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Savannah O. Steele
Brigham Young University - Provo

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Professional Development as a Community of Practice and Its Associated Influence

on the Induction of a Beginning Mathematics Teacher

Savannah Steele

A thesis submitted to the faculty of
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Master of Arts

Daniel Siebert, Chair
Steven Williams
Blake Peterson

Department of Mathematics Education

Brigham Young University

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ABSTRACT

Professional Development as a Community of Practice and Its Associated Influence
on the Induction of a Beginning Mathematics Teacher

Savannah Steele
Department of Mathematics Education, BYU
Master of Arts

This qualitative study analyzes a professional development course and its associated influence on the induction of a beginning mathematics teacher from a sociocultural perspective. Specifically, it examines whether a specific high school mathematics professional development course formed a community of practice through the elements of mutual engagement, joint enterprise, and shared repertoire. A community of practice is an inherently sociocultural framework. The results show how each element was present in the professional development, indicating that a community of practice had formed. Using those three elements of community of practice, the study further analyzes the induction of one first-year teacher, Sarah, who was a participant in the community of practice. Sarah's induction is framed as consisting of her conformance to the school mathematics department accepted by both her colleagues and herself, as well as her transformation of the system. The results of the study demonstrate how each element of the community of practice influences each aspect of Sarah's induction into the mathematics department at her school.

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Chapter 1: Introduction

This study addresses a problem pertaining to the induction of beginning mathematics teachers. In this chapter, I first outline a typical trajectory for developing teachers and proceed to outline how current research fails to address all the issues facing those beginning teachers. I close with a statement of my research problem and how I believe my study will contribute to the field of mathematics education.

Typical Trajectory for Developing Teachers

In the United States, most mathematics teachers progress through a common sequence of events in becoming a teacher. Prior to any formal instruction in teaching, teachers are educated in what Lortie (1975) referred to as an "apprenticeship of observation." That is, in their primary and secondary education, teachers learn not only regular school subjects but also, through observation, they develop ideas about what it means to be a teacher. By observing their own teachers in action, they come to espouse certain beliefs about what a teacher does and how teaching should be done. In the particular domain of mathematics teaching in the United States, a traditional approach has been firmly established and is recognizable to many. After experiencing 13 years of this informal training, pre-service mathematics teachers have become entrenched in traditional ideas about what it means to teach and do mathematics in the public schools (Ball, 1989).

Due to demonstrated deficiencies with traditional mathematics instruction, many pre-service teacher education programs advocate reformed philosophies and methods of teaching consistent with the ideas espoused by the National Council of Teachers of Mathematics (NCTM). NCTM calls for more student engagement in learning mathematics and for students to engage in inquiry-based styles of learning (NCTM, 2000). Pre-service teacher education

programs offer courses to inform their students of these reformed ideas about teaching mathematics and convince students of their need. Additionally, such teacher education programs offer practicum and methods courses as a way for these pre-service teachers to better understand how an inquiry-based style of instruction might look in the mathematics classroom (Ball, 1989). Pre-service teachers' past experiences in the public schools are mediated by the philosophies and courses, the beliefs and requirements, of their teacher education programs.

When teachers begin teaching, they often find their expectations do not match the realities of the classroom (Freiberg, 2002; Friedrichsen, Chval, & Teuscher, 2010). They are met with obligations inherent in teaching, such as planning, classroom management, and assessment, as well as with a new school culture in which they must find their own place. Despite the instructional philosophies and practices they learned during their pre-service teacher education, the difficulties of teaching provoke new teachers to either develop coping strategies for trying to reconcile their desires with the difficulties of teaching (Gregg, 1995) or to simply leave the teaching profession (Friedrichsen et al., 2010). Often, due to the familiarity of the school setting, and the difficulty in enacting new ways of thinking and acting in this familiar setting (Ball, 1989), beginning mathematics teachers will revert back to the traditional teaching methods they were exposed to in their own education (Gellert, 2008). Despite the difficulties of teaching, certain support structures in school, including professional development courses and collaborative communities of practice (Blanton & Stylianou, 2009; Lave & Wenger, 1991), can help beginning teachers to stay afloat and to find their place in the school system.

Drawing on the above ideas, we see that the typical situation faced by beginning teachers is problematic. A number of mathematics teachers who initially desire to do what they feel is best for their students become jaded by the pressures and politics of school culture. It therefore

would be helpful to come to understand how a beginning mathematics teacher might begin to negotiate her place in the school community while still holding firmly to that which she believes to be true.

Trends in Research on Beginning Mathematics Teachers

Much of current research on beginning mathematics teachers has approached the dilemmas of these teachers from a cognitive point of view (Ball, 1990a, 1990b, 1991; Borko et al., 1992; Shulman, 1986). Problems faced by beginning teachers point to a lack of knowledge or incorrect beliefs about learning and teaching mathematics.

Beginning mathematics teachers may struggle in the classroom due to limited subject matter knowledge for teaching. Subject matter knowledge involves knowledge *of* mathematics and knowledge *about* mathematics (Ball, 1991). Adequate subject matter knowledge for teaching involves a conceptual understanding of mathematical principles and procedures (Ball, 1990a, 1990b; Borko et al., 1992). Borko et al. (1992) gave the example of Ms. Daniels, who struggled when teaching division of fractions. The authors highlighted Ms. Daniels' lack of subject matter knowledge for teaching division of fractions as well as her lack of motivation for obtaining such knowledge; she did not see the need for that knowledge earlier in her pre-service courses. Ball (1990b) also pointed to inadequate subject matter knowledge, particularly about division of fractions but also about division by zero or solving algebraic equations that have division, as a limitation of prospective teachers. If beginning teachers have a weak understanding of mathematics, it is hard to see how they will be able to teach for understanding. Therefore, having limited subject matter knowledge can be a source of struggle for beginning mathematics teachers.

Beginning teachers might also struggle because of limited pedagogical content knowledge for teaching mathematics. Pedagogical content knowledge is "subject matter knowledge *for teaching*" (Shulman, 1986, p. 9, emphasis in original). Teachers who possess pedagogical content knowledge have "an understanding of how to represent specific topics and issues in ways that are appropriate to the diverse abilities and interests of learners" (Borko et al., 1992, p. 196). Teachers might have a strong mathematical understanding, but this does not guarantee that they possess the knowledge of how to teach those mathematical concepts in such a way that it is accessible to their students. That is, the teachers may understand the mathematics, but they lack the knowledge of how to help students develop that same understanding. A lack of pedagogical content knowledge might be due to several factors: lack of knowledge of what preceded the topic in the curriculum, lack of understanding what conceptions are required to develop an understanding of the topic, or a lack of knowledge of valuable representations or contexts in which to develop the ideas. Beginning mathematics teachers who lack pedagogical content knowledge struggle because they do not have access to the several tools and strategies that are useful in teaching for understanding.

Finally, beginning mathematics teachers might also struggle because of their beliefs about what mathematics *is* (and how that impacts the meaning of "doing" mathematics) as well as their beliefs about learning and teaching mathematics. Beliefs about what mathematics is are tied to Ball's (1991) idea of teachers' knowledge *about* mathematics. In her study, Ball (1990a) examined the mathematical understandings of 252 prospective teachers. The questionnaire and interviews used in the study were intended to help her look at the prospective teachers' ideas about, feelings toward, and understandings of mathematics and good mathematics instruction. She asserted that many of the teachers she interviewed possessed "a view of mathematics as a

domain where algorithms, not meanings, are central" (Ball, 1990a, p. 457). These teachers were unable to generate any representation for a division of fractions problem, highlighting the fact that they never developed mathematical understanding when they learned mathematics; therefore, the teachers have a perception of mathematics as a collection of arbitrary rules that must be memorized (Ball, 1990a, 1990b; Borko et al., 1992). Beginning teachers who possess this view of mathematics often cite rules as mathematical explanations rather than actually stating why something works, meaning they will likely not teach their students for mathematical understanding. This leads to struggles because teachers do not see connections between different mathematical ideas and they cannot provide any other explanation than the simple statement of a mathematical rule.

Overall, much of the research that has been done on the struggles of first-year teachers has stressed the lack of subject matter knowledge and pedagogical content knowledge for teaching or limitations in prospective teachers' beliefs about learning and teaching mathematics. Much of this research has pointed to pre-service teacher education programs, and called for changes in such programs.

Sociocultural Approaches to Research on Beginning Teachers

Now, while the above characteristics of beginning teachers might be accurate, they do not paint a complete picture of a beginning teacher's experience. By focusing on the subject matter knowledge, pedagogical content knowledge, and beliefs of the beginning teacher, research is limited. Such studies fail to address that teachers might possess all of the desired characteristics and knowledge and still experience problems when entering the teaching profession. There is something more that might be considered when examining beginning teacher's struggles. That is,

many key issues in beginning teachers' struggles might be missed by researching them solely from a cognitive perspective.

One important consideration that should be addressed is that beginning teachers are entering a well-established social institution. Upon entrance, they are expected to fit in and to function fully in a social situation that is different than what they might have experienced in their teacher preparation program. Even if beginning teachers possess all of the above characteristics (subject matter knowledge, pedagogical content knowledge, specific beliefs about learning and teaching mathematics, etc.), it is unclear whether or how they would fit in and be able to function within the given school system. Viewing beginning teachers' experiences from a sociocultural point of view might therefore be helpful in considering how teachers fit in and function in their new role. Adopting a sociocultural perspective would allow researchers to better address the issue of first-year teachers reconciling their several viewpoints and trying to fit into a well-established school culture. Teaching does not occur in a vacuum, but is rather embedded in a social institution. Public education has several established norms, policies, and practices. Beginning teachers are forced into the middle of this social institution and are expected to conduct themselves in ways consistent with the school culture. A sociocultural perspective on beginning teachers' experiences would allow a reinterpretation of the difficulties they face in light of their entrance into this institution. Such a perspective allows a special consideration of the expectations of the social institution that the teachers are entering (that is, the ways of acting, doing, and being that are expected of teachers) and how beginning teachers might negotiate their role in this new social setting.

Gregg (1995) explored the use of a sociocultural perspective to investigate beginning teachers' experiences; he used a social lens in his case study of a first-year mathematics teacher.

His theoretical framework was based in radical constructivism and symbolic interactionism, both of which he used to focus on the social aspects of teaching. Specifically, he studied the tensions and contradictions of the "school mathematics tradition" that impacted Ms. Weston, a first-year high school mathematics teacher. In his study, Gregg discussed the relationship between Ms. Weston's beliefs and practices and the institutionalized practices of the school mathematics tradition. That is, he highlighted how Ms. Weston's practices and beliefs may have been influenced by the system, or by the established school culture. Though her traditional perspective on teaching mathematics fit well with the department and school into which she was hired, Ms. Weston still struggled and had to develop certain coping strategies when trying to fit into the school culture. Gregg's (1995) critique of the difficulties of first-year teaching was different than what was done previously because he noted how beginning teachers are really trying to find a place within the school culture. Further research on the experiences of beginning mathematics teachers, using a social lens, might lend insight into the nature of school culture and how beginning teachers find their place within that culture.

Professional Development Efforts

One promising area of education that aims to support teachers in developing and changing their practice is professional development. In particular, professional development is seen as a source with rich potential for the support of beginning mathematics teachers. Research has shown how professional development can have a powerful influence on teachers' practices. However, as with other research on beginning teachers, much of professional development has focused on the cognitive aspects of teachers' experiences. In particular, professional development has been used as a way for teachers to develop subject matter knowledge and pedagogical content knowledge. In this sense, a lot of professional development efforts focus on

developing teachers' understanding of a specific mathematical concept or increasing teachers' knowledge about effective teaching practices (Matos, Powell, Sztajn, Ejersbo, & Hovermill, 2009; Silver, 2009).

Recently, however, research has begun to look at the social aspect of teaching in general and of professional development in particular. Blanton and Stylianou (2009) and Gellert (2008) both looked at the social aspect of mathematics professional development. Blanton and Stylianou (2009) asserted that a professional development program that fosters a community of practice, wherein individuals work together toward a common goal, can provide a critical dynamic between its members that influences each individual. Gellert (2008) discussed that one key element of successful professional development is that teachers experience a sense of community and support in taking risks, noting the merits of community and the "social dimension in mathematics teacher education" (p. 94).

Professional development, therefore, offers a particularly promising avenue for supporting and studying a beginning teacher's induction into a school system from a social point of view. There is potential for a professional development course to create a specific community of practice among its participants. Such a community of practice might provide the beginning teacher with the support and resources necessary to be successful in the school mathematics teaching culture. Further, the analysis of a community of practice in a professional development course would give insight into different aspects of a beginning teacher's induction into the school culture.

Research Problem

Marrying the need for a sociocultural approach to beginning mathematics teachers' struggles and the recent push to consider the social aspects of mathematics professional development leads us to a new area to study. We can see how professional development might be a good forum for beginning teachers to reconcile their several ideas and perceptions about learning and teaching mathematics with the institutionalization of traditional school mathematics. Professional development can be seen as an effort to support beginning teachers' induction into the school. Nobody has yet looked carefully at the problem of beginning teachers' negotiating their induction into the school culture in the specific context of a professional development course.

This qualitative study explores a high school mathematics professional development course and a first-year mathematics teacher's experiences in that course. The focus of this study is her experiences in the professional development course, and how those experiences prepare her to navigate and negotiate the high school mathematics teaching culture. By approaching beginning teachers' experiences from a social perspective, in the particular context of professional development, this study will add new insight into the several aspects of and influences on the induction of first-year mathematics teachers into her new school culture.

Chapter 2: Theoretical Framework and Literature Review

A beginning mathematics teacher's induction into her new teaching culture can be facilitated by professional development. This section first discusses the components of induction for a beginning teacher, including a description of the system into which the teacher is being inducted. Next, the merits of professional development as a way to help beginning teachers are discussed. Finally, the key components of communities of practice are outlined, followed by a discussion of how those key components might play out in a professional development course and therefore might influence a beginning teacher's induction into the school mathematics teaching system. This framework focuses specifically on communities of practice and how their three defining characteristics might help beginning mathematics teachers negotiate and navigate their way in the school mathematics teaching system.

Defining Induction

Lawson (1992) argued that "becoming a teacher is not a simple transition from one role to another; it is a social process involving complex interactions between and among prospective and experienced teachers and their social situations" (p. 164). This complex process might be seen as one of induction, focusing on how one comes to "fit in" to a system. The specific type of induction that is pertinent to this study is induction into the school mathematics teaching system. The school mathematics teaching system is comprised of several groups of people, such as the school administration, the mathematics department, the students, the parents, and the community, as well as all the associated norms, policies, and practices thereof. While the system itself is extensive, this study limits its scope to examine specifically how a teacher is inducted into the mathematics department at the school. Examining induction in terms of the entire system is beyond the scope of a Master's thesis, and the mathematics department is a key part of the

system that seems critical to study. Therefore, I focus my study on how one first-year mathematics teacher comes to fit in to the mathematics department at her school.

My definition of teacher induction into the school mathematics teaching culture has three aspects. The first two aspects deal with the new teacher conforming to the norms, policies, and practices of the system: the stakeholders in the system (in this case, the teachers in the mathematics department) must accept the teacher as acting in accordance with the system's norms, policies, and practices, and the teacher must accept herself as acting in accordance with those same norms, policies, and practices. The third aspect of induction deals with the degree to which the system is responsive to the new teacher's efforts to transform system norms, policies, and practices. The degree to which a teacher is successfully inducted into the school mathematics teaching system depends on the degree to which these three aspects of induction are present.

Research on beginning teachers has discussed the three aspects of induction, also referring to the process as teacher socialization (Feiman-Nemser, Schwille, Carver, & Yusko, 1999; Lawson, 1992; McGinnis, Parker, & Graeber, 2004). Feiman-Nemser et al. (1999) reviewed the literature on teacher induction, giving several meanings or uses of the concept of induction. Two relevant meanings of induction are a phase of intense teacher learning (corresponding with the first years of teaching) and a time of teacher socialization. Similarly, McGinnis et al. (2004) also reviewed literature on the induction of mathematics teachers. Mathematics teacher induction, they noted, might be viewed as learning, as socialization, and as a form of development. Each of the ideas set forth by these researchers can be tied to the three aspects of teacher induction described below.

Conforming accepted by the system. One important aspect of induction is that members of a school mathematics teaching system recognize and accept the new teacher as conforming to

the established norms, policies, and practices of the system; that is, the system's stakeholders see the beginning teacher as acting in accordance with how they expect him/her to act. Lawson (1992) noted that "every subject field has…accepted examples of the ways in which teachers describe and perform their work" (p. 169). In a school mathematics teaching system overall, there are several groups that must recognize, in unique ways, the beginning teacher as being a teacher: the students, the administration, the department, and others. As stated above, this study focuses specifically on the mathematics department aspect of the system. The teacher needs to be recognized by the mathematics department into which she is entering. From the department standpoint, the teacher needs to act like a mathematics teacher. She needs to talk like she knows what she is doing. She needs to express the concerns, excitements, and doubts that come with the territory. She needs to demonstrate fluency in mathematical knowledge for teaching.

This aspect of induction is evident in the notion of teacher induction as a phase of learning, where "beginning teachers are expected to perform and be effective" (Feiman-Nemser et al., 1999, p. 6). Additionally, with a conception of induction as teacher socialization, the beginning stages of teaching are a critical time when the teacher learns how to engage in the practice of teaching and the stakeholders in the system must recognize that the beginning teacher is competently engaging in the expected practices of teaching (Feiman-Nemser et al., 1999; McGinnis et al., 2004).

Conforming accepted by the individual. Beginning mathematics teachers must also recognize themselves as acting in accordance with the norms, policies, and practices of the system. To do so, the beginning teachers must first understand the norms, policies, and practices that dictate how they should act. Lawson (1992) argued that "through the induction process recruits are 'induced' to accept as their own the profession's dominant definitions of appropriate

language, norms, missions, knowledge, technology, and ideology" (p. 163). When beginning teachers are being inducted into a school mathematics teaching system, they must recognize and accept that they are conforming to the established norms, policies, and practices of the system. This aspect of induction is closely tied to Feiman-Nemser et al.'s (1999) conception of induction as teacher learning because the teacher must learn the norms, policies, and practices of the system during their first years as a real teacher in a real classroom with real students. The development of such understanding is evident as beginning teachers feel the need for support within the system and seek information about district policies, classroom procedures, and instructional resources (Feiman-Nemser et al., 1999).

Once beginning teachers understand the behavior that is expected of them, they must see themselves acting in ways that are consistent with that understanding. Feiman-Nemser et al. (1999) noted that beginning teachers are faced with new complexities of teaching and often feel overwhelmed and inadequate despite their competency and capacity to do what they are expected to do. So, even when teachers understand their expected behavior, an important part of induction deals with recognizing that they can competently act in accordance with that expected behavior. This acceptance can be seen as the focus of beginning teachers shifts from personal inadequacies toward student learning, indicating that the teacher focuses more on what is important to the system (Feiman-Nemser et al., 1999). When this shift in focus has occurred, the actions of the teachers indicate conformity because the teachers are engaged in acting successfully rather than in reflecting and thinking about whether or not they fit in.

Transforming the system. The final aspect of induction involves beginning teachers transforming the school mathematics teaching system as they enter and begin to participate in the system. That is, beginning teachers are not passive, but rather exert change on the system into

which they are being inducted, influencing the profession, the policies, their own responsibilities, and the standards to which they will be held (Feiman-Nemser et al., 1999). Feiman-Nemser et al. (1999) refer to such an impact as a "transformative induction process" (p. 16). McGinnis et al. (2004) also noted that teacher socialization might be viewed from an interpretive and critical standpoint, where "the individual takes an active role in making sense of the context and modifying influences" (p. 5). That is, the individual teacher serves both to perpetuate the practices and values of the school culture, while also exerting some amount of change on those practices and values. Overall, beginning teachers must be actively involved in their induction and in transforming the system into which they are entering (Feiman-Nemser et al., 1999; Lawson, 1992; McGinnis et al., 2004).

Professional Development

Professional development courses have been suggested by some as a way to influence and support beginning teachers' induction into the school mathematics teaching culture (Blanton & Stylianou, 2009; Feiman-Nemser et al., 1999). Feiman-Nemser et al (1999) conceptualized beginning teacher learning as part of a larger continuum of professional development, noting that beginning teachers "need learning opportunities that are connected to their daily work with students, related to the teaching and learning of subject matter, organized around real problems of practice, [and] sustained over time" (p. 12). A professional development course that meets such criteria would provide support for beginning teachers as they become inducted into the school mathematics teaching system, and therefore would provide a promising setting for studying teacher induction.

Research has shown how professional development experiences in mathematics education can be influential for mathematics teachers' growth and change, key to Feiman-

Nemser et al.'s (1999) conception of beginning teachers' phase of learning. Studies have shown that one key element of successful professional development is that teachers experience a sense of community and support in taking risks and changing practices. Gellert (2008) discusses the merits of community and the "social dimension in mathematics teacher education" (p. 94). Paralleling the views of Gellert (2008), Thompson, Philipp, Thompson, and Boyd (1994) argue that changing practice requires a movement away from comfort and toward vulnerability. A crucial moment in the change of teaching practice occurs when the teacher feels uncomfortable and perhaps insecure when leaving behind familiar teaching routines, a process made easier with the support of colleagues (Gellert, 2008). Though these ideas refer to change in more experienced teachers, they can also be applied to beginning teachers who are being supported as they enter the teaching profession. Everything the beginning teachers experience is new to them and therefore different from what they experienced either as students or as pre-service teachers. Entering the school mathematics teaching system and engaging in the norms, policies, and practices thereof is taking a risk, and professional development can provide a support system for these beginning teachers. Because of these ideas about collaboration and professional development, it is reasonable to assume that the induction of beginning mathematics teachers into the school mathematics teaching system will be impacted by their dynamic relationships with other participants in a professional development course.

Communities of Practice

Discussing the merits of professional development courses, Blanton and Stylianou (2009) asserted that "teacher learning is a process situated within a *community of practice*, within which the goal is to build collaborative relationships among faculty members so as to engage them in research and practice" (p. 82, emphasis in original). Similarly, Feiman-Nemser et al. (1999)

noted that novice teachers learn best in communities of practice. The phrase *community of practice* was introduced by Lave and Wenger (1991) and Wenger (1998) to describe a group of people who are joined in a common purpose. In a community of practice, social learning occurs as individuals work toward a common goal. The inherent social nature of learning is thus emphasized, as such communities depend on members and their relationships (Lave & Wenger, 1991; Wenger, 1998).

The relationship between members of a community of practice is inherent in the three key dimensions of such a community, introduced by Wenger (1998): mutual engagement, a joint enterprise, and a shared repertoire. These components serve to distinguish a community of practice from other communities or groups of people working together. The idea of mutual engagement requires that a member be involved with the community's practice and have relationships with other members based in that practice. The notion of joint enterprise involves a complex negotiation of ideas and understandings based on members' situations in the community. This idea does not necessarily mean that all participants share the same perspectives and beliefs. Participants are not necessarily joined in harmony, but their activity is joined around a common enterprise. Lastly, a shared repertoire of resources or tools for community members to use develops from their common practice and joint negotiation.

The above criteria can be used to consider the extent to which the participants of a specific professional development course form a community of practice. The mutual engagement of community members means that all participants are engaged with one another in some type of practice relevant to the system and aimed at the community's enterprise. That is, the teachers of a professional development course must be interacting with one another on some level, negotiating the meanings of their actions with one another, as they are engaged in the particular practices of

the system. These interactions are not necessarily positive. In fact, Wenger (1998) describes how such interactions could be negative or full of tension, but mutual engagement exists as long as the relationships between community members serve to make meaning of and give purpose to their practice. Further, communities of practice take time to build. Grouping individuals into a professional development course does not constitute a community of practice. Rather, the community of practice may emerge over time as the participants engage together and negotiate communally a joint enterprise, described below.

A joint enterprise means that the professional development participants have developed common goals that they are all working toward. These goals do not necessarily coincide with the stated goals of the professional development course. That is, the enterprise of a community of practice cannot be imposed upon that community. Rather, the negotiation of an enterprise occurs by the participants of the community of practice as they pursue it. Similar to the idea of mutual engagement, not all members of the community need to share beliefs or agree on everything for a joint enterprise to exist. Instead, the negotiation of the community's enterprise needs to occur communally, be based on the community's practices, and involve accountability of community members.

Finally, a shared repertoire constitutes the practices, discourse patterns, and tools that community members develop and use to engage in the community's practice and to work toward their joint enterprise. This repertoire of tools is used as community members communicate and collaborate, and helps community members to communally negotiate meanings of the community's practice. In a professional development course, this means that the participants will develop specific ways of interacting and specific tools to accomplish their communally negotiated enterprise.

How Professional Development Communities of Practice Might Influence Teacher

Induction

As a community of practice forms in a professional development course, the mutual engagement, joint enterprise, and shared repertoire of that community might influence a beginning mathematics teacher's induction into the school mathematics teaching system.

The mutual engagement of professional development participants will give insight about the beginning teacher's induction. When the professional development course includes all members of a high school's mathematics department, analyzing the mutual engagement of participants will give insight into the relationships and interactions between the beginning teacher and the other teachers in the department. As the professional development participants engage together in the community's practice, their engagement could illuminate conformance accepted by the system and by the individual.

Further, by analyzing the activity of the participants in the community of practice, their joint enterprise can be determined. The joint enterprise of the community will influence the beginning teacher's induction into the school mathematics teaching system as it might help all of the professional development participants, including the beginning teacher, negotiate the meanings of the norms, policies, and practices of the system; that is, the goals of the community might make explicit the goals and standards of the system. This would influence how the beginning teacher is recognized by the department and by himself/herself as conforming to the system. Further, the negotiation of that joint enterprise might lend insight into how the beginning teacher is transforming the school mathematics teaching system as he/she is being inducted into that system.

Finally, the shared repertoire that develops among members of the professional development community of practice might provide tools and ways of acting, doing, and being that the beginning mathematics teacher can carry out in the school mathematics teaching system. The repertoire of social tools will aid in the teacher's induction as it helps the beginning teacher to act in accordance with the norms, policies and practices of the system.

Research Questions

Overall, the notion of a community of practice provides a lens from which to study a beginning mathematics teacher's induction into the school mathematics teaching system. An assessment of the formation of a community of practice within a professional development course will help to illuminate the nature and extent of the mutual engagement, joint enterprise, and shared repertoire of that community. The elements of that community can provide insight into how the professional development course facilitates the induction of the beginning teacher into the school mathematics teaching culture. My research questions, therefore, are as follows:

1. What elements of a community of practice (mutual engagement, joint enterprise, and shared repertoire) are evident in a high school mathematics professional development course?
2. What influence do the three key elements of the community of practice have on a beginning teacher's induction?

Chapter 3: Methodology

This chapter outlines the qualitative case study I used to answer my research questions. Data were collected in a high school mathematics department professional development course. I used qualitative analysis of several data sources to determine first what elements of a community of practice existed in the professional development course and second how those elements influenced the induction of a beginning mathematics teacher into the mathematics department at her school. In this chapter, I first describe the subjects and setting of my study. Then, I outline data collection sources and processes. Finally, I describe how I managed and analyzed the data to answer each of my two research questions.

Subjects and Setting

This study was part of a larger qualitative study in which data were collected at a local suburban high school in a BYU Public School Partnership District. The entire project involved five groups of participants: students enrolled in Algebra 2 and Geometry classes at the high school, all ten members of the high school's mathematics department, pre-service teachers enrolled in BYU's capstone mathematics education methods course (MthEd 377/378), BYU mathematics education graduate students, and mathematics education faculty from the university. The purpose of the larger study was threefold. One goal was to increase understanding of high school students' reasoning and sense-making in mathematics. A second goal was to increase understanding of pre-service teachers' growth and development while participating in a new practicum model. The third and final goal was to increase understanding of in-service teachers' growth and development while participating in a collaborative professional development course.

While the larger study had many different parts, I focused my study on the portion in which the high school teachers met after school. I refer to this portion as the professional

development portion of the study. The overall structure of the course was as follows. Professional development sessions were held bi-weekly (every other Monday afternoon) for the duration of the 2009-2010 academic year, and were typically 3 hours in length. There were a total of 15 professional development sessions during the year. The course was facilitated by university mathematics education faculty as well as mathematics education graduate students (including the author) who were enrolled in a special topics course about professional development. During the last hour of each of the last 9 professional development sessions, the graduate students joined the high school teachers for whole-group discussions about topics pertinent to learning and teaching mathematics. Additionally, for 8 of the 15 professional development sessions, the pre-service teachers joined the high school teachers for the first 30 minutes for small-group or whole-group discussions about learning and teaching mathematics.

The intended purpose of the professional development course was to build unity among the teachers. The entire project was requested by the high school administration and the mathematics department chair for the dual purposes of improving high school students' capacities in mathematics and of building community in a department that had had substantial change in faculty from previous years. Since there were several new teachers in the department (either new to the school or new to the profession) and different teachers held conflicting philosophies about learning and teaching mathematics, the course was aimed at establishing unity between teachers.

The high school teachers participated in various activities as part of the professional development course. Professional development activities were intended to meet the needs of the teachers in the department by focusing on teaching strategies, research on learning and teaching mathematics, worthwhile mathematical tasks, common assessments, and student work. For each

professional development session, the teachers had assigned reading from one of three books: *Assessment for Learning: Putting it into Practice* (Black, Harrison, Lee, Marshall, & William, 2003)*, Focus in High School Mathematics: Reasoning and Sense Making* (NCTM, 2009), and *Mathematics Teaching Today: Improving Practice, Improving Student Learning* (NCTM, 2007). The teachers were also required to construct written responses to their assigned reading, often answering reflective questions posed at the end of the chapters. During each session, the teachers would discuss the reading they had done, focusing on their answers to the reflective questions or on how the reading was applicable to them. The teachers also engaged in worthwhile mathematical tasks as part of their professional development activities. They would work on tasks, then discuss the big mathematical ideas that emerged from their work. Finally, the teachers created common assessment questions together during the professional development. After administering and grading the assessments, the teachers discussed student performance on those common assessment questions.

Within the professional development course, I focused specifically on Sarah, a first-year teacher who had earned a Bachelor of Science degree in Mathematics Education from BYU in April 2009. The professional development course spanned her first full year of teaching, though she had completed a 16-week student teaching course the previous year at the same location, working with another teacher in the mathematics department. During student teaching, she taught Algebra 2 and Pre-calculus. During the 2009-2010 academic year, when data collection took place, she taught Algebra 2 and Geometry. The professional development course in this study was her first and only formal professional development experience following the completion of her degree.

Data Collection

In order to consider the three key aspects of a community of practice (mutual engagement, joint enterprise, and shared repertoire) in the professional development course and Sarah's participation in that community of practice, data had to come from that professional development course. Therefore, data sources for the project included video recordings of all professional development sessions, documents crafted by Sarah as part of course requirements, and video recordings of the exit interviews of each high school teacher. Through these data sources, I developed a more complete understanding of what elements of the community of practice were evident in the professional development course and how those three elements influenced Sarah's induction into the mathematics department at her school.

All professional development sessions were videotaped, with video recordings focused on what in-service teachers said and did during professional development sessions. That is, the camera "[zoomed] in to particular details consonant with the purposes of the study" (Wolcott, 1994, p. 16); such detail provided insight into the mutual engagement, joint enterprise, and shared repertoire of the professional development participants. Facial expressions were recorded during discussions, when possible, to provide additional information for interpretation. In data collection, the author was considered an "observer as participant" during the first half of the year, and a "participant as observer" the second half of the year (Preissle & Grant, 2004). The "observer as participant" was in the professional development sessions simply to videotape and observe, but did not participate in the social setting of the professional development course in any significant way during the first semester. The "participant as observer" during the second semester still engaged in video recording and observation, but additionally had a role in the professional development community as a student in a graduate course.

Additional course documents were collected from the in-service teachers. These documents included a list of common assessment questions, which were created by the teachers during the professional development course, and subsequent teacher analysis of student performance on the assessment questions. These documents provided further insight into the mutual engagement, joint enterprise, and shared repertoire of the professional development participants. Particularly, the common assessments administered and graded by each of the teachers allowed an analysis of a key part of the teachers' shared repertoire.

Finally, two weeks after the final professional development session, I conducted an exit interview with each of the teachers about their experiences in the professional development program. I used data from Sarah's exit interview in my analysis. Such an interview provided me with the opportunity to "examine [Sarah's] experience in close, detailed ways" (deMarrais, 2004, p. 56) and to develop greater insight about her perspectives about learning and teaching mathematics from her own terms (Brenner, 2006; Hollway & Jefferson, 2000; Roulston, deMarrais, & Lewis, 2003; Zazkis & Hazzan, 1999). This insight provided information about Sarah's experiences with the professional development course, and lent insight into how her engagement in the course influenced her induction into the school mathematics teaching system.

Data Analysis

In this section, I present an outline of what data I chose for analysis and how I analyzed that data for each research question. I begin with a description of my data management, including an explanation for my choice of data sources. I then describe the methods I used to analyze the data. I conclude with a description of how each method was applied to the data sources to answer each research question.

Data management. Because of the wealth of video data, I constructed a data management plan to efficiently examine the data and select which pieces of data would likely allow me to answer my two research questions.

Fifteen professional development sessions throughout the course of the academic year yielded a total of approximately 45 hours of video data. I selected two professional development sessions, for a total of 6 hours of video data, to analyze for my study. I selected two sessions because no one single session included all types of professional development activities in which the teachers engaged, and more than two sessions seemed to be an overwhelming amount of video data to analyze. These two sessions were selected for several reasons. First, these two sessions occurred toward the end of the professional development course. They were the 11th and 12th sessions of the course, and they occurred during the first week in March (March 1st and March 8th). My reasoning in choosing sessions toward the end of the professional development course was that if a community of practice had formed, the key elements of that community would be more evident toward the end of the course after teachers had had time to establish such a community. That is, sessions toward the end of the course would be more likely to help me answer my first research question about elements of a community of practice in a professional development course.

Second, the activities during these two sessions spanned a wide range of different professional development activities. The first session had teachers working on and discussing different mathematics tasks. The second session had teachers discussing their students' performance on a common assessment designed by the teachers in a previous professional development course, as well as continuing their work on the mathematics tasks from the first

session. Both sessions included a whole-group discussion with the graduate students at the end of the session. I describe each session in more detail below.

Finally, these sessions were selected because Sarah was an active participant in each. An examination of her interactions in the professional development would highlight her participation in a community of practice. Further, her interactions would highlight how her participation influenced her induction into the mathematics department at her school.

Professional development on March 1st. The first professional development session I selected for analysis occurred on March 1st. During this session, the pre-service teachers met with the high school teachers during the first 25 minutes of the professional development. Additionally, the graduate students met with the high school teachers during the last 30 minutes of the professional development. During the course of the three-hour session, the high school teachers participated in several different activities. An outline of this session, listing the time, participants, and activity, is summarized in Table 1.

Table 1

Professional Development Session on March 1st

Time	Participants	Activity
0:00:00-0:04:33	High school teachers Pre-service teachers	Whole group discussion of worthwhile mathematical tasks
0:04:33-0:16:52	High school teachers Pre-service teachers	Small group work on Towers task
0:16:52-0:25:48	High school teachers Pre-service teachers	Presentations on initial work on Towers task
0:25:48-1:07:26	High school teachers	Small group work on Towers task
1:07:26-2:00:21	High school teachers	Whole group discussion/presentation of solution strategies, justifications, and big ideas for Towers task
2:00:21-2:17:11	High school teachers	Small group work on World Series task
2:17:11-2:44:33	High school teachers Graduate students	Whole group discussion of worthwhile mathematical tasks

In this session, the teachers worked on two different mathematics tasks, the Towers task and the World Series task. The Towers task asked how many four-cubes-high towers you can build if

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you can choose from two colors of cubes, how you know you have all the towers and no

duplicates, and how you could convince someone else of your answer. Next, the high school

teachers worked on a similar task, the World Series task, which had teachers considering the

probability of the World Series being won in exactly four games, exactly five games, exactly six

games, or exactly seven games.

Professional development on March 8th. The second professional development session I

selected for analysis occurred on March 8th, one week after the first session I analyzed. During

this session, the graduate students again met with the teachers during the last 30 minutes of the

session. Throughout the course of the session, the teachers participated in several different

activities. Table 2 summarizes the entire session, listing each activity with its associated time and

participants.

Table 2

Professional Development Session on March 8th

Time	Participants	Activity
0:00:00-0:19:19	High school teachers	Whole group discussion of student performance on common assessment
0:19:19-0:32:48	High school teachers	Small group work on Pizza task
0:32:48-1:51:00	High school teachers	Small group work on World Series task
1:51:00-2:30:33	High school teachers	Whole group discussion of solution strategies, justifications, and big ideas for World Series task
2:30:33-2:57:27	High school teachers Graduate students	Whole group discussion of mathematical learning environment

During this session, the high school teachers again worked on two different tasks. The Pizza task

asked the teachers to consider how many different types of pizza would be made with different

combinations of toppings and sauces. After working on the Pizza task, the teachers continued to

work on the World Series task from the first professional development session I analyzed.

Methods of analysis. In the analysis of my selected data, I used several methods to

answer my two research questions. The data I collected and the methods I used were sufficient to

determine how mutual engagement, joint enterprise, and shared repertoire were evident in the professional development course, and how those three key components of a community of practice influenced Sarah's induction into the mathematics department at her school. In this section, I first describe the basic methods I used. Next, I discuss how the methods were used to answer each of my research questions.

In analyzing my video data, I first transcribed both of my selected professional development sessions in their entirety. I also transcribed Sarah's exit interview. Following the transcription process, I coded the data. The unit of analysis I used during coding was a speaker turn. I used this unit of analysis so that I could analyze what the teachers were saying individually, but also look for patterns in the codes highlighting how the teachers interacted with one another. I used a constant comparative analysis during my coding, which involved the development of initial codes, followed by the development of clusters of codes depending on patterns evident in the coded data (Glaser, 1978; Miles & Huberman, 1994; Strauss & Corbin, 1998; Walter & Hart, 2009). As codes were developed and used to analyze these data, I constantly compared the codes with my understanding of communities of practice and the influence of such a community on Sarah's induction into her mathematics department.

Lastly, I used the process of memoing during my data analysis (Charmaz, 2006; Glaser, 1978; Miles & Huberman, 1994; Strauss & Corbin, 1998). Such a process allowed me to write out, to myself, "little conceptual epiphanies" (Miles & Huberman, 1994, p. 74) that I had during analysis, generally during the coding process. Memos provided a way to articulate my thoughts and ideas. From such memos, I was able to better see and describe patterns in the data. Further, I was able to develop and organize my ideas, which I used subsequently in writing this paper.

The above methods were useful in answering each of my research questions. I describe in more detail below how I analyzed the data to answer each question.

Research question 1. My first research question addressed the evidence of mutual engagement, joint enterprise, and shared repertoire in the professional development course. The analyses of these three key components allowed an assessment of the existence of a community of practice within the professional development course.

To answer this question, I first used open coding on the transcripts of the two professional development sessions I had selected for analysis. This open coding involved a quick but thorough analysis of each teacher utterance to develop initial codes pertaining to each key element of communities of practice: mutual engagement, joint enterprise, and shared repertoire (Creswell, 1998; Glaser, 1978; Miles & Huberman, 1994; Strauss & Corbin, 1998). In my initial open coding, I coded for anything that I thought would give insight into the relationships, goals, and tools of the professional development participants. For example, one of my initial codes was Questioning for Understanding. I coded a teacher utterance as Questioning for Understanding if the teacher asked a clarifying question about the mathematics or the task they were working on. Another example of one of my initial codes was Classroom Application. I coded a teacher utterance as such if the teacher mentioned how something from the professional development might relate to something in his/her classroom.

Following my initial coding, I created memos about each element of community of practice, using Wenger's (1998) definitions and characterizations of each element. Using those definitions and characterizations, I identified which of my codes would give insight into each element. I then went back and further analyzed the data for each element in turn by looking for patterns in the data and noting particular episodes that seemed compelling.

In analyzing for evidence of mutual engagement, I focused on the activities of the teachers in the professional development. To show evidence of mutual engagement, I needed to show that the activities the teachers engaged in together were ones in which they could create meaning. This was important because mutual engagement entails not just doing things together, but negotiating the joint enterprise and shared repertoire of the community while participating in the practice of the community. Further, I looked for a bounded nature to the teachers' activities because I needed to identify who was and was not a member of the community of practice. I analyzed their interactions by looking at the participants who were involved and how they interacted with one another. Specifically, I identified which of my codes gave me insight into the activities of the teachers, and the nature of their interactions while doing such activities. This allowed me to identify whether a mutual engagement existed and who the participants of the community of practice were.

In my analysis of the joint enterprise, I focused on codes that would give me insight into the goals of the professional development participants. I identified which of my codes gave me such insight, then analyzed the data for those codes by looking for patterns in what seemed to be motivating the professional development participants' interactions. Further, because the joint enterprise of a community of practice is defined by the participants in the community rather than imposed upon them by some outside force, I looked for evidence that such motivation was either intrinsic or extrinsic for the professional development participants.

Lastly, in analyzing the shared repertoire of the community of practice, I looked for the different ways and means the professional development participants used to interact. This gave me insight into what tools were used by the teachers to accomplish their jointly negotiated goals.

The overall analysis of the data allowed me to answer my research question by showing how mutual engagement, joint enterprise, and shared repertoire were evident among the high school teachers in the professional development course.

Research question 2. My second research question addressed how the elements of a community of practice influenced Sarah's induction into the mathematics department at her school. I used the results of my first analysis of the key elements of the community of practice to answer my second question.

To analyze the data for my second research question, I used the same codes as in my first analysis. I created a matrix with the three aspects of induction along the side, and the three elements of community of practice along the top (see Appendix). To fill in the matrix, I identified which codes for each element of community of practice might give me insight into each aspect of Sarah's induction. I then went back to the transcripts of the professional development sessions, using the codes from my matrix, to identify patterns of whether and how each element of the community of practice influenced each aspect of Sarah's induction. After looking at the professional development transcripts, I analyzed the transcript of Sarah's exit interview using the patterns I had developed. During my analysis, I noticed three common categories in each section of the matrix regarding Sarah's conformance to the system. Each section included ideas about Sarah teaching mathematics, doing mathematics, and collaborating with her colleagues. These ideas seemed to be important aspects of the community of practice, and therefore could also be seen as important to the mathematics department into which Sarah was being inducted. As Sarah was able to demonstrate competency in each of those areas, she and her colleagues could accept Sarah as conforming to important aspects of the system. Therefore, I decided to use those categories to organize my results about how the mutual

engagement, joint enterprise, and shared repertoire influenced Sarah's induction, as shown in

Chapter 5. Overall, I was able to identify how each element of the community of practice

influenced Sarah's induction into the mathematics department at her school.

Chapter 4: Community of Practice Results

The data presented in the previous chapter allow me to answer my two research questions. In this chapter, I address my first research question, which is, *What elements of a community of practice (mutual engagement, joint enterprise, and shared repertoire) are evident in this high school mathematics professional development course?* I argue that all three elements of a community of practice were evident in this professional development course. I discuss the evidences of each element below.

Mutual Engagement

The teachers in the professional development are mutually engaged in the practice of being mathematics teachers at the high school. There are two key (different but related) activities involved in the practice of being a mathematics teacher, and each highlights the mutual engagement of these teachers. The first activity is classroom teaching. The second activity is collaboration. In this section, I discuss how each activity constitutes the teachers' mutual engagement.

Classroom teaching. The main activity the teachers participate in is classroom teaching at their high school. Each teacher comes to the same school for the same hours everyday. These physical boundaries of space and time serve to bind the teachers into a specific group. The other groups in the professional development (facilitators, grad students, pre-service teachers), while they might elsewhere engage in classroom teaching, do not engage in classroom teaching at this school. Further, while engaging in classroom teaching, each high school teacher works under the policies of the same departmental, school, and district administration. This institutional structure also serves as a boundary separating the high school teachers from members of the other groups

(and, specifically, from anyone in the other groups who might also engage in classroom teaching at a different location).

Overall, classroom teaching is the main, foundational activity in which the high school teachers engage. Without their mutual engagement in classroom teaching, the teachers' other interactions, which are based around classroom teaching, would lack substance and would no longer make sense. The practice of classroom teaching is the activity that lays the foundation for their collaboration.

Collaboration. The second activity in which teachers engage is collaboration, or working together to create a common product. The collaboration I found in the data had two different dimensions: participants and content. The participants of the collaboration involved either a mixed group (involving the high school teachers with the pre-service teachers, graduate students, or professional development facilitators) or the high school teachers alone. The content of the collaboration was based either on doing mathematics or on teaching mathematics. This created four different forms of collaboration in which the teachers were engaged: mixed group collaboration about mathematics, mixed group collaboration about teaching, high school teacher collaboration about mathematics, and high school teacher collaboration about teaching.

Mixed group collaboration about mathematics. The first form of collaboration was mixed group collaboration about mathematics. An example of this occurred during the first part of the first session of professional development I analyzed. The high school teachers were working with the pre-service teachers in small groups on the Towers task. During this time, the camera focused on two high school teachers, Justin and David, working with two pre-service teachers, Madison and Kaylee. Over the course of four minutes, the group worked together to ensure they had all the possibilities of towers they could make. Justin started by claiming they

had fourteen different towers, and then asked the group if that was the solution they all agreed on. All four of them then worked to establish a way to verify that they had counted all the towers. Eventually, they realized they needed to organize their towers by composition, making sure they counted all towers with four blue cubes, three blue cubes, two blue cubes, and one blue cube. David concluded by stating, "Sixteen then, instead of fourteen." Kaylee verified by asserting, "We got the one with all four. And then we got the ones with three, and the ones with two, and one." In this example, we see that the high school teachers and the pre-service teachers collaborated about mathematics. Their interaction can be seen as collaboration because they were working together on the mathematical task to create a solution they all agreed on.

Such collaboration was a part of the teachers' mutual engagement. Their work together was bounded by time and space, as they all met at the same time in the same physical location. Additionally, all of the high school teachers participated in such professional development mathematical activities with members of other groups. While the high school teachers were working with members of other groups, so their work was not bounded solely to their group, they all still participated in the same practice of collaboration during this time.

Mixed group collaboration about teaching. The second form of collaboration that was evident was mixed group collaboration about teaching. An example of such collaboration occurred when the teachers worked with the professional development facilitators to discuss the outcomes of the common assessment. In the discussion of common assessments, teachers responded to a question from the facilitators prompting them to share their ideas about their students' performance. The discussion continued among the teachers and facilitators. The groups discussed together what the teachers' concerns were, and possible ways that the teachers could address those concerns in their classrooms. This interaction between the high school teachers and

the professional development facilitators can be considered collaboration because both groups worked together to develop possible solutions for the teachers' concerns.

The teachers' interaction about classroom teaching with other groups further served as a part of the teachers' mutual engagement. As above, their collaboration was bounded by time, space, and group participation. Specific time was set aside each week for the teachers to meet in professional development or other collaboration. The teachers physically met together in the same classroom for each professional development session. Finally, the high school teachers were bound together through their group participation in collaboration. Though they collaborated with different groups throughout the course of the professional development, the high school teachers were the only group present for the entirety of their collaboration about teaching.

High school teacher collaboration about mathematics. The third form of collaboration was high school teacher collaboration about mathematics. As part of the professional development, the teachers worked on several different mathematical tasks together. An example when the teachers collaborated while doing mathematics is shown in the following dialogue, which occurred during small group work on the pizza task. In this transcript, David, Katie, Erin, and Sarah discussed their questions and ideas when doing the pizza task, which asked how many different pizzas could be created from different combinations of toppings and sauces. In this instance, David had a question about how to think about the mathematics of the problem without listing all of the possible combinations.

David:	How can you think about it without writing them all out?
Katie:	What?
David:	I have ninety-six, 'cause I just timesed it by sixteen and I got six, but how can I think about this?
Erin:	So without, without like, doing these? Is that the question?
David:	Yeah. 'Cause-
Katie:	Without doing what?

David:	I could say two different sauces times three different ways times sixteen different-
Sarah:	That's what I did.
David:	I could do two times three times sixteen, which is fine. But how do I do this and get sixteen without writing them all out?
Katie:	That's like a two to the n.
Erin:	Doing the… Or yeah, you could do-
Katie:	This is a row here.
Sarah:	Twenty-four divided by-
David:	Oh my goodness, I see it.

In this transcript, we see how the four individuals worked together to address David's question about the mathematics behind the pizza task. They discussed several different mathematical ideas, including powers of two and Pascal's Triangle (Katie's mention of "a row" referred to a row in the triangle). Eventually, David got his question answered through their collaboration.

In this form of collaboration, the teachers were mutually engaged in the process of doing mathematics and working toward a solution to the task. There were space and time constraints to the teachers' mutual engagement in doing mathematics; the teachers worked on mathematical tasks together during professional development sessions. Further, as above, the teachers were the sole group of people who worked on all of the mathematical tasks that were part of the professional development.

High school teacher collaboration about teaching. The last form of collaboration was high school teacher collaboration about teaching. One striking episode of this type of collaboration occurred during a discussion about worthwhile mathematical tasks. The graduate students were present for the discussion, and were assigned to lead the discussion by asking questions. The discussion, however, included many long, uncomfortable silences. A graduate student would pose a question, followed by a 7- to 10-second silence before a high school teacher would answer, typically mentioning their classroom teaching. The high school teachers would then have a conversation among themselves about the response, almost as if the graduate

students were not in the room. Whenever graduate students interjected comments or questions, conversation again fell silent. This example can be seen as collaboration among only the high school teachers because they were the only ones who were participating in the conversation.

In the above example, and others like it, there was a self-motivated nature to the teachers' collaboration, which helped to bound the teachers in this aspect of their mutual engagement. The teachers seemed to talk more easily when they were discussing their classrooms and when they were conversing with their colleagues. The teachers discussing their own classroom teaching placed a social bound on their collaboration because they alone shared the activity of teaching at that particular school. Further, as seen in the above example, the teachers seemed to converse among themselves with relative ease, but conversation seemed more forced when two different groups of people were conversing. It seems that the teachers were comfortable collaborating on a personally driven level. However, when other groups entered the picture, there was an apparent disconnect between the groups. That is, there was not mutual engagement among all those present during the conversation. Rather, the high school teachers as a specific group were bounded in their collaboration with one another.

Joint Enterprise

In the professional development community of practice, the high school teachers' joint enterprise has two purposes. The first purpose of the high school teachers' joint enterprise is to navigate through each professional development session. The second purpose of their joint enterprise is to apply the professional development to their teaching practice..

Navigating each professional development session. Navigation through each professional development session means the teachers are trying to satisfy the demands of others, such as administrators, facilitators, or other teachers, while still meeting their own needs as

teachers. The teachers all appeared to play the part of a committed mathematics teacher while still staying in their comfort zone. I refer to the idea of teachers trying to satisfy the demands of others as maintaining professionalism. I refer to the idea of teachers staying in their comfort zones and meeting their own needs as enacting self-preservation.

Maintaining professionalism. In trying to navigate through each professional development session, the teachers appeared to want to act professional and play the part of a committed mathematics teacher. In front of professional development facilitators, graduate students, pre-service teachers, and colleagues, they seemed to act professional. Acting professional involves being civil toward others, completing assignments, and participating in required professional development activities. In doing so, the teachers appeared to want to meet the expectations of the facilitators and administrators for how a committed teacher would act.

The teachers' professionalism is evident in the fact that they were civil toward those with whom they interacted. They responded with respect to the questions of others, both professional development facilitators and other faculty. They communicated with their colleagues in ways that were respectful of their opinions and their status. One prime example of this is when the teachers are pressing for justification, but do not press too hard. They are willing to ask another teacher to provide an explanation, but not go so far as to make the other teacher look bad if he/she cannot provide an adequate explanation. For example, when working on the towers task, Justin pressed David for an explanation of the pattern David claimed he saw. Justin seemed genuinely interested in what the pattern was, but when David could not provide an adequate justification of a pattern, Justin did not press him so hard as to make him look bad in front of the whole group.

The teachers acted professionally when they completed assignments for the professional development. At each professional development session, teachers turned in reflections of what changes they were trying to make in their classroom. Additionally, they completed course readings in preparation for whole-group discussion during professional development sessions. Finally, they turned in responses to reflective questions they answered after completing the course readings.

Lastly, the teachers met the expectations of others as they engaged in professional development activities without hesitation. The teachers attended every professional development session, and they arrived on time. As evidenced in the video data, whenever teachers were asked to do something by the facilitators, they did it. Sometimes, the teachers went above and beyond the call of the facilitators by working on required tasks during their break time. They kept conversations centered on professional development or classroom experiences. In the video data, most conversations were relevant to the activities they were working on. There were only two episodes where the conversation did not directly revolve around what they were doing, and those lasted about three turns. For example, in one episode the teachers were working on the pizza task. David remarked that pizza sounded good, and Katie mentioned a deal currently running at a local pizzeria. Following this brief exchange, the teachers continued to work on the pizza task.

Overall, the high school teachers seemed to desire the appearance of being committed math teachers, meeting the norms, policies, and practices of the school at which they taught and the professional development course in which they were enrolled. This qualifies as part of their joint enterprise because it meets the following criteria. Maintaining such professionalism revolved directly around the practice of teaching mathematics. Further, the teachers' desire to appear professional was something that sprung from within and was not imposed on them from

the facilitators. Finally, the teachers' mutual responsibilities/accountabilities were reflective of their joint enterprise as they demonstrated an understanding of what was appropriate to say and not to say (or to do and not to do) when acting professional. For example, as described above, when Justin pressed David about his pattern comment, he appeared to understand not to press too hard because he did not want to make David look unprofessional.

Enacting self-preservation. While trying to meet the expectations of others, the teachers also seemed to act in ways that protected themselves. These teachers had to reconcile the different activities as they saw them in the professional development course with how they saw them as a potential reality in their classrooms. Some teachers expressed legitimate concerns with how the professional development might impact their classroom and the ways they felt comfortable teaching. Other teachers appeared more willing to try new things, but remained cautious toward completely changing the way they did things. In doing so, the teachers protected their own needs and were able to stay in their comfort zones in terms of how they taught in their own classrooms.

One example of this can be seen as teachers explained how the professional development might not apply to their classrooms. For example, in one whole group discussion, the high school teachers and graduate students were discussing the use of worthwhile mathematical tasks in their classroom. Roger described how implementing tasks in his classroom would inevitably lead to students' mathematical tangents that he was not prepared to address. He then argued that he would have to tell his students how to think about the task to meet the intended objective of the lesson, which would be "no better than just telling them how to do it." In this example, Roger expresses a legitimate concern about implementing tasks, a concern that he would not be ready to address his students' tangents and would inevitably end up telling his students how to think

about the task. Roger's concern allowed him to justify that implementing tasks would not be better than telling his students how to do the mathematics, a method of teaching that he seemed more comfortable with. In this and other such examples, the teachers argued, using legitimate concerns, that the professional development might not apply to their classrooms.

Other teachers seemed to view professional development in a different light. They enacted self-preservation in a different way, by describing how the professional development could fit in with what they were currently comfortable doing in their classroom. For example, when discussing the towers task, Sarah remarked that she would have to add several scaffolding questions to the task to bring it to a level that she would feel comfortable giving to her students. She did not completely reject the idea of using the task in her classroom, but rather suggested modifications that would make the task align with her comfort zone in teaching.

There is not complete homogeneity among the professional development participants in how they went about enacting self-preservation. However, they all engaged in different, though all meaningful, ways with the several professional development activities as they navigated through them. All teachers drew connections between the professional development sessions and being a teacher they were comfortable being. This idea is closely related to the section below labeled *Relating professional development mathematics to classroom mathematics*.

Applying the professional development to their teaching practice. The second purpose of the high school teachers' joint enterprise is to apply the professional development to their teaching practice. This means that the teachers seemed to want their time spent to revolve around and have value for their practice. This involves the teachers understanding mathematics, applying professional development mathematics to classroom mathematics, and solving classroom issues.

Understanding mathematics. One way in which the teachers tried to apply the professional development to their practice was by working to understand the mathematics. This part of their joint enterprise is apparent as they engaged with the mathematics and as they worked together to solve the problems. The data is full of evidence that the teachers questioned and explained as they worked on the several mathematics tasks. This includes the instances when teachers questioned for understanding, pressed others for justification, and explained their reasoning.

When questioning for understanding, the teachers questioned each other about the mathematics task on which they were working. For example, when working on the pizza task, Erin and Katie discussed the nature of the toppings ("Does cheese count as a topping?" "No, but extra cheese would, I think.") in order to better understand the task and how they might solve it. These instances, when teachers questioned each other about the task or about the mathematics they are doing, occurred often. This suggests that the teachers truly wanted to understand the tasks and the mathematics behind them, rather than just wanting to put down an answer and be done.

When pressing for justification, the teachers questioned each other about their thinking. When a teacher did not provide an adequate explanation, another teacher would ask questions about or explicitly demand an explanation of his thinking. The most compelling episode of pressing for justification was the episode described above between Justin and David. David said he noticed a pattern, but when Justin asked about it David could not elaborate on the pattern. Justin continued to push David to provide an explanation. This shows that teachers seemed to want to understand the mathematics and the reasoning of others. Like above, this situation

suggests that the teachers did not want to take the answer for granted, but wanted to understand the answer and the mathematics behind it.

Explaining reasoning is an activity teachers participated in constantly while working on and presenting their ideas about the mathematics tasks. When a teacher made a statement about the mathematics, he would also include a statement about his thinking and reasoning. For example, when working on the World Series task, David was explaining his group's thinking to Sarah: "We said it's out of 70 because they're evenly matched and … you can win in four games, you can win in five games, you can win in six games, you can win in seven games. So I, what we did is we added up how many total options there are for winning. Does that make sense?" In this example, David not only told Sarah what his group thought the total should be, but he described how his group thought about it as well. Overall, the teachers explained their reasoning whether they were in small groups or presenting their ideas to the whole group. It is especially compelling to think about their explaining reasoning in the small group discussions. It appears that the teachers wanted to be understood, and knew their colleagues also wanted to understand. The teachers seemed to know what types of justification were important to their colleagues. They explained their reasoning while doing mathematics to help others in the enterprise of understanding mathematics.

Finally, there are some examples of instances that illustrate the teachers' desire to understand the mathematics that do not quite fit in the above categories. Sometimes, during the five- to ten-minute breaks between activities, some of the teachers would continue to work on the mathematics. This seems extremely telling about the teachers' intrinsic desire to understand the mathematics. Two teachers who exemplified this part of their joint enterprise were Sarah and David. In one episode, when the teachers were given a five-minute break, Sarah continued to

work with Bill throughout the five minutes on a piece of mathematics she had been struggling to understand. Another time, Steven came to work with Sarah's group. Before he sat down, Sarah told him not to tell her the answer because she wanted to figure it out for herself. These two instances illustrate Sarah's apparent inner desire to understand the mathematics and not just find the answer. Finally, during a whole-class discussion, David was working on an extension of a task, remarking that, "Steven was making me think of a harder one." This instance suggests David's willingness to work beyond the constraints of the task, demonstrating that he really is interested in doing the mathematics. All of these examples show how understanding mathematics was something seemingly desired by the teachers, not imposed upon them by some outside force, and therefore truly is their own enterprise.

Relating professional development mathematics to classroom mathematics. Another way the teachers tried to apply the professional development to their teaching practice is they drew connections between the mathematics they were doing in the professional development and the mathematics their students did in the classroom. Such connections included ways in which the professional development mathematics either would or would not work well in the teachers' classrooms.

An example of a teacher discussing how the professional development mathematics would work well in her classroom was Erin, who noted the merits of using the linking blocks with the towers task. In a whole-group discussion, she referenced how the linking blocks helped her to "see the patterns and be able to count them," then went on to say that "having manipulatives helps make mathematics more accessible to students." She argued that a student would be able to use the linking cubes to make every possible tower and know that he had the

correct answer. In this instance, it appears that Erin is relating her use of the linking cubes with how her students might also use them to be successful with the task.

An example of when a teacher discussed how the professional development mathematics would not work well in her classroom was also Erin, who cited a lack of time for teaching specific curricula as a hindrance to implementing tasks in her classroom. She noted that the teachers, in working on the several tasks, "were going off on all these tangents" that they found interesting. She then argued that, while such thinking and exploring can be beneficial for students, the lack of time and the need to cover specific topics made such tangents "something that we don't necessarily want in our classroom." In this instance, Erin is relating her mathematical experience in the professional development with perceived constraints of her mathematics classroom.

In several different episodes, the teachers made statements relating the mathematics of the professional development to the mathematics their students might experience in the classroom. These statements served to illustrate how the professional development mathematics either would or would not work well in the teachers' classrooms.

Solving classroom issues. Finally, the teachers tried to make the professional development applicable to their teaching practice by addressing classroom issues. Teachers in the professional development would use professional development discussions to both seek and provide answers to classroom issues.

An example that shows a teacher seeking an answer and another teacher providing a possible solution occurred during the whole-group discussion of the common assessment. Roger noted that his students seemed to struggle with the notation for, rather than the actual concept of, inverse trigonometry functions. He was concerned that when he "tried to explain using the

inverse sine notation, then [his students] got lost." In this instance, Roger described an issue he had in his classroom, and it appeared he was seeking answers for how to address such an issue. Following this remark, Erin posed a possible solution to Roger's issue. She suggested that when introducing the unit circle with sine and cosine, Roger might also introduce inverse sine and cosine to his students. Erin also remarked that her students did well on that portion of the common assessment, and then suggested that it might have been due to her use of the notation "for so much of the unit." In this instance, we see how Erin suggested a way for Roger to address his classroom issue.

Seeking answers and providing solutions to classroom issues directly revolved around the teachers' practice of classroom teaching. As they collaborated about their classroom teaching, this enterprise emerged naturally. Further, it belonged to them solely; it was not the result of some institutional mandate, but rather the teachers sought and gave these answers because they were trying to fulfill their own needs in classroom teaching.

Shared Repertoire

For the high school teachers in the professional development, sharing the practices of classroom teaching and collaboration meant they developed a shared repertoire for negotiating these practices. Their shared repertoire consisted of several different tools, the most evident in the data being stories, common assessments, and mathematical justification. In this section, I describe each of these elements of their shared repertoire.

Stories. Throughout the professional development sessions, the teachers told stories of classroom occurrences. The teachers seemed to be fluent in this genre of communicating, and they used it in much of their discussion. The teachers' stories related both negative and positive events that occurred in their classroom. Often, the negative events were a tool the teachers used

to help communicate about a classroom issue for which they were seeking an answer. For example, in a whole-group discussion Erin voiced her concern of student dependence on calculators, which she illustrated with the story of a student who could not determine the slope of a line without a calculator. The positive events the teachers related were often used as a way for teachers to highlight an answer for other teachers' classroom issues. For example, Sarah described a success she was having with students presenting their work in her classroom. She related a story about a student who would often volunteer to present his thinking because he claimed that working in front of the class, with their input as he worked, was a way for him to understand his mistakes and fix them.

Sharing these stories was a way for the teachers to relate to each other, and, therefore, further served to bound the community of practice. Because the teachers were mutually engaged in the unique practice of mathematics classroom teaching at that particular school, their stories about that teaching further served to set them apart from the other groups in the study. Additionally, the use of stories was evident in the teachers' joint enterprise. It appears that stories were a way for the teachers to maintain professionalism with their colleagues. Sharing stories was a genre which all of the teachers demonstrated ability to use. As they shared stories of their classrooms, the teachers could effectively illustrate classroom issues or solutions to such issues. Overall, the shared repertoire included stories as a useful tool for teachers to illustrate their concerns and satisfactions about classroom teaching.

Common assessments. Another tool that the teachers used as part of their community of practice was the common assessment. As requested by their administration, the teachers created and discussed common assessments as part of their professional development course. To create the common assessments, the teachers brought previous tests and homework assignments to use

as resources. After they had administered the test to their students and graded it, the teachers discussed what concerned them, what pleased them, and what surprised them about their students' performance on the assessment.

Because the teachers had communally constructed the common assessment, and had administered the assessment to their students, their familiarity with the assessment allowed it to be a useful tool. This part of their shared repertoire gave them talking points for their collaboration. A main discussion included in the data I analyzed was the teachers' discussion of their students' performance on the assessment. Additionally, many of the teachers used their students' performance on common assessment questions to illustrate issues they were having with student misconceptions. Therefore, the discussion of the common assessment highlighted the teachers' joint enterprise of seeking answers to classroom issues.

Mathematical justification. Lastly, the teachers used the tool of mathematical justification as a part of their practice. The teachers would provide explanations of their mathematical ideas as a part of their collaboration while doing mathematics. If an explanation was not provided, other teachers often pressed for justification. It appears that the teachers understood the need for justification, and were fluent in providing acceptable justification to their colleagues.

Mathematical justification was used as a tool in the mutual engagement of the community of practice as teachers collaborated while doing mathematics. Much of their collaboration included asking questions of and explaining to one another. Further, the tool of mathematical justification was used in the teachers' joint enterprise of understanding the mathematics. This part of their shared repertoire catered directly to the teachers' pursuit of explaining their reasoning and pressing for justification.

Conclusion

Overall, a community of practice appears to have formed among the high school teachers in the professional development course. The teachers' mutual engagement, joint enterprise, and shared repertoire all appeared in the data gathered from professional development sessions.

Chapter 5: Induction Results

The data collected and the results from my first research question allow me to answer my second research question, which is, *What influence do the three key elements of the community of practice have on a beginning teacher's induction?* As described earlier, induction into the system involves both conforming to the system and transforming the system. In this chapter, I discuss the influence of the professional development community of practice on both aspects of Sarah's induction.

Conforming to the System

In this section, I describe how Sarah's participation in the professional development community of practice influenced her conformance to the mathematics teaching system at her school. Conformance to the system has two facets: acceptance by members of the system, and Sarah seeing herself as a part of the system. While the data do not allow an examination of the entire mathematics teaching system at the school, we can look closely at how Sarah's colleagues, who are members of the system and of the community of practice, have opportunities to accept Sarah as part of the system. In all of the instances I analyzed, conforming accepted by Sarah's colleagues and conforming accepted by Sarah herself were co-exhibited. Therefore, I have consolidated evidence for both types of conformance into one section. In each instance, Sarah's colleagues, as well as Sarah herself, can recognize Sarah's practices as consistent with those of the system. Both parties can then accept Sarah as being a part of the mathematics teaching system.

While analyzing Sarah's conforming to the system in light of mutual engagement, joint enterprise, and shared repertoire, three common themes emerged for how Sarah might be accepted by her colleagues and herself. Through the elements of the community of practice,

Sarah demonstrated her competency as a teacher, as a doer of mathematics, and as a colleague. Through demonstrating each of these competencies, Sarah could be accepted by the members of the mathematics department and by herself. I describe instances of each below.

Competent teacher. Through her interactions as part of the professional development, Sarah was able to demonstrate to herself and to her colleagues that she had attributes of a competent mathematics teacher. Characteristics of a competent mathematics teacher that were apparent in the data included such abilities as preparing and executing good lessons, assessing student strengths and weaknesses, and addressing student needs. In the following examples, we see how the mutual engagement, joint enterprise, and shared repertoire of the community of practice allowed Sarah to demonstrate such abilities to herself and to her colleagues.

Demonstrating competency through mutual engagement. The professional development teachers' mutual engagement involved classroom teaching and collaboration, both of which were instrumental in Sarah's demonstration of competency in this area. Classroom teaching was the main vehicle that drove Sarah's ability to demonstrate her competence as a teacher, because it allowed her to have teaching experiences that she later discussed during her collaboration with colleagues.

When the teachers collaborated with each other, they often focused their collaboration around their classroom teaching. In these discussions, when Sarah shared her own thinking and experiences, she was often met with agreement or praise from the other teachers. For example, Sarah shared her observation that when she does not spend enough time thoughtfully preparing lessons, she has to spend that time with students later "fixing their mistakes on the [lessons where she] just kind of threw the formulas at them." She described how she would rather spend time "building learning" rather than fixing mistakes. Katie responded, "Yeah, I agree with that.

That's happened to me, too." In this episode, Katie validates Sarah's teaching experience by saying the same thing has happened to her. In a different episode, Sarah shared her thinking about how to use worthwhile mathematical tasks with her students, to which Roger replied, "I really like this idea of trying to get them…to ask, like Sarah said, the really cool questions." This shows that Roger accepts Sarah's idea about using tasks in classroom teaching. Overall, there were repeated instances in the data where Sarah's ideas were supported by her colleagues' comments.

Through these collaborative discussions among the high school teachers, which existed as a result of the mutual engagement of the community of practice, Sarah's colleagues were able to hear her thoughts about and experiences with mathematics teaching. As we see in the above examples, her colleagues expressed agreement with or praise for Sarah's ideas. They never expressed disapproval of her comments. It appears, therefore, that Sarah's colleagues accepted Sarah's thoughts and experiences about teaching as valid.

Additionally, through collaboration of the high school teachers about teaching, Sarah was able to voice her agreement with other teachers' thinking about or experiences with classroom teaching. In one instance, during a whole-group discussion with the graduate students, Erin related her thinking about developing classroom routines so students know what to expect and can feel comfortable. Sarah commented that she was going to "say something very similar," then went on to describe her gradual increase in expectations for her students throughout the course of the school year. Sarah agreed with other teachers' comments several times throughout the course of professional development discussions.

The collaboration among the teachers also allowed Sarah to see and accept herself as having valid thoughts about and experiences with mathematics teaching. She was able to hear the

verbal praise and acceptance from her colleagues. A statement she gave in her exit interview reveals that those supportive comments helped Sarah to accept her own competency in teaching. In the exit interview, she was asked how the professional development experience influenced how she viewed mathematics teaching and learning. She responded that the experience "made some of [her] beliefs about mathematics teaching firmer, … just to hear that a lot of people agree with [her]." She stated, "A lot of my beliefs were … reinforced by a lot of the other teachers that have been teaching for awhile, so I'm thinking maybe I do have an idea of what's going on." These statements by Sarah highlight the acceptance she felt as part of the professional development, and how such acceptance influenced her thoughts about herself. Overall, all of these experiences, when other teachers would agree with Sarah or vice versa, would likely not have occurred without the mutual engagement of the community of practice.

   Demonstrating competency through joint enterprise. The joint enterprise also influenced Sarah's demonstration of teaching competency. Part of the teachers' joint enterprise was their need to apply the professional development to their teaching practice, which included relating professional development mathematics to classroom mathematics, as well as solving classroom issues. Both of these aspects allowed Sarah and her colleagues to recognize and accept Sarah's teaching competency.

   In one compelling episode, which will be used several times throughout this chapter, the teachers were involved in a whole-group discussion about worthwhile mathematical tasks. Courtney asked a question about implementing worthwhile mathematical tasks in the classroom, and Sarah responded with her own insights. The transcript of their interchange is given in Table 3 on the following page.

Table 3

Courtney's Problem

Speaker	Line
Courtney:	Yeah. Like this task took us over two hours, right? That's probably at least two class periods for our students and do we really have two class periods after they've learned this material, or trying to teach this material, to go through something like this? Like, how do you create a task that takes a small enough amount of time and leads them the direction you want them to go and keep them focused on even something mathematical 'cause most of, at least the students in my class, you give them something like this and tell them they have their own time, and they're not doing anything to do with math at all and they're not working on the task, period. So how do you implement it in your classroom and get them to work? … So, you know, how can you make one that's good enough to achieve what you want to achieve in a short enough amount of time that does keep the students fully engaged in mathematics, which I don't know if that's possible for all students, but at least most of them, and be able to apply it into a classroom setting?
Sarah:	I have a couple, I don't know, 'cause, like, I'm not, like, awesome at this by any means, but like- 'Cause I'm trying to find a good balance between these tangent ideas and these ideas in my classroom and stuff and I think what, like, in my opinion, I think what it all comes down to is really knowing where your students are mathematically. Like, these tasks that we did today isn't something I would ever give as is to my students.
Courtney:	Right.
Sarah:	But the thing is, because of where we were mathematically, they engaged us for this long. So you have to, like, come up with things that maybe your students mathematically are within their reach and they feel are within their reach but at the same time are something that's getting them thinking. I also know that a lot of times like in my Geometry class, my students are really starting to ask some really cool questions like, well, we defined parallel lines as lines that don't touch. So then they asked if two hyperbolas were parallel and stuff like that. And I think it's okay every once in a while, if you're giving these tasks and getting them thinking, you as a teacher need to know where you want the math to go. Like, do I go down this path, or do I just tell them, guys, that's really good mathematics, it's called hyperbolic geometry, we just can't talk about it. I wish we had time, but we can't talk about it. You know, and I think if you're getting math to come out, then you'll have these students that are so excited and you feel bad, but you're like, hey, we can't, we just don't have time to go there. But at the same time, every once in a while, someone will come up with something that's really awesome and worth all the time that was spent on it. I also think that in your classrooms, especially- I know that what I'm trying to do in my Algebra 2 is I maybe go like halfway of how open I want my tasks to be. I have to give it, like, a little bit more structure, just to make sure that in the allotted time they can get there. I still try and make them open, but I usually make them a little bit more structured than I may want to give them.

Courtney asked a question about the feasibility of implementing tasks given the time constraints of the school year and the variability in her students' abilities. She was trying to see how she could apply the mathematics of the professional development to the mathematics her students would do. Sarah responded to Courtney's question by discussing how she would still use the task idea as given in professional development, but would modify it before using it with her students. In providing this solution to Courtney's question, she highlighted the importance of developing tasks that are "mathematically within [students'] reach." Following Sarah's remark, Diane responded that she "really like[d] what Sarah said."

In this episode, we see Sarah offering advice to help answer Courtney's question. Sarah's advice included a practical way to use the professional development mathematics in her own classroom. The joint enterprise is evident as the teachers in this example sought answers to classroom problems and looked for ways to make the professional development applicable to their classroom teaching. Because Courtney did not offer an argument to Sarah's suggestion, it appears that she accepted Sarah's idea as a valid answer. Further, Diane's response is indicative that she, too, accepted Sarah's suggestion. We can speculate that through this example, and those similar to it, Sarah's colleagues had opportunities to recognize Sarah's ability to apply the professional development to her teaching.

Similarly, it appears that Sarah also had opportunities to recognize and accept her own competencies through the same experiences. When other teachers posed questions about their classroom issues or concerns, Sarah was able to provide solutions. Therefore, it appears that she recognized her own ability to provide answers to questions about classroom teaching. Further, the other teachers never voiced disapproval of Sarah's ideas. Rather, her ideas were met with praise from her colleagues. Because of this praise, we speculate that Sarah had the opportunity to

recognize her own ideas as valid. Further, both she and her colleagues could recognize Sarah's ability to address the joint enterprise of the community of practice by providing solutions to classroom issues.

   Demonstrating competency through shared repertoire. Lastly, the teachers' shared repertoire included stories and common assessments. Sarah's ability to communicate with stories, combined with her familiarity with the common assessment, allowed her to demonstrate her competence as a classroom teacher.

   In the following discussion of the common assessment, Sarah was an active teller of a story that was constructed by many teachers:

Sarah:	They couldn't find an angle.
Roger:	Yes.
Erin:	Even, like, they couldn't isolate the trig.
Sarah:	They couldn't isolate the trig.
Erin:	Even if it was isolated, they didn't know what to do with it.
Roger:	A lot of kids came up to me and said, like, What does this mean?
Sarah:	Yeah. I've never seen this before, and I'd be like, Oh gosh, you've seen that before.
David:	You smile like, you should have asked me on the review. I can't help you now.

In this discussion of the common assessment, the teachers told a common story about their students' struggles. As a teller of the story, Sarah contributed just as well as any other teacher. None of the other teachers stopped her or declared her contributions invalid. Rather, they built on what she said to continue the story.

   The shared repertoire elements of stories and common assessments both contributed to Sarah's demonstration of competent teaching. The teachers' familiarity with the common assessment questions allowed them to discuss their students' performance. Their use of the story genre allowed them to construct together a story about their common experiences. In this example, Sarah was able to use the medium of story-telling to contribute to the discussion.

Because her colleagues allowed Sarah's submissions into their co-constructed story without rejection, it appears they accepted her ideas as valid. Similarly, Sarah could see herself that her comments added to the story and she was not met with rejection. We can speculate that she, too, was able to recognize and accept her own ideas as valid. Overall, through shared stories about the common assessment, the teachers in the professional development were able to find common ground and recognize common experiences, leading to further recognition and acceptance of Sarah's abilities as a teacher.

Competent doer of mathematics. Through her interactions, Sarah was also able to demonstrate her competency in doing mathematics. Such competency involves actions such as asking questions about mathematics, working to solve mathematical problems, and explaining mathematical thinking, all of which were exhibited by Sarah in the data. Again, the mutual engagement, joint enterprise, and shared repertoire of the professional development community of practice facilitated these opportunities for Sarah to demonstrate her competence to herself and to her colleagues.

Demonstrating competency through mutual engagement. The teachers' mutual engagement included their collaboration while doing mathematics. Through this collaboration, Sarah was able to demonstrate her competency as a doer of mathematics.

Several examples of this occurred when Sarah, Jessica, and Courtney were working on the Towers task together. As they discussed their ideas, Sarah would often present her thinking to the group. If her ideas were correct, the others would provide positive feedback such as "Uh-huh" or "Yeah, that's right." Occasionally, Sarah would offer ideas or conjectures that were incorrect. If Sarah's ideas were incorrect, she would either correct herself, or the other teachers

would kindly explain her error to her. None of the teachers made disapproving comments about Sarah's incorrect thinking.

Through their collaboration on mathematical tasks, the teachers, including Sarah herself, were able to recognize Sarah's thinking as consistent with that of one doing mathematics. Because the other teachers responded to Sarah's correct ideas with positive comments, it appears that they accepted her thinking as valid. Further, because they did not criticize Sarah's incorrect ideas, we can speculate that either they recognized making small errors is inherent in doing mathematics, or they judged her errors to be the type that doers of mathematics occasionally make. Finally, Sarah could see the other teacher's acceptance and respectful treatment of her own ideas. It seems reasonable to assume that Sarah could interpret her own successes on the tasks and the acceptance by others of her mathematical participation as strong evidence that she is a competent doer of mathematics. Overall, the teachers' collaboration while doing mathematics provided a forum for Sarah to demonstrate to her colleagues and herself that she was a competent doer of mathematics.

Demonstrating competency through joint enterprise. In the teachers' pursuit to make the professional development applicable to their teaching practice, they worked to understand the mathematics. Doing so provided Sarah with the opportunity to demonstrate her mathematical competency to both her colleagues and herself.

In two different situations, Sarah's desire to understand the mathematics was apparent. In the first example, Sarah had worked hard to prove algebraically that the sum of two consecutive numbers in Pascal's Triangle is equal to the number between and below the two numbers on the triangle. After she completed her work, she remarked to her group, "I'm pretty sure I just did it. Not gonna lie. I'm a genius. I did it!" Later, she remarked to one of the professional development

facilitators, "I proved it algebraically. I'm very proud of myself." The facilitator responded positively, then said he thought that was a useful explanation that Sarah's group could provide to the whole group.

In a second example, Sarah was very confused by an idea presented by another group. She made a statement very clearly expressing her confusion: "I don't know. I think that this, because it's powers of two, that's what's telling us that there's two colors, but I don't really know. I really don't know. It's this binary thing that they were talking about, but I don't really understand. I don't understand binary." In this statement, and others in which Sarah admits confusion, her lack of understanding did not have any hint of despair or giving up on understanding. Rather, her tone alluded to a curiosity and willingness to come to an understanding. It appears that she was not afraid to admit her weakness to herself or to her colleagues. Furthermore, her colleagues did not respond to her admission with disdain, but used it as a cue to help her come to an understanding.

In the teachers' desire to understand the mathematics, Sarah was a key participant. She persisted in working on problems, even if her lack of understanding was an obstacle. In these instances, both Sarah and the other teachers could recognize Sarah's competency in doing mathematics. In the first instance, where Sarah worked hard and succeeded on her algebraic proof, she demonstrated to herself and to others that she was capable of using mathematics and developing a logical algebraic argument. Further, everyone was able to see Sarah as willing to persevere through problems while doing mathematics. Because the professional development facilitator remarked that Sarah's argument was useful, it seems reasonable to assume that the other teachers also thought her argument was helpful. Further, Sarah's proud exclamations about her own success indicate that she recognizes her own ability to do mathematics. In the second

instance, where Sarah expresses confusion and curiosity about a mathematical concept, we see that her colleagues do not respond negatively to her confusion. Rather, they tried to help her understand the concept. It appears that they recognized the type of confusion that Sarah was expressing over this problem as consistent with being a competent doer of mathematics. Similarly, because the tone of Sarah's comments alluded to curiosity and willingness to learn, we can speculate that she, too, recognized her own confusion but persisted in trying to understand the mathematics.

Demonstrating competency through shared repertoire. Lastly, the teachers' shared repertoire included mathematical justification. Sarah used mathematical justification with her colleagues, thereby demonstrating her competency in doing mathematics.

In her mathematical interactions with the other teachers, Sarah was constantly providing mathematical reasoning and justification to back up her statements. For example, Sarah presented her algebraic proof (described above) to the whole group as a justification for why the sum of two numbers in Pascal's Triangle is equal to the number between and below them in the triangle. After Sarah's presentation, Katie presented to the group. Katie remarked in her presentation that she "could use Sarah's thing" to add to her own explanation.

The ability to construct and critique logical mathematical arguments is an important part of doing mathematics. In the above example, we see how Sarah was able to successfully engage in mathematical justification. Because Katie referred to Sarah's justification to add to her own explanation, it appears that other teachers recognized Sarah's ability to create sound mathematical arguments. Similarly, by seeing other teachers accept her work, Sarah could also recognize her own competency at mathematical justification.

Competent colleague. Finally, Sarah's involvement in the professional development allowed her to demonstrate to herself and to those she worked with that she was a competent colleague. Being a competent colleague involves the ability to work well with others by contributing and working toward solutions. The mutual engagement, joint enterprise, and shared repertoire of the professional development community of practice allowed Sarah to collaborate with her colleagues, provide solutions to classroom issues, and participate in valuable discussions.

Demonstrating competency through mutual engagement. Through their mutual engagement in the professional development, the high school teachers participated in collaboration with one another, either about mathematics or about teaching. This collaboration provided a setting wherein Sarah was able to demonstrate her ability to contribute valuable ideas to group discussion.

A good example of Sarah's ability to contribute occurred during a whole-group discussion about implementing tasks in the classroom. Sarah contrasted her positive experiences implementing tasks with her negative experiences "throw[ing] the idea at [her students]." She noted that when she used tasks to build her students' understanding, her students would retain and be able to apply that understanding for much longer than if the students simply "drilled and memorized." This idea seemed to resonate with several other teachers. Roger thought it was "a really good example," and continued to ask Sarah more questions about the lessons that she thought went really well. Such contributions from Sarah were common in the professional development course, and she once noted that she was aware she talked a lot during discussions.

In the above example and in other collaboration, it is apparent that Sarah is not hesitant to share her ideas with her colleagues. From Roger's response, it appears that he valued Sarah's

ideas enough to validate them and ask for more details. Sarah's contributions were never met with rejection or hostility, so we can speculate that the other teachers also accepted Sarah's contributions as a valuable part of their collaboration. In the same vein, Sarah could see that she was never met with rejection, and so she continued to contribute to discussion. It seems reasonable to assume that her continued contributions indicate that she recognized her own ability to add to the teachers' discussion.

Demonstrating competency through joint enterprise. Part of the teachers' joint enterprise was their desire to make the professional development applicable to their teaching practice by seeking answers for and posing solutions to classroom issues. In professional development discussions, Sarah provided solutions to her colleagues' questions, and was thereby able to demonstrate her ability to work toward solutions.

One compelling instance when Sarah provided answers to classroom issues is shown above in Table 3, *Courtney's Problem.* In this example, Courtney did not reject Sarah's idea. Furthermore, following their interchange other teachers even agreed with Sarah's contributions. Several such instances, when Sarah provided answers to classroom issues, occurred in the data.

In this example, we again see Sarah's willingness to contribute to group discussion. Because Courtney did not verbally disagree with Sarah, we can infer that she saw some validity to Sarah's contributions. Further, the other teachers agreed with Sarah's comment. We can reasonably assume, because of their agreement, that they viewed Sarah's contribution as a valuable response to Courtney's question. Similarly, Sarah could see her own comments being accepted by the other teachers, and we can speculate that she, therefore, could have accepted her own comments as valid. Overall, the community's joint enterprise of seeking answers to

classroom issues highlighted Sarah's ability to provide valuable contributions and work toward solutions with her colleagues.

Demonstrating competency through shared repertoire. Lastly, the shared repertoire of the community of practice influenced how Sarah demonstrated her competency as a colleague. The two elements of the shared repertoire through which she demonstrated her competency were stories and the common assessment.

A prime example of Sarah's demonstration of competency was described above, when the teachers were discussing their students' performance on the common assessment. In this example, Sarah was a key contributor to a story co-constructed by several of the teacher. Her additions only served to build and further the story, and she was not met with rejection from the other teachers.

In this example, we see how Sarah was able to contribute to the group story-telling without being stopped or disapproved. Her ability to use the story-telling genre, paired with her knowledge of the common assessment, allowed her to contribute to the discussion as well as any of the other teachers. Because she was not stopped, and continued to contribute, it appears that both Sarah and her colleagues recognized her willingness and ability to discuss important and applicable things such as the common assessment.

Overall, the mutual engagement, joint enterprise, and shared repertoire of the community of practice certainly influenced Sarah's conformance to the school mathematics teaching system. Each element had an impact on the ways in which Sarah's colleagues, as members of the mathematics teaching system at the school, could recognize and accept Sarah as being a part of the system. Similarly, each element influenced the ways in which Sarah herself was able to accept herself as being a part of the system.

Transforming the System

The final aspect of Sarah's induction involves the way in which she transforms the school mathematics teaching system. In this section, I describe how her participation in the professional development community of practice influenced her transformation of the mathematics teaching system at her school. This occurred in two key ways: the influence she had on the professional development, and the influence she had on her classroom.

Influencing the professional development. Sarah's participation in the professional development community of practice allowed her to influence what was discussed in the professional development sessions. Sarah was a key contributor to professional development discussions as she was not hesitant to offer her thoughts. Her comments would often drive the conversation toward a particular topic, or keep the conversation on a particular topic that she seemed to value.

One exemplary whole-group discussion, *Courtney's Problem,* depicted in Table 3 above, showed how Sarah could both steer the conversation in a particular direction and keep the conversation centered on that topic through her comments. While Courtney's initial question had a skeptical tone, Sarah immediately responded with some ideas about how to successfully use tasks with her students. David and Diane made subsequent comments to support Sarah's initial response. Following this, Sarah made another comment describing two very different outcomes as a result of teaching two different ways. She highlighted the positive experience of using worthwhile mathematical tasks with her students, discussing how it helped her students to better retain and apply the information. She contrasted that with the negative experience she had when she simply told her students about the concept or formula. In the latter situation, when students "drilled and memorized," their performance on subsequent assignments and assessments

suffered. While several teachers seemed to agree with Sarah's statement, Roger in particular seemed very interested and used it to drive further conversation. He continued to ask Sarah several questions about what the different lessons were about and how she used tasks. Later in the conversation, Sarah discussed how using tasks with her students elicited thought-provoking questions from them. Roger remarked, "I really like this idea of trying to get them…to ask, like Sarah said, the really cool questions."

In this example, we see how Sarah drove the conversation away from Courtney's skepticism to highlight the positive aspects of using worthwhile mathematical tasks. In subsequent comments, Sarah and her colleagues kept the conversation centered on the successful use of tasks in the mathematics classroom. David and Diane shared Sarah's positive outlook about tasks, and often made comments to support her. However, it is compelling to note that Roger, who often seemed curious about tasks but not completely committed to using them in his classroom, also kept the conversation focused on the positive aspects of tasks. Overall, we see how Sarah was able to drive the conversation in a certain direction with one comment, and keep the conversation focused on that topic with subsequent comments. Further, her comments did not receive pushback from other teachers; rather, the other teachers who commented seemed supportive and interested. Several such instances of Sarah influencing the discussion during professional development sessions were evident in the data.

Sarah's opportunities to influence the direction of professional development discussion were made possible by the mutual engagement, joint enterprise, and shared repertoire of the community of practice. The mutual engagement of the participants involved their collaboration with one another. Their discussions occurred during the set-aside time for professional development, both in structured whole-group discussions (such as discussing the required

reading from the previous week) and less structured small-group discussions (such as groups working on solving mathematical tasks). These conversations between Sarah and her colleagues would not have occurred without the context of the professional development collaboration.

The joint enterprise of the community of practice included the teachers' need to make the professional development applicable to their teaching practice. Their pursuit of applying the professional development to their classroom as well as solving classroom issues allowed the above conversation, and those similar to it, to unfold. Sarah related the ideas from the discussion to events from her actual classroom in an effort to make their discussion valuable and applicable. She used her experiences to illustrate how tasks could enhance student understanding and limit students' struggles with memorization and retention. In these ways, she was able to shed positive light on using tasks in the classroom, thereby steering the direction away from Courtney's skeptical question. Without these key motivators of the teachers' joint enterprise, these types of conversation likely would not have existed in the professional development.

Finally, the shared repertoire of the teachers in the community of practice included sharing stories. This was a genre that Sarah understood and could use as a member of the community of practice. She often used stories to illustrate a point she was trying to make in a discussion. In the above example, we see Sarah sharing stories about her, and her students', experiences with two different types of lessons. Her stories allowed her to convey the idea that the amount of time spent preparing and implementing tasks was equivalent to the amount of time spent doing "damage control" after lecturing, with the added benefit of greater student retention when tasks were used. Therefore, the shared repertoire of the community of practice provided a medium through which Sarah was able to influence the direction of the professional development discussions.

Influencing her classroom. Sarah's participation in the professional development community of practice also allowed her to influence what occurred in her own classroom. Her participation impacted how she handled outside pressures on her classroom, specifically those from the professional development facilitators and administration. Working on mathematical tasks and creating common assessments were both required of Sarah in the professional development, and it was expected that she use them in her classroom. The joint enterprise of the community of practice gave Sarah the bargaining power to modify both before actually using them with her students.

Modifying tasks. Through the community's joint enterprise, Sarah had the power and flexibility to modify mathematical tasks to meet the needs of her students. An important component of the professional development course was doing mathematical tasks. The professional development facilitators thought that the tasks they gave the teachers were good, not only for the teachers themselves, but also for the students in their classes. We can speculate that, in the absence of the teacher's joint enterprise, the facilitators might have insisted that the teachers use the exact same tasks in their classrooms. However, the facilitators most likely recognized the collective bargaining power the teachers had negotiated for themselves in their joint enterprise. The teachers had a common pursuit of self-preservation, as well as a need to make the professional development applicable in their own classroom. They would have pushed back if the facilitators had insisted on anything that threatened this enterprise. Therefore, it seems consistent that the teachers were not required to give their students the exact same tasks they did in the professional development course.

We can clearly see this power and flexibility in action in the following example. The teachers were discussing together the idea of worthwhile mathematical tasks. Sarah remarked

that the tasks the teachers had worked on as part of the professional development were not "something [she] would ever give as is to [her] students." In this statement, the "as is" indicates that Sarah would want to modify the tasks to fit the needs of her students. She went on to say that she would want to develop tasks that are "mathematically within [students'] reach" but that also make them think and ask good questions. In these statements, we see that Sarah used the negotiated need for self-preservation to maintain a level of control over the task. Additionally, she worked to apply the professional development mathematics to her actual classroom in a way that would fit her classroom needs. Overall, we see that Sarah had the flexibility to transform the tasks, thereby influencing her classroom, as a result of the joint enterprise of the community of practice.

Modifying the common assessment. The community's joint enterprise also afforded Sarah the power and flexibility to create and modify a common assessment to meet the needs of her classroom. The school administration had mandated that the mathematics teachers give their students a common assessment. However, as described above, the teachers had negotiated a joint enterprise that gave them some power and flexibility over what occurred in their classrooms. The administration could not, therefore, mandate all of the specifics of the common assessment. The teachers would have pushed back if this had occurred. Rather, the administration allowed the teachers to construct the common assessment together in the professional development course. Therefore, the teachers had a direct influence on what questions were on the common assessment. The teachers also had flexibility in how they implemented the common assessment in their classrooms.

In particular, through the power granted by the joint enterprise, Sarah had the ability to transform the common assessments to meet the needs of her students. While the math department

had to create common questions to give to their students, Sarah was allowed the flexibility to modify the actual test before administering it to her students. She was allowed to add questions of her own to the test to assess things that she felt were important, and she did. She was also allowed to determine how the test would be used in calculating student grades, which she also did. Because the teachers had negotiated their own pursuit of making the professional development applicable to their teaching practice, Sarah had the power to make such changes and thereby transform what occurred in her classroom.

Overall, we see how the mutual engagement, joint enterprise, and shared repertoire of the community of practice impacted the way in which Sarah was able to influence both her colleagues and her classroom. Her participation in the professional development community of practice allowed her to both conform to the system and transform the system as part of her induction process.

Chapter 6: Conclusion

This study addressed the formation of a community of practice in a professional development course, and its associated influence on the induction of a first-year mathematics teacher. In this section, I give a brief overview of the results of my study. I then identify contributions my study makes to mathematics education research and practice. Finally, I describe the limitations of my study along with future directions that might be taken in this area.

Overview

My study addressed two key questions. The first was what elements of a community of practice were evident in the professional development course. The second was how those elements influenced the induction of Sarah, a first-year mathematics teacher in the professional development course.

Elements of a community of practice. I argued that all three elements of a community of practice were evident in the high school teacher's professional development course. The teachers' mutual engagement consisted of their classroom teaching and their collaboration. Their collaboration included mixed group or teacher only collaboration about teaching or about mathematics. A joint enterprise was also evident as the teachers attempted to navigate through the professional development and apply the professional development to their teaching practice. The teachers' navigation through each professional development session included their need to maintain professionalism and also to enact self-preservation. To make the professional applicable to their teaching practice, the teachers worked to understand the mathematics, relate the professional development mathematics to their classroom, and solve classroom issues. Finally, the high school teachers developed a shared repertoire of tools. These tools included stories, the common assessment, and mathematical justification.

Community of practice influencing Sarah's induction. I also argued that Sarah's induction into the school mathematics teaching department at her school was influenced by her participation in the professional development community of practice. Both Sarah's conformance to the system and transformation of the system were impacted. I examined Sarah's conformance to the system by focusing on three different competencies that she demonstrated. As Sarah showed competence in teaching, doing mathematics, and working as a colleague, both she and the other teachers in the department could accept Sarah as part of the mathematics teaching system. Sarah's involvement in the professional development community of practice also influenced her transformation of the system. Through her participation, she had the opportunity to transform the discussion in professional development as well as the tasks and assessments she used in her classroom.

Contributions

This study makes contributions to the fields of mathematics education research and practice. As described in the introduction and framework of this paper, such a study adds to research on the professional development of beginning mathematics teachers. Further, this study has implications for the education of mathematics teachers.

Contributions to mathematics education research. This study was driven by the fact that many beginning mathematics teachers struggle during their first years of teaching. My study contributes to sociocultural research on beginning mathematics teachers. It also adds to research about mathematics professional development.

My study contributes to the research on beginning mathematics teachers framed in a sociocultural viewpoint. Much of current research on the struggles faced by beginning mathematics teachers has approached such struggles from a cognitive viewpoint, focusing only

on what the teachers know (Ball, 1990a, 1990b, 1991; Borko et al., 1992; Shulman, 1986). However, I argued that a sociocultural viewpoint might be better suited to such a situation, as beginning teachers are entering and trying to fit in to a well-established system. This study addressed Sarah's induction using the lens of a community of practice. A sociocultural viewpoint allowed me to identify specific elements of the community of practice, and how Sarah's participation in the community of practice was beneficial to her induction. For example, collaboration among the high school teachers was a part of their mutual engagement. Sarah's ability to participate in such collaboration influenced her conformance to the system. Overall, using a sociocultural viewpoint, I was able to identify elements that were specific to the system into which Sarah was being inducted. Then I was able to examine how Sarah acted and interacted within that specific system.

This study also adds to current research about mathematics professional development. Specifically, my study extended the idea presented by Blanton and Stylianou (2009) that a professional development course can foster a community of practice. Using the community of practice framework introduced by Lave and Wenger (1991) and Wenger (1998), I examined in-depth how each element of a community of practice was present in the mathematics teachers' professional development course. I then used that examination to show how each element supported each aspect of Sarah's induction. These results show that viewing professional development as a community of practice can give insight into the impact of the professional development on its participants. Examining what elements of a community of practice are present in a professional development course can lead to further analysis of how each element (or the lack thereof) influences the participants' interactions with one another.

Contributions to mathematics education practice. This study also has implications for the practice of mathematics education. Both mathematics professional development designers and beginning mathematics teachers can benefit from the results of this study.

Mathematics professional development designers might use the results of this study to design a course in which a community of practice could likely form. In Chapter 4, I analyzed the development of a community of practice in a specific professional development course. In Chapter 5, I argued that the mutual engagement, joint enterprise, and shared repertoire of that community of practice supported Sarah's induction. Therefore, to support the induction of other new teachers, professional development designers might consider implementing a course with the same characteristics as seen in my study. That is, the course would be extended over a period of time. This would allow time for a community of practice to develop among the participants. Also, the teachers in the course would work together on activities that were relevant to mathematics teaching. In particular, professional development designers might want to include activities such as reading current publications about learning and teaching mathematics, then subsequently discussing the reading. Another activity might be to do mathematical tasks, then discuss the big mathematical ideas that emerged from doing such tasks. Such activities would be directly related to the teachers' practice of classroom teaching, and would allow for a mutual engagement, joint enterprise, and shared repertoire related to the practice of mathematics teaching. For example, my study showed how the collaboration of all the teachers about mathematics and about teaching was beneficial to Sarah's induction. To foster a mutual engagement of collaboration about teaching, or a joint enterprise of relating the professional development to the classroom, or a shared repertoire of sharing stories, professional development designers might include discussing classroom practices or classroom issues as an important

activity in their course. To foster a mutual engagement of collaboration about mathematics, or a joint enterprise of understanding mathematics, or a shared repertoire of mathematical justification, professional development designers should include the activity of doing mathematics as part of their course. While the exact same mutual engagement, joint enterprise, and shared repertoire might not form in each course, through careful design mathematics professional development designers might expect that a community of practice could form among the participants in the course.

Beginning mathematics teachers can also benefit from the results of this study. Such teachers might use my conceptualization of teacher induction consisting of conformance to and transformation of the system. The teachers could consciously consider how they might see themselves as a part of the system, or what resources they might use to transform the system. Further, such teachers could seek out professional development or collaboration opportunities similar to those described in this study. In this study, we saw that an important aspect of the professional development was that it involved all of the teachers at the high school collaborating together. Therefore, beginning mathematics teachers might look for professional development opportunities that allowed them to collaborate with all of the other teachers at their school about mathematics or about teaching, or both. If no such opportunities exist, teachers could lobby for such professional development courses to be offered at a school or district level.

Limitations and Future Directions

Lastly, this study has limitations that open up avenues for future research. Two of the main limitations of this study involve the scope of what was studied. First, I analyzed only a small part of the whole mathematics teaching system into which Sarah was being inducted. I focused specifically on Sarah's induction into the mathematics department at the high school.

This focus allowed me to make some claims about how the community of practice influenced Sarah's induction. However, to narrow the scope of my research to the level of a Master's thesis, I did not analyze Sarah's induction in terms of other groups comprising the system, such as students, administrators, or the community. To develop a more complete view of how a professional development community of practice might influence a beginning teacher's induction into the school mathematics teaching system, future research might focus on other groups of people who comprise the system.

Second, my study focused only on one professional development course and how it influenced the induction of one specific teacher into one department at one school. Future research might be done to analyze more professional development courses in terms of communities of practice. A collection of such research might lead to a better understanding of specific aspects of professional development that could foster a community of practice. Further, more research about beginning mathematics teachers' induction, focusing on more teachers at more departments and more schools, could create a more complete understanding of how a professional development community of practice influences the induction of a beginning mathematics teacher.

Overall, my study has important implications for mathematics education research and practice. I have shown how viewing professional development as a community of practice can be useful for analyzing the interactions among professional development participants. Specifically, I have shown how such research is beneficial for examining the induction of beginning mathematics teachers. My study opens up new avenues for research about professional development and its associated impact on beginning mathematics teachers.

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Appendix: Data Analysis Matrix

The following matrix was used in the analysis of my second research question. In each section on conformance, I saw ideas about teaching mathematics, doing mathematics, and collaborating with colleagues.

<table>
<tr><td></td><td></td><td colspan="3" align="center">Community of Practice</td></tr>
<tr><td></td><td></td><td>Mutual Engagement</td><td>Joint Enterprise</td><td>Shared Repertoire</td></tr>
<tr>
<td rowspan="3">Induction</td>
<td>Conformance Accepted by System</td>
<td>Classroom Teaching

Collaboration about Teaching: Validating, Classroom Application

Collaboration about Mathematics: Explaining Reasoning, Validating</td>
<td>Maintaining Professionalism

Understanding Mathematics: Pressing for Justification, Explaining Reasoning, Questioning for Understanding

Relating Professional Development Mathematics to Classroom Mathematics

Classroom Issues: Seeking Answers, Posing Solutions</td>
<td>Sharing Stories: Positive Stories, Negative Stories, Agreeing with Stories

Mathematical Justification: Explaining Reasoning, Pressing for Justification, Validating</td>
</tr>
<tr>
<td>Conformance Accepted by Individual</td>
<td>Classroom Teaching

Collaboration about Teaching: Validating, Classroom Application

Collaboration about Mathematics: Explaining Reasoning, Validating</td>
<td>Enacting Self-Preservation

Understanding Mathematics: Pressing for Justification, Explaining Reasoning, Questioning for Understanding

Relating Professional Development Mathematics to Classroom Mathematics

Classroom Issues: Seeking Answers, Posing Solutions</td>
<td>Sharing Stories: Positive Stories, Negative Stories, Agreeing with Stories

Mathematical Justification: Explaining Reasoning, Pressing for Justification, Validating</td>
</tr>
<tr>
<td>Transforming the System</td>
<td>Classroom Teaching

Collaboration</td>
<td>Solving Classroom Issues</td>
<td>Sharing Stories

Common Assessments</td>
</tr>
</table>