodbury, 2014; Boaler & Staples, 2008; Boaler & Staples, 2014; Hand, 2012; Horn, 2002; Horn, 2005; Horn, 2007; Horn, 2010; Horn & Little, 2010; Horn & Little, 2014; Lieberman, 1997; Little, 2002; Little, 2003; Little & Horn, 2007; Louie & Nasir, 2014; Staples, 2008; Tsu, 1998; Tsu, Lotan, & Cossey, 2014).
8. Septima Clark High School Freshman Team (Bannister, 2009; Bannister, 2015; Hall & Horn, 2012; Horn & Kane, 2015)

APPENDIX C. FOCI OF STUDIES REVIEWED IN CHAPTER 2

School site of the community	Categories of questions	Focus of papers (i.e., research questions in empirical analyses)
Elementary		
Crestview	Teacher learning	• What do teachers learn through collective examination of student work? How is teacher learning evident in shifts in participation in discussions centered on student work? (Kazemi, 1999; Kazemi & Franke, 2004) • What does generativity look like for teachers in classrooms? (Franke & Kazemi, 2001b)
	Resources for teacher learning	• What role does the classroom play in the design of professional development? (Kazemi & Hubbard, 2008) • What were the defining moments in the story of teachers' learning at Crestview Elementary? (Franke, Kazemi, Shih, Biagetti, & Battey, 2005) • What has changed in how Cognitively Guided Instruction researchers conceptualize what it means to engage with student work, how to understand what teachers and students are learning, and how to create opportunities for teacher and student learning? (Franke & Kazemi, 2001a)
Hilltop	Teacher learning	• Through their participation in the implementation of the school-wide approach to fractions instruction, what did teachers learn about teaching fractions? (Lewis, 2016)
	Resources for teacher learning	• How did the professional learning opportunities support the development of collective understanding around fractions teaching and learning? (Lewis, 2016) • What is the potential of the Teacher Time Out routine for supporting teacher learning about ambitious mathematics instruction, including dilemmas that arise as educators engage students in rich mathematical learning experiences? (Gibbons, Kazemi, Hintz, & Okun, under review)
	Facilitation / coaching practice	• What does the work of coaching look like if it is organized to engage teachers collectively in service of school-wide improvement? (Gibbons, Kazemi, & Lewis, 2017)
	Student learning	• How did what students know and understand about fractions change over three years of a school-wide approach to instruction? (Lewis, 2016)

Mapleton	Teacher learning	• To what extent do teachers develop professional vision, the ability to notice and interpret significant features of classroom interactions, as they participate in a video club? (Sherin & van Es, 2009) • What are the changes in teachers' thinking as they participated in a video club designed to help them learn to notice and interpret students' mathematical thinking? (van es & Sherin, 2008)
	Facilitation practice	• What particular practices do facilitators of video-based professional development enact to support teachers in productive discussions of mathematics teaching and learning? How do these practices coordinate to support teacher learning? (van es et al., 2014)
Western	Teacher learning	• How did elementary teachers in a mathematics lesson study make sense of student learning, teaching, and content, as related to using representations in teaching multidigit subtraction? (Murata et al., 2012) • How did changes occur over time in teachers' talk and practice? (Murata et al., 2012)
Middle		
Magnolia	Teacher learning	• What is the influence of mathematics teacher meetings on advice-seeking networks? That is, how do formal learning spaces shape informal ones? (Horn, Garner, Chen, & Frank, 2020) • What are the effects of teachers' collaboration on their expertise? (Horn, Garner, Chen, & Frank, 2020)
	Resources for teacher learning // Nature of conversations	• What are themes regarding successful and less successful uses of teachers' collaborative time? (Horn, Kane, & Garner, 2018) • How do different kinds of collegial conversations shape teachers' professional learning opportunities? (Horn, Garner, Kane, & Brasel, 2017) • What are the learning opportunities afforded by teachers' data use conversations? (Horn, Kane, & Wilson, 2015) • How does a teacher workgroup analyze data under the guidance of instructionally expert facilitators? (Garner & Horn, 2018)

Nile	Teacher learning	• What learning occurred for teachers as they engaged in video clubs? (Sherin & Han, 2004) • To what extent do teachers develop professional vision, the ability to notice and interpret significant features of classroom interactions, as they participate in a video club? (Sherin & van Es, 2009)
High		
Railside	Department vision	• What was the department's vision for equitable learning, and how was it built? (Tsu, 1997; Tsu, Lotan, & Cossey, 2014)
	Factors impacting the department's work	• What makes a department a generative professional community for teachers? (Lieberman, 1997) • What are the department practices that developed to support collaboration and learning? (Cabana, Shreve, & Woodbury, 2014) • What led to "derailment" at Railside, in terms of teaching, professional community, and students learning? (Louie & Nasir, 2014)
	Resources for teacher learning	• What are the resources for learning, outside of the context of formal, well-designed professional development? (Horn, 2005) • What is the nature of conversations that support teachers' informal learning? (Horn, 2010)
	Nature of conversations	• What are the details of the dialogue as teachers talk with one another about teaching and learning mathematics? (Little & Horn 2007; Horn & Little, 2014) • How are conceptions of students, subject, and teaching embedded in teachers' daily work, particularly as they encounter problems of practice and work to solve them with colleagues? (Horn, 2007) • How did conversational routines in two teacher work groups enhance or limit opportunities for the in-depth examination of problems of practice and hence shape opportunities for teacher learning? (Horn & Little, 2010) • What is the nature of conversations that support teachers' informal learning? (Horn, 2010)
	Student learning	

		• [These studies ask various questions about student learning in relation to teachers' work at Railside] (Boaler & Staples, 2008, 2014; Staples, 2008; Hand, 2012)
Septima Clark	Nature of conversations // Teacher learning	• What is the relationship between teachers' talk and professional learning? (Horn & Kane, 2015) • How do teachers' participation patterns and framings of a common problem of practice over time show learning within a teacher community? (Bannister, 2009, 2015)

CURRICULUM VITAE

ACADEMIC DEGREES

University of Washington, Seattle, WA 2020
Doctor of Philosophy in Teaching, Learning, & Curriculum
Emphasis in Mathematics Education

Dissertation: "Collectively we're stronger than we are as individuals": Understanding the development of inquiry-oriented professional communities of math teachers

Committee: Dr. Kara Jackson (chair)
Dr. Elham Kazemi; Dr. Mark Windschitl; Dr. Julia Aguirre

University of Washington, Seattle, WA 2015
Master of Education in Teaching, Learning, & Curriculum
Emphasis in Mathematics Education

Thesis: Supporting collective enactments of instruction: A decomposition of the practice of an expert teacher educator

Committee: Dr. Kara Jackson (chair); Dr. Elham Kazemi

Georgia Institute of Technology, Atlanta, GA 2010
Bachelor of Science in Industrial & Systems Engineering

RESEARCH INTERESTS

Teacher community, professional learning, systems of professional learning, facilitation practice, leadership practice, mathematics education, and equitable teaching practices

AWARDS, GRANTS, AND FELLOWSHIPS

Dissertation Fellowship, National Academy of Education/Spencer Foundation 2019

Travel Grant, University of Washington College of Education 2019

Travel Grant, University of Washington Graduate and Professional Senate 2019

Dissertation Fellowship Semi-Finalist, National Academy of Education/Spencer Foundation 2018

Most Dedicated Teacher, Coretta Scott King Young Women's Leadership Academy High School**,** *Nominated by High School Teaching Faculty* 2012

Center for Education Integrating Science, Mathematics, and Computing Teaching Fellow, Georgia Institute of Technology 2011 – 2012

Most Outstanding Sophomore, Omicron Delta Kappa Society National Leadership Honor, *Nominated by Peer Leaders* 2008

President's Scholarship, Georgia Institute of Technology 2006 – 2010

RESEARCH EXPERIENCE

Post-Doctoral Research Scientist — September 2020 – present
College of Education, University of Washington, Seattle

- *Improving the implementation of rigorous instructional materials in middle-grades mathematics: Developing a system of practical measures, routines, and representations*
  National Science Foundation Grant #1719744
  Kara Jackson (PI), Marsha Ing, June Ahn, Paul Cobb, and Thomas Smith (Co-PIs)

Graduate Research Assistant
College of Education, University of Washington, Seattle

- *Improving the implementation of rigorous instructional materials in middle-grades mathematics: Developing a system of practical measures, routines, and representations* — September 2016 – August 2020
  National Science Foundation Grant #1719744
  Kara Jackson (PI), Marsha Ing, June Ahn, Paul Cobb, and Thomas Smith (Co-PIs)
- *Development of practical measures for improving the quality of mathematics classroom practice* — December 2014 – August 2016
  Spencer RPP Program
  Kara Jackson (PI), Marco Muñoz, Erin Henrick, and Paul Cobb (Co-PIs)
- *Teach For America Chicago summer training redesign* — June 2014 – June 2015
  Morva McDonald (PI)

PUBLICATIONS (* peer reviewed; † second authors listed alphabetically)

*** Nieman, H.,** Kochmanski, N., Jackson, K., Cobb, P., & Henrick, E. (2020). Using student surveys to inform and improve classroom discussion practices. *Mathematics Teacher: Learning & Teaching PK-12.*

*** Nieman, H**., Jackson, K., & Lenges, A. (2020). Facilitators' and school leaders' role in establishing an inquiry-oriented professional community of mathematics teachers. In Borko, H. and Potari, D. (Ed.), Proceedings of the *25th Study Conference of the International Commission on Mathematics Instruction: Teachers of Mathematics Working and Learning in Collaborative Groups* (pp. 500 - 507).

* Jackson, K., & **Nieman, H.** (2017). Discursive perspectives on mathematics teaching and learning. In S. E. F. Wortham & D. Kim (Eds.), *Encyclopedia of language and education: Discourse and education* (3rd ed., Vol. 3): Springer.

Jackson, K., Henrick, E., Cobb, P., Kochmanski, N., & **Nieman, H.** (2016). *Practical measures to improve the quality of small-group and whole-class discussion* [White Paper]. Retrieved from University of Washington: http://pmr2.org

Publications in Preparation

† Gibbons, L., Lewis, R., **Nieman, H.,** & Resnick, A. F. (Under review). Conceptualizing the work of leading practice-embedded teacher learning experiences. *Revised and resubmitted to Teaching and Teacher Education, May 2020.*

Jackson, K., **Nieman, H**., Campos, F., & DiGiacomo, D. (In preparation). Making sense of teachers' varied responses to representations of practice.

Nieman, H. (In preparation). A review of the literature on inquiry-oriented communities of mathematics educators.

Nieman, H. (In preparation). An analysis of leaders' practice in supporting inquiry-oriented professional community in a middle school math department.

Nieman, H. (In preparation). An analysis of how tensions are aired and addressed in an inquiry-oriented professional community.

PRESENTATIONS († second authors listed alphabetically)

Invited Presentations

Nieman, H. (2020, April). Supporting the development of an inquiry-oriented professional community of mathematics teachers. Poster invited to the *Annual Meeting of the American Educational Research Association*, San Francisco, CA. (Cancelled due to COVID-19)

Nieman, H. (2020, March). Understanding the development of inquiry-oriented professional communities. Presentation invited to the *2020 Spring Fellows Retreat*, Washington D.C. (Cancelled due to COVID-19)

Nieman, H. (2019, November). Supporting teachers to see and treat students as mathematically capable. Poster presented at the *2019 National Academy of Education Annual Meeting & Fellows Retreat*, Washington D.C.

Refereed Conference Presentations

Nieman, H. (2020, April). Designing and facilitating school-embedded professional learning to support productive, shared discourses about students' mathematical capabilities. Poster accepted to the *Annual Meeting of the American Educational Research Association*, San Francisco, CA. (Cancelled due to COVID-19)

Nieman, H., Jackson, K., & Lenges, A. (2020, February). Facilitators' and school leaders' role in establishing an inquiry-oriented professional community of mathematics teachers. Paper presented at the *25th Study Conference of the International Commission on Mathematics Instruction*, Lisbon, Portugal.

Jackson, K., **Nieman, H.**, Kochmanski, N., & DiGiacomo, D. (2019, April). Making sense of teachers' varied responses to representations of practice. Paper session presented at the *National Council of Teachers of Mathematics Research Conference,* San Diego, CA.

Jackson, K., Cobb, P., Henrick, E., Smith, T., Ahn, J., Ing, M., **Nieman, H.,** Kochmanski, N., Campos, F., Chinen, S., DiGiacomo, D., & Hays, M. (2019, April). Developing a system of practical measures, routines, and representations to inform and enhance instructional

improvement efforts. Poster presented at the *Annual Meeting of the American Educational Research Association*, Toronto.

Kochmanski, N. & **Nieman, H.** (2019, February). Using practical measures of key aspects of instruction in mathematics coaching. Individual session presented at the *Annual Conference of the Association of Mathematics Teacher Educators,* Orlando, FL.

Ing, M., Jackson, K., Cobb, P., Kochmanski, N., **Nieman, H.,** Smith, T., Ahn, J., Hays, M., DiGiacomo, D., Chinen, S., & Campos, F. (2018, April). Exploring measurement issues in the context of practical measures: The case of a practical measure of the quality of discussion in mathematics classrooms. Session presented at the *Annual Meeting of the American Educational Research Association*, New York, NY.

Kochmanski, N., **Nieman, H.,** Jarry-Shore, M., Treviño, E., Jackson, K., & Borko, H. (2018, February). Practical measures of instruction: Improving mathematics teaching with quick, actionable feedback. Individual session presented at the *Annual Conference of the Association of Mathematics Teacher Educators,* Houston, TX.

Nieman, H. & Jackson, K. (2017, October). Using practical measures to inform and improve mathematics teaching. Presentation given at the *Northwest Mathematics Conference,* Portland, OR.

Hartmann, L., **Nieman, H.,** Lewis, B., Fox., A., & Gibbons, L. (2017, September). Japanese Lesson Study and American Math Labs: A comparative analysis of professional learning in two school-based professional development models. Poster presented at the *Japan-U.S. Teacher Education Conference,* Honolulu, HI.

Nieman, H. (2017, April). Mediation matters: Disrupting deficit discourse through classroom-based methods courses. Research report presented at the *American Educational Research Association Annual Conference,* San Antonio, TX.

Nieman, H. (2017, April). Supporting productive views of students through teacher education. Paper session presented at the *National Council of Teachers of Mathematics Research Conference,* San Antonio, TX.

† Gibbons, L., Fox, A., Jackson, K., Jarry-Shore, M., Kobiela, M., Lewis, B., Lin, T., Muro-Villa, A., & **Nieman, H.** (2017, April). Researching facilitation practices: A discussion across three contexts. Discussion session presented at the *National Council of Teachers of Mathematics Research Conference,* San Antonio, TX.

Jackson, K., **Nieman, H.,** Kochmanski, N., Harris, A., Slayton, J., Treviño, E., & Asturias, H. (2017, April) District leaders', coaches' and teachers' use of practical measures to improve the quality of mathematics teaching. Session presented at the *49th National Council of Supervisors of Mathematics Annual Conference,* San Antonio, TX.

Henrick, E., Jackson, K., Cobb, P., Kochmanski, N., & **Nieman, H.** (2017, April). Design-based research-practice partnerships: Connecting the expertise of researchers and practitioners to improve educational opportunities for all students. Poster presented at the *American Educational Research Association Annual Conference,* San Antonio, TX.

† Gibbons, L., Fox, A., Lewis, R., & **Nieman, H.** (2016, April). Facilitating the collective learning of teachers in practice-based, in-classroom learning experiences. Paper session presented at the *National Council of Teachers of Mathematics Research Conference,* San Francisco, CA.

Kochmanski, N., **Nieman, H.,** & Cobb, P. (2016, March). Developing practical measures of the quality of the mathematics classroom learning environment. Poster presented at the *Carnegie Foundation Summit on Improvement in Education,* San Francisco, CA.

† Gibbons, L., Fox, A., & Lewis, R., & **Nieman, H.** (2016, January). Examining how professional development facilitators and teacher educators help establish a culture of risk-taking. Individual session presented at the *Annual Conference of the Association of Mathematics Teacher Educators,* Irvine, CA.

TEACHING EXPERIENCE

Higher Education Teaching Experience

Lead Instructor, Understanding and Communicating Mathematics in the Elementary Classroom (B EDUC 391) — Summer 2018
University of Washington Bothell, Educational Studies

Lead Instructor, Math for Elementary School Teachers (EDUC 170) — Spring 2017, Fall 2017
University of Washington, College of Education

Teaching Assistant, Math for Elementary School Teachers (EDUC 170) — Winter 2016, Fall 2016, Winter 2017
University of Washington College of Education

Teaching Assistant, Elementary Mathematics Methods (EDUC 523) — Winter 2016
University of Washington College of Education

Corps Member Advisor, Secondary Mathematics Methods; Coaching — Summer 2012, Summer 2013
Teach for America

K – 12 Teaching Experience

Mathematics Teacher (9th and 10th grades) — Fall 2010 – Spring 2012
Coretta Scott King Young Women's Leadership Academy High School
Atlanta Public Schools, Atlanta, GA

Mathematics Teacher (8th grade summer school) — Summer 2010
Harper Archer Middle School
Atlanta Public Schools, Atlanta, GA

SERVICE

- Guest reviewer for the Journal of Teacher Education
- Guest conference reviewer for the American Educational Research Association Annual Meeting and National Council of Teachers of Mathematics Research Conference

PROFESSIONAL AFFILIATIONS

- American Educational Research Association (AERA)
  - Division K: Teaching & Teacher Education
  - Special Interest Group: Research in Mathematics Education
- Association of Mathematics Teacher Educators (AMTE)
- National Council of Supervisors of Mathematics (NCSM)
- National Council of Teachers of Mathematics (NCTM)