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Identities in Practice: Relating Identity and Instructional Practices among Middle Grades Mathematics Teachers

A Dissertation
Presented for the
Doctor of Philosophy
Degree
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Thomas Edward Hodges
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DEDICATION

This dissertation is dedicated to Jennifer, my wife. Over the last three years she has cared for our first son Tyler, given birth to our second son, Carson, and worn more hats as an insurance agent, house manager to eleven teenage girls, and personal counselor to me – all to support my efforts to earn a Ph.D. She is truly a remarkable person and without her unending support I would not have been successful. The end result is a degree that is shared among every member of our family.

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ABSTRACT

This qualitative case study documents the identities of four middle grades mathematics teachers and the influences of those identities on their instructional practices. Three sources of data were collected: interviews, observations, and the Scoop Notebook (Borko et al., 2005). Wenger's (1998) characteristics of identity provided the framework for data analysis. This view of identity aligns with situative views of learning and provided an analytic lens that allowed a focus on the development of a mathematics teaching identity in relation to the communities in which teachers participate. Both within-case analyses and a comparative analysis across contexts were conducted. The within-case analyses indicated that the perceived alignment of goals, values, and beliefs for mathematics instruction between each of the communities is an important element of developing a reform-minded identity. The comparative analysis indicated that several differences in the schools played an important role in this identity formation, including school size, socioeconomic status of students, the existence of a school-based professional teaching community, and the role of the teacher in making curriculum decisions. Three areas of teachers' identities were reflected in their instructional practices: (1) teachers' preparations for mathematics instruction, (2) teachers' views of the role of the student, and (3) teachers' use of curriculum materials and discourse as pedagogical tools. Results indicated the need for professional development to carry a dual focus on increasing teachers' knowledge and skills while also attending to promoting reform-minded views at a school and district level. Ongoing opportunities for teachers to participate in a professional teaching community appear to be an important catalyst for these changes.

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CHAPTER I

Introduction

Despite significant efforts to transform instructional practices in mathematics classrooms, the considerable changes called for in reform documents have yet to take place (Braswell et al., 2001; National Commission on Mathematics and Science Teaching for the 21st Century, 2000; National Research Council, 2001; Stigler & Hiebert, 1999). Research on changing instructional practices suggests that the process is dynamic and subject to the contexts of teachers' work (Apple & Jungck, 1992; Senger, 1999). Thus, the difficulties in transforming mathematics teachers' instructional practices suggest that efforts to improve instruction not only must focus on individuals' practices, but also the contexts in which these practices take place. Likewise, understanding the construction of teachers' identities requires more than observing teachers' instructional practices as a result of their professional development experiences; it involves a view of identity as situated within classrooms, schools, and districts. Despite the fact that teachers seem to work in relative isolation, instructional practices are distributed across multiple individuals, including state and district curriculum coordinators, district and school level administrators, other mathematics teachers, and students (Cobb, McClain, Lamberg, & Dean, 2003). Yet, the collection of individuals that influence the ways in which teachers instruct students may not have similar visions of what it means to teach and learn mathematics, nor the same ideas about what is needed to improve student achievement. Therefore, teachers are often left with conflicting ideas about what it means to be a mathematics teacher within the context of their classroom, school, and district.

Recent efforts to improve mathematics instruction and coordinate the work of policymakers, administrators, and teachers have focused on the development of standards for mathematics teaching and learning. The publication of the *Curriculum and Evaluation Standards for School Mathematics* by the National Council of Teachers of Mathematics (NCTM) in 1989 set the stage for the publication of the *Professional Standards for Teaching Mathematics* by NCTM in 1991 and the *Assessment Standards for School Mathematics* by NCTM in 1995. States followed suit with their own sets of content standards that often mirrored those developed by NCTM. Given the increased pressure on schools with newly implemented performance-based accountability, these standards were seen as a way to delineate learning goals for students by:

1. Creat[ing] a coherent vision of what it means to be mathematically literate both in a world that relies on calculators and computers to carry out mathematical procedures and in a world where mathematics is rapidly growing and is extensively being applied in diverse fields.
2. Creat[ing] a set of standards to guide the revision of the school mathematics curriculum and its associated evaluation toward this vision. (National Council of Teachers of Mathematics., 1989, p. 1)

Additionally, educational reformers knew that improving student achievement meant more than developing new curricula based on the standards; improving student achievement would depend as well on the professional development of teachers and administrators (Ball & Cohen, 1999; Sykes, 1999). Sykes stated that the view of professional development as a catalyst for educational improvement is fairly new and derived from educational research, policy changes, and the increased commitment to improving the education of all.

Professional Development as a Catalyst for Change

While a consensus may exist as to the need for professional development to meet the vision of the Standards documents, the nature of the opportunities for growth remains under criticism. Ball and Cohen (1999) noted that many professional development opportunities impose a one size fits all mentality and consist of one time sessions and workshops that intellectually limit teachers' opportunities to learn about curriculum, students, and teaching. More recent formulations (e.g., Ball & Cohen, 1999; Borasi & Fonzi, 2002; Sykes, 1999) yield a new set of goals for professional development activities, goals that show promise for creating lasting change in teachers' instructional practices as well as improved student achievement. These goals were summarized by Sowder (2007) and include:

1. Developing a shared vision (e.g. the *Principles and Standards for School Mathematics* (NCTM, 2000) outlines a vision of what students should know and do)
2. Developing mathematical content knowledge
3. Developing and understanding of how students think about and learn mathematics
4. Developing pedagogical content knowledge
5. Developing an understanding of the role of equity in school mathematics
6. Developing a sense of self as a mathematics teacher

To meet these ambitious goals for instruction, teachers need sustained opportunities to develop new knowledge and skills as well as new ways of thinking about what it means to learn, teach, and do mathematics (Borko & Putnam, 1995). However, despite advances in the ways professional development can be used as a catalyst for improving instruction, research regarding the influences of professional development on teachers' instructional practices and their views of

mathematics teaching and learning has largely taken place independent of the contexts where teachers' instructional practices actually take place, including the organizational features of schools and districts (Franke, Carpenter, Levi, & Fennema, 2001). Thus an analytic view that situates the ways professional development is interpreted and implemented within the contexts of teachers' own classrooms, schools, and districts may serve to inform why reform oriented instructional practices take hold in some teachers' classrooms and not in others.

Instructional Practices in Relation to Communities of Practice

These ideas regarding professional development as a catalyst for change and the influences local contexts play on teachers instructional practices suggest that researchers also need a different methodology to examine why teachers do and do not implement instructional practices suggested in professional development. In her recent address at the annual meeting of the American Educational Research Association, Deborah Ball argued for an approach to educational research that focuses on "understanding the dynamic interactions among teachers, students, content, and environments" (Ball & Forzani, 2007, p. 538). To understand these dynamic interactions in the contexts of teachers' instructional practices, researchers have begun to draw on perspectives that treat individual cognition as socially and culturally situated (Cobb, 2007). Whereas cognitive approaches focus on the ways in which individuals reorganize and develop new forms of knowledge, situative perspectives focus on the ways in which people participate within established cultural practices and the ways in which individuals perceive themselves within communities (Greeno & the Middle School Mathematics through Applications Group, 1998; Lave & Wenger, 1991). Studying the multiple communities in which teachers engage (including districts, schools, classrooms, and professional development) is often

problematic in attempting to understand teachers' identities as communities can serve to constrain and/or afford teachers' access to certain forms of pedagogical reasoning, including teachers' knowledge and beliefs about teaching mathematics. However, a situative view specifically focuses on the culture and context in which individuals participate and the ways in which opportunities for change align with the values, goals, and beliefs of certain communities.

Within situative perspectives, identity is accounted for by analyzing how individuals engage in social and cultural activities. Changes in the ways people participate in cultural activities, such as teaching, involve the transformation of roles and the development of new identities that are linked to new knowledge and skills (Kazemi & Franke, 2004). The development of identities is strongly linked to learning in that "learning is about becoming as well as knowing" (Nasir, 2002, p. 219). Evidence of a shift in identity occurs as individuals become more knowledgeable, thus yielding new ways of participating in a community and new identity in relation to the community. Furthermore,

[a]s individuals come to participate in cultural practice, they negotiate an identity that is part of what they have come to view as consistent about themselves in their lives, part of what they perceive to be available to them in their practice, and part how they are perceived by others. (Nasir & Hand, 2006, p. 467)

While identity is a focus in mathematics education research, the field has yet to adopt an agreed upon singular definition (Gee, 2000; Sfard & Prusak, 2005). Yet, from a situative perspective, the concept is useful in that it allows the researcher to focus attention "on human beings in action and on the mechanisms underlying human action" (Sfard & Prusak, p. 14). Additionally, identity is central to participation as it is linked to individuals' access to certain forms of knowledge, ideas, and ways of reasoning, as well as individuals' ability to participate in various communities (Diversity in Mathematics

Education Center for Teaching and Learning, 2007). A situated view of identity includes individuals' views of themselves, the ways others view them, and the negotiation of these various views to their positions in communities. The notion of identity in practice recognizes the ongoing negotiation between individuals and social structures, capturing the histories and practices of communities and the trajectories of individuals as they adapt practices within local communities (Diversity in Mathematics Education Center for Teaching and Learning, 2007).

Equally important are the aspects of these identities that are relatively consistent across communities. The elements of one's identity that appear stable denote important core features of an individual that span many situations and contexts. Gee (2000) referred to this as a core identity – “whatever continuous and relatively ‘fixed’ sense of self underlies our contextually shifting multiple identities” (Gee, 2001). Not only does the notion of a core identity allow for a focus on consistencies across contexts, but also inconsistencies in relation to the goal, values, and beliefs of particular communities. Thus, observing consistencies and inconsistencies through a situated view of mathematics teachers' identity helps to understand differences in the local and global construction of what counts as effective mathematics teaching, what it means to be a mathematics teacher, and the role professional development experiences might play in supporting this identity construction.

Statement of the Problem

Many studies exist (e.g., Birman, Desimone, Garet, Porter, & Yoon, 2002; Carpenter, Fennema, Franke, & Levi, 2001; Hill & Ball, 2004) that measure teacher learning as a result of

professional development activities. These studies take a cognitive approach and focus on increasing mathematics content, pedagogical content, and general pedagogical knowledge, as well as shifting teachers' beliefs about students, teaching, and learning. Furthermore, some of these studies investigated the aspects of professional development content that teachers are able to incorporate into their instructional practices.

On the other hand, another body of literature exists (e.g., Senger, 1999; Stein & Brown, 1997; Stein, Silver, & Smith, 1998) that utilizes situative approaches to highlight the strong influence school and district contexts have on teachers' instructional practices. Studies using situative perspectives have utilized the communities of practice framework, focusing on characteristics of communities, and/or a focus on the individual in terms of his/her shifts in participation within these established communities as a measure of teacher learning (Cobb, 2007; Cobb et al., 2003). However, research that characterizes how teachers reconcile the views presented in professional development with the contexts of their classroom, school, and district communities is limited. In addition, the characterization of how teachers mediate the tension created from their core identities regarding mathematics teaching with the constraints of the institution, classroom, or professional development is sparse.

The few lasting effects of reform efforts in schools underscore the divide between analyses that focus on school and district constraints and those that focus on the effects of professional development (Engestrom, 1998). Thus, an analysis that determines the effectiveness of professional development provided to support teacher learning by focusing on the ways in which teachers use curriculum materials in the context of their own classrooms (Ball

& Forzani, 2007) may narrow the divide between professional development and local constraints in both the research literature and the contexts of teachers' work.

Purpose Statement

Research in mathematics teacher education indicates the highly contextual nature of implementing reform practices (Carter, 1990; Drake, Spillane, & Hufferd-Ackels, 2001; Lampert & Ball, 1998; Wood, Cobb, & Yackel, 1991) and the importance of developing site-based teacher communities (Cobb et al., 2003; Franke & Kazemi, 2001b; Grossman, Wineberg, & Woolworth, 2001; Kazemi & Franke, 2004; Little, 2002; Stein et al., 1998). Thus, a view of identity as situated within classroom, schools, districts and professional development, as well as the interactions between people and tools within these communities, provides a systematic view of the development of a mathematics teaching identity. The difficulties in understanding the process of incorporating the instructional strategies suggested in professional development become palatable when the analytic lens is shifted to a situated view of identity, bringing into focus both the individual teachers and the communities which influence their work. Thus, the purpose of this study was to examine mathematics teachers' identities within their district, school, classroom, and professional development communities in relation to their core identities as mathematics teachers, connecting these identities to their instructional practices.

Research Question

To address the purpose of the study, I ask the following questions:

1. How are teachers' core identities reflected in and how do teachers' core identities contribute to their participation in professional development (online courses), district, school, and classroom communities

2. How are teachers' instructional practices consistent/inconsistent with their identities as mathematics teachers?

Significance of the Study

To address the research questions, I used a theoretical construct developed by Wenger (1998). Wenger used a company of insurance claims adjusters to outline the constructs of identity, community, and practice. In Wenger's view, identity narrows the focus to individuals, but in relation to their practices within communities. Identity in terms of teachers, then, includes individuals' ability or inability to construct meaning from participation in professional development and school-based communities and the forms of belonging within those various communities. Chapter II outlines in greater detail Wenger's construct for identity in terms of mathematics teachers.

Understanding the formation of teachers' identities yields insight into their access to certain forms of pedagogical reasoning. Research using Wenger's (1998) notion of identity may better characterize why some teachers are able to incorporate instructional practices suggested during professional development activities and others are not. The importance of such a focus is two-fold: (1) mathematics teacher educators (MTEs) need to understand the complex endeavor of implementing the new ideas suggested in professional development effectively, as well as MTEs role in bringing about change in schools and districts regarding mathematics instruction; and (2) the use of a situative perspective in research regarding mathematics teachers' identity is limited, yet a situative perspective provides a characterization of individual teacher's learning and their implementation of reform oriented instructional practices that may help to understand

why some teachers implement reform oriented instructional practice suggested in professional development and others do not.

Limitations

This qualitative study utilized a case study approach to inquiry, thus the results are limited in their generalizability. Given the emphasis on interview data, participants may limit their remarks to predominantly positive aspects of participation in the professional development program. Additionally, I had an existing relationship with the participants through teachers' work in the professional development program and ongoing professional development activities in the district that may influence outcomes related to the study. Participating teachers have been promised confidentiality but not anonymity, thus possibly influencing interview data.

Delimitations

This qualitative study included seven middle grades mathematics teachers who completed four blended format (i.e. online synchronous, online asynchronous, and face-to-face) courses in one professional development program within a rural, Southeast United States school district. While I have made efforts to triangulate data related to classroom practice, characterizing their classroom practice is limited to observations, a collection of artifacts from practice, and interview descriptions. Thus, their selection of artifacts may deviate from typical classroom instruction. Additionally, the dates and times participating teachers select for classroom observations may not accurately represent typical instructional practices. Since teachers who participated in the professional development program are the focus of the study, other

stakeholders' perspectives (e.g., those of students, principals, parents, other teachers) are not included in the study.

Definition of Terms

For clarity, I define the following terms for use in the context of this study.

Community of practice

Communities of practice are “groups of people who share a concern or passion for something they do and learn how to do it better as they interact regularly” (Wenger, 2008, para. 1). Communities of practice are defined by three characteristics: a joint enterprise, mutual engagement, and a shared repertoire of resources to utilize in practice (Wenger, 1998).

Identity

In this study I consider identity to be individuals' views of themselves, the ways others view them, their perceptions of how others view them, and the negotiation of these various views to individuals' positions in communities of practice. Identity is not static, but rather an ongoing negotiation between individuals and communities. Identity captures the trajectories of individuals as they participate in local communities and adapt practices within these communities (Diversity in Mathematics Education Center for Teaching and Learning., 2007). Attention to identity focus on individuals, but does so from a social perspective (Wenger, 1998).

Beliefs about mathematics teaching and learning

Beliefs are psychologically held understandings, premises, or propositions about mathematics teaching and learning that are thought to be true (Philipp, 2007). Beliefs about mathematics teaching and learning involve teachers' views regarding the use of calculators and other technological tools, drill and practice, collaborative activities, applications of mathematics,

students' role in learning mathematics, and what constitutes mathematical understanding in teachers' classrooms. While cognitive, beliefs are less consensual than knowledge of mathematics teaching and learning (Phillip). Beliefs are an aspect of identity since they are formed through participation in communities of practice.

Reform practice/ Reform oriented mathematics teaching

“A comprehensive approach to mathematics instruction that is centered on teaching for understanding and enabling students to engage with meaningful problems and ‘big ideas’ in mathematics. This approach is characterized by a set of beliefs and theories about what counts as significant mathematics, how students learn and what conditions call such learning in a classroom environment, as articulated in the NCTM Standards (1989, 1991, 1995, 2000) and much of the current literature in mathematics education” (Borasi & Fonzi, 2002, p. 9).

Instructional practices

While teaching practices include aspects of teachers' work such as grading papers, supervising students, and taking attendance, instructional practices are a specific subset of teachers' practices that center on the actions teachers take within their classroom that directly involve the teaching and learning of mathematics. These actions include the classroom level procedures, teaching tools and materials, *sociomathematical norms* (Yackel & Cobb, 1996), pedagogical strategies, and assessment instruments and techniques used in teaching students mathematics.

Organization of the Study

This study is organized into six chapters. Chapter I provides an introduction to the study, including the statement of the problem, purpose of the study, significance of the study,

limitations and delimitations, and definition of terms. Chapter II includes a review of literature related to a situated view of mathematics teachers' identities. Given the importance of the communities in which teachers form this identity, I also included research on situated views of mathematics teacher identity in professional development settings since all participating teachers completed a two-year professional development program. Next, I describe the influence of local communities on mathematics teachers' identities and instructional practices. To conclude the review of literature, I contrast traditional and reform oriented mathematics teaching. Chapter III describes the case study approach to inquiry. Additionally, this chapter includes the sites and samples used and the strategy for their selection, a reflexivity statement, data collection procedures, data analysis procedures, and strategies I used to ensure validity. Chapter IV contains the within-case analyses of the selected cases, while Chapter V contains a comparative analysis across each of the contexts. Finally, Chapter VI includes a brief summary of the study, recommendations for future research, theoretical and empirical implications, and final conclusions.

CHAPTER II

Literature Review

A mathematics teacher's identity and instructional practices are highly influenced by the contexts of their work. Characterizing the identities that mathematics teachers have in relation to these contexts calls for a view of identity as situated within their work as mathematics teachers and based upon their participation in the communities within the scope of teachers' work. Several contrasting images of identity exist in the research literature; therefore, Chapter II begins with a description of some of these contrasting views and follows with an argumentation for a view of identity that mirrors the aspects of practice as defined by Wenger (1998). Wenger's view of identity focuses on the individual, but in relation to the individual's participation in communities of practice. Therefore, a critical aspect of one's identity includes the professional communities in which they engage. As a result, Chapter II includes an argument for Wenger's view of identity by discussing professional development designs that situate learning within mathematics teachers' work, since all participating teachers in this study were members of a professional development community that sought to situate their experiences in professional development within the context of the classroom. This section on professional development designs focuses specifically on two central elements: (a) the use of tools and artifacts in support of mathematics teacher as an indication of shifting instructional practices, and (b) the use of cases of mathematics instruction to support reflective analyses of classroom practice. These elements are central since because both situate professional development within the context of the classroom.

Wenger's notion of identity focuses on the multiple communities to which teachers belong. Therefore, this literature review moves beyond teachers' professional development communities to describe the influences of teachers' school and district communities on their instructional practices, including formal and informal sources of assistance, as well as the constraints and affordances related to institutional design and expectations. A focus on communities calls attention to the ways in which teachers must reconcile their personal goals, values, and beliefs with the goals, values, and beliefs of each of the communities to which they belong.

Shifts in the ways teachers participate in communities which focus on improving mathematics instruction involve the development of new identities. These new identities are linked to new ways of teaching mathematics (Kazemi & Franke, 2004). Therefore, the pedagogical choices teachers make provide concrete images of the identities they hold. Both the Scoop Notebook and observation protocol (see Chapter III for greater detail on the methodology) used in this study focus on the extent to which reform oriented practices were evident in participating teachers' classrooms, providing evidence of the development of new identities connected to reform oriented mathematics teaching. Therefore, this chapter includes a comparison of traditional and reform oriented instructional practices. To make this comparison, Chapter II contrasts traditional and reform oriented views of teaching and concludes with a diagram of the relationships between mathematics teachers' identities and beliefs, the communities in which they participate, and the instructional practices they take in the classroom.

Views on Mathematics Teacher Identity

Several non-converging views of mathematics teacher identity exist in the literature (Gee, 2000; Sfard & Prusak, 2005). While the perspectives taken by researchers interested in identity can be viewed along a continuum from highly cognitive to sociocultural accounts, I will use one distinction to categorize these non-converging views. Cognitive or traditional views consider an identity as *acquired* through life experiences, whereas situative views of identity consider identity to be an ongoing *negotiation* between the individual and their participation in social settings. Thus, the difference might center on the extent to which the individual has agency in the construction of their identity. Since cognitive views focus on the acquisition of an identity, the individual has little agency in who they become, whereas in situative accounts individuals have considerable agency as they negotiate an identity in specific contexts.

Traditional views often define identity as an “amalgamation of self-concept, self-understanding, and evaluating oneself in relation to others” (Nasir, 2002, p. 217). While this perspective on identity does take into account the social context, it does so through a view that locates identity within the individual, with the social context acting as an outside influence. Recently, however, more attention (e.g., Gee, 2000; Sfard & Prusak, 2005; Van Zoest & Bohl, 2005) has been given to views that incorporate a more complex picture of who an individual is in relation to participation in communities. Using sociological accounts of identity, researchers are able to highlight multiple identities that individuals develop as they participate in varying ways in social situations. Yet, these views on identity do not exclude the role the individual plays in this identity formation. In fact, there is an ongoing negotiation of identity between the individual and the social contexts in which they participate. The following paragraphs highlight several

recent studies that utilize various views of mathematics teacher identity. Additionally, two views of identity (Hodge, 2006; Van Zoest & Bohl, 2005) are highlighted that utilize Wenger's (1998) notion of identity.

Wenger (1998) described identity as “a constant becoming” that characterizes who we are by:

the ways we participate and reify ourselves; our community membership; our learning trajectories (where we have been and where we are going); reconciling our membership in a number of communities into one identity; and negotiating local ways of belonging with broader, more global discourse communities. (p. 149).

This notion of identity highlights the individual within their practices, emphasizing the importance of what individuals know and believe in the process of developing these identities. In Wenger's view, the process of learning is linked to identity through new ways of belonging and being within a community of practice. Conversely, Drake et al. (2001) focused on identity as a “sense of self” captured through life stories. In their view, teachers' identities were socially constructed in practice, but were restricted to the ways in which they characterize themselves as learners and teachers of mathematics through stories of mathematics teaching and learning. The researchers suggested these stories provided insight into how teachers view and make sense of their work as mathematics teachers. The mathematical teaching and learning experiences shared by these teachers led the researchers to categorize the teachers as *turning point* teachers, *failing* teachers, or *roller coaster* teachers with regards to their experiences in mathematics teaching and learning. The turning point teacher had mostly negative experiences in mathematics, but recently described positive experiences in mathematics. The failing teacher had exclusively negative experiences in mathematics, while the roller coaster teacher had alternating positive and

negative experiences in mathematics. Furthermore, these authors noted a strong relation between beliefs and identity, focusing almost exclusively on the teachers' beliefs and dispositions towards mathematics teaching and learning.

Collopy (2003) built on Drake et al. (2001) in defining identity to be the “constellation of interconnected beliefs and knowledge about subject matter, teaching, and learning as well as personal self-efficacy and orientations toward work and change” (p. 289). In this sense, Collopy's and Drake et al.'s characterizations of identity might best represent a view of identity held within the individual, taking into account social aspects that influence the individual. Thus the studies conducted by Collopy and Drake et al. constitute a view of identity not as *negotiated*, but as *acquired* through life experiences. This predominantly cognitive view of identity fails to capture the dynamic aspects of individuals' participation in the practices of teaching in which the teacher is shaped and is being shaped by their participation in communities of practice (cf. Wenger, 1998).

Within situative perspectives, the process of belonging to a community of practice involves the development of identities that are linked to the knowledge, skills, and beliefs made available by the community. Changes in identity can be accounted for by shifts in the ways individuals participate within established communities of practice (Lave & Wenger, 1991; Wenger, 1998). As Lave (1996) stated, “crafting identities is a social process, and becoming more knowledgeably skilled is an aspect of participation in social practice . . . who you are becoming shapes crucially and fundamentally what you ‘know’ ” (p. 157). Kazemi and Franke (2004) used this view to characterize the development of mathematics teachers' identities and the learning across a workgroup of elementary teachers. This workgroup of teachers met to discuss

children's mathematical thinking, bringing samples of student work to the workgroup sessions. Researchers observed these workgroup sessions, specifically focusing on teachers' engagement with student work. In analyzing teachers' engagement, Kazemi and Franke attend to two areas of shifts in participation and denote those shifts as evidence of teacher learning. Namely, they noted changes in ways teachers attended to the details of student thinking and changes in teachers' instructional trajectories for mathematics. While their focus was on shifts across the workgroup and not on that of individual teachers, the authors conjectured that their findings regarding shifts in participation provided evidence of the kinds of identities that teachers may be forming through their discussions.

To provide a complete view of identity, we must take advantage of both individual and group level analyses that focus on social participation. Thus a view of identity that provides a dual focus on both the individual and their social arena may provide a more complete characterization. The development of identities related to mathematics teaching occur in many different contexts including professional development, university coursework, their own K-12 experiences as students, as well as the classroom in which they teach. Considering the contexts of teacher learning is one important aspect to understanding their process of becoming a mathematics teacher. Yet, attending to the broader community fails to capture individual teachers' patterns of participation in learning activities across multiple communities (Borko, 2004).

In attempting to capture both individual and social aspects, Sfard and Prusak (2005) take a narrative view of identity which consists of stories, consisting of two subsets: *actual identities* (actual state of affairs) and *designated identities* (anticipated state of affairs). In this sense,

designated identities consist of the trajectories that mathematics teachers take and work to achieve. In other words, designated identities define what counts as success and failure. Thus, learning, from this perspective, consists of “closing the gap” between actual identities and designated identities. Through this narrative view, Sfard and Prusak were able to equate identity building with storytelling. Yet, they used these stories differently than the stories generated in Drake et al. (2001). Drake et al. created static images of three mathematics teachers based upon their life stories, categorizing teachers based upon their experiences of successes and failures as teachers and learners of mathematics. Conversely, Sfard and Prusak developed characterizations of immigrant mathematics students that focus on the “kind of person” they are and the extent to which they belong to specific communities, combined with their anticipated belonging to communities. The authors’ goal in doing so was to create a definition of identity that was “operationalized” – an element the authors were critical of in Wenger’s view of identity.

Despite the criticism, Wenger’s situative view of identity has been used in mathematics education research. For example, Hodge (2006) drew on Lave and Wenger’s (1991) characterization of learning as shifts in participation. In this sense, individuals develop an identity as they participate in the practices of a particular community. Hodge used this view to describe students’ participation in mathematics classrooms as evidence of the identities students develop as doers of mathematics. An analogy for teachers then would be the ways in which they participate in various communities, including the classroom, school, and possibly professional development communities as evidence of their identities as mathematics teachers. Additionally, Hodge drew on Wenger’s (1998) notion of identity as partially constituted by the ways in which individuals reconcile their participation in various communities, noting it as a relational view of

identity. As individuals come to participate in the practices of a particular community, they bring with them an identity that may be contradictory to the practices of the new community. Thus, their identity influences the ways in which they participate in the new community and consequently the ongoing formation of a new identity (Hodge, 2006). Although her work centered on students in mathematics classrooms, I draw on Hodge's relational view of identity as an aspect to mathematics teachers' situated identities. In particular, I draw on her relational perspective of identity as the critical aspect of creating a *nexus of multimembership* (Wenger, 1998) between teachers participation in professional development, district, school, and classroom communities. In particular, this study focuses on the ways in which teachers' identities are consistent across contexts and the teachers, reconciliation of competing goals, values, and beliefs across each community.

Van Zoest and Bohl (2005) also utilized Wenger's view of identity, but in contrast to Hodge, focus on Wenger's modes of belonging in communities of practice – imagination, engagement, and alignment. Imagination includes an individual's view of themselves, the world, and their images of the past and the future. Engagement entails interactions and relationships with others in communities of practice. Alignment involves the coordination of efforts towards a common enterprise (Wenger, 1998). Additionally, Van Zoest and Bohl added to this notion mathematics teachers' knowledge (in particular, pedagogical content knowledge), and arrived at a definition of identity that includes teachers' knowledge and beliefs, in concert with teachers' modes of belonging. The authors used this view of mathematics teacher identity to analyze learning among soon-to-be and new secondary mathematics teachers. I follow this conception of identity as containing both socially and individually (or cognitively) held aspects. Yet, rather

than focusing on specific forms of knowledge, I turn my attention to teachers' beliefs about mathematics teaching and learning. Additionally, Van Zoest and Bohl's reliance on Wenger's notion of modes (or ways) of belonging fails to capture the parallel characteristics of practice and identity construction. As Wenger noted, "our practices deal with the profound issue of how to be a human being. In this sense, the formation of a community of practice is also the negotiation of identities" (p. 149).

Theoretical Perspective: Wenger's Notion of Identity in Terms of Mathematics Teachers

Within situative perspectives, the construction of an identity may be characterized as a "process of increasing participation in the practice of teaching, and through this participation, a process of becoming knowledgeable in and about teaching" (Adler, 2000, p. 37). Increased participation in the practices of teaching corresponds to shifts in teachers' identities. Wenger calls the forum for this participation a community of practice.

Practice

Practice, in the cognitive sense, is often used as an antonym to theories and ideas (Wenger, 1998). From situative perspectives, practice signifies doing in a "historical and social context that gives structure and meaning to what we do" (Wenger, 1998, p. 47). From this view, practice includes both explicit and implicit ways of acting, focusing on the whole person's process of engagement in social activities. The theories and ideas seen in contrast to practice in cognitive perspectives are subsumed in a broader sense of practice that provides a context for developing, negotiating, and sharing theories and ideas. Thus, the context for interaction is characterized as *communities of practice* (Lave & Wenger, 1991; Wenger, 1998). A central tenet of the communities of practice framework is that all learning is situated within particular

contexts, taking place with individuals who are members of multiple communities of practice. Communities are “repositories” of meaning and convey the rules, norms, and expectations for members of the community (Wenger, 1998). Positions associated with these various communities is negotiated by individuals who participate in these communities as a part of their everyday lives. Wenger provides five characterizations of practice. For each, I provide an example in terms of mathematics teachers:

1. *Negotiation of meaning* – the process by which we experience the world and our engagement in it. Teachers enter the classroom with some set expectations for their instruction. Norms of interaction between students and between the teacher and students have been established. Certain ways of acting have been identified as either good or bad. What constitutes good teaching and effective learning has been decided. This process of participation and reification outlines what it means to be a student and a teacher within the classroom.
2. *Community* – those that share a joint enterprise, mutual engagement, and a shared repertoire of resources in their practice. For example, a group of teachers working towards a common goal of improving student achievement, working together to meet that goal, and using a shared set of tools and language for their interaction constitutes a community of practice.
3. *History of learning* – Practice is not stable, but an emergent structure developed over time. Becoming a mathematics teacher involves understanding practices of the past as well as the present. Expectations for present and future instructional practices are based in part on the successes and failures of instructional practices of the past.

4. *Boundaries* – Practices are connected in certain ways, by people (*brokers*) and objects (*boundary objects*). These come into play through *boundary encounters* in practice.

For example, a broker may be a school principal engaged in a professional development program for mathematics teachers. While the principal is a leader in the school community, she is also a member of the professional teaching community focused on mathematics instruction, acting as a broker between the two communities. Her participation in each community serves as 0 boundary encounters. Within a school district, the curriculum map may serve as a boundary object for school-based communities, a tool that is used across community boundaries.

5. *Constellations of practice* – Groups of communities that, from a particular perspective, have similar characteristics to their practice. While mathematics teachers across a state or country may not be members of the same community of practice, their work is connected in ways. Their interest in seeing students achieve in mathematics provides a common bond. That bond denotes similar characteristics to their practices, creating a constellation of connected communities.

In delineating practice for mathematics teachers, this construct includes not only individual teachers' ways of acting and being within the classroom, but also their ways of acting in mathematics or grade level departments, school community, and possibly professional development communities. This notion of teaching practices is therefore not limited to instruction, but also includes teachers' views of mathematics content and students, which may be contradictory to their instructional practices. These views include their notions of what is mathematics, how mathematics should be taught, and students' abilities to learn mathematics.

Research indicates a strong link between teachers' instructional practices and their beliefs about learning and teaching mathematics (Philipp, 2007). Teachers' beliefs about mathematics teaching and learning impact the pedagogical decisions they make in the classroom. As Wenger (1998) stated, communities of practice convey the norms, values, and beliefs that define appropriate ways of participating in a particular community. Thus, community participation helps to shape mathematics teachers beliefs about teaching and students and thus their identities as mathematics teachers. Additionally, as beliefs have been shown to change prior to reform-oriented teaching or after experimenting with reform-oriented teaching, it is useful to consider that practices and beliefs coevolve through a negotiation of engagement in the practices of reform-oriented teaching (Philipp) and are related to identity development.

Identities in Practice

Focusing on identity from a situative perspective brings the individual to the fore, yet casts the individual in terms of their social participation in practice. In this sense, there exists a mutual constitution of identity between the individual and the community. As Wenger (1998) stated, focusing exclusively on the individual misses the ways in which we become who we are through social relations. Conversely, focusing exclusively on the community leads to stereotypes and generalizations that may not reflect the complexity of the individual. Although Wenger discusses claims adjusters to outline is view of identity, in terms of mathematics teachers, participation in various communities (professional development, school, district, mathematics department, etc.) involves both the individual shaping and being shaped by each community. The ways in which teachers reconcile the various values, goals, and norms of

multiple communities is a part of their ongoing formation of identity. This study uses Wenger's characterizations of identity in practice:

1. *Negotiated experience* – we define who we are by the ways we experience our selves through participation as well as by the ways we and others reify ourselves.
2. *Community membership* – we define who we are by the familiar and the unfamiliar.
3. *Learning trajectory* – we define who we are by where we have been and where we are going.
4. *Nexus of multimembership* – we define who we are by the ways we reconcile our various forms of membership into one identity.
5. *Relation between the local and global* – we define who we are by negotiating local ways of belonging to broader styles and discourses (Wenger, 1998, p. 149).

These characterizations of identities in practice mirror the characterizations of practice, yet recast them in terms of the individual in relation to the social. Figure 1 (from Wenger, 1998, p.150) highlights the parallels between practice and identity.



Figure 1. Parallels between practice and identity.

Although Wenger used a medical insurance claims department to construct his view of identity, in the following paragraphs I illustrate my view of each of the five aspects of identity provided by Wenger in terms of mathematics teachers.

Negotiated Experience

Being a mathematics teacher within a school is much more than a label, it is an integral aspect of teachers' identities within the school. It represents the school's view of what mathematics teaching should look like, based upon local and historical expectations of mathematics teachers. Other subject areas may come with somewhat different expectations for competencies and expertise in teaching. Yet, proving a label fails to capture the processes of belonging to a community and the contributions they make to their shared practice (Wenger, 1998). For example, it fails to identify who is "good", who is "helpful", who is central, and who is peripheral. These notions of identity take place as individual mathematics teachers engage in the practice of teaching – which includes not only formal teaching situations, but also professional development activities, and informal talks in the teacher's lounge or cafeteria.

The process of negotiation involves two aspects: participation and reification (Wenger, 1998). Mathematics teachers' participation involves elements of their work related to mathematics teaching and learning, both in and outside the classroom. Though they may belong to a community of mathematics teachers, an act of participation occurs as teachers teach students behind closed doors, far away from other mathematics teachers. We may view instructional practices as participating in the community since what constitutes effective mathematics teaching, proper classroom management, and appropriate classroom mathematical norms as defined by the communities to which they belong. Conversely, students need not be a part of the

act of participation. As teachers come together, often in professional development settings, they engage in a community that centers its practice on students' learning of mathematics without the presence of students. Yet, a different set of norms for participation, forms of knowledge, as well as tools and artifacts are used by mathematics teachers. For instance, teachers may engage one another through synchronous and asynchronous software, developing ways of communicating with one another that is quite different from that of the classroom. Additionally, a different knowledge and language is used in these settings. For instance, while teachers may ask their students to justify their solution using graphs, words, and symbols, in conversations with other teachers, words like "multiple representations" might be used in describing the same pedagogical strategy. Additionally, when working in a professional development setting, teachers may discuss how students' use of multiple representations can lead to conceptual understanding of a particular concept. The depth of content and pedagogical content knowledge called on in this setting may be quite different from that of the classroom. Thus, the identities they construct as members of this community are built upon a myriad of their experiences (participation and reification) in and outside the classroom.

As acts of participation build, mathematics teachers begin to build self-images and images of others as mathematics teachers. These images involve the process of reification – the creation of labels (e.g., good, bad, traditional, reform, etc.) that in part constitutes who they are as mathematics teachers, and thus their identities. Yet, participation and reification are but one dimension of identity. Teachers often belong to multiple communities of practice. Therefore, since participation and the subsequent reification are lived experiences connect to practices within specific communities (Wenger, 1998), the labels created through reification may be

different across different communities. Using the example above, teachers may be members of a professional development community, but are also likely to be members of local communities of mathematics teachers within their school. Thus, who they are as mathematics teachers and what constitutes being “good” within each community may be quite different. Therefore, to understand mathematics teachers’ identities, we must concern ourselves with teachers’ forms of belonging to the communities which impact their work as mathematics teachers, a second dimension.

Community Membership

In defining a community of practice, Wenger (1998) outlined three characteristics: a joint enterprise, mutual engagement, and a shared repertoire of resources with which to utilize in practice. Thus, to understand individuals forms of belonging to a particular community, he parallels these characteristics to community membership and identity through: (a) the extent to which an individual is accountable to the joint enterprise; (b) their extent of engagement in the community; and (c) the extent to which an individual can make use of the tools and artifacts of a particular community. Individuals’ community membership may not be identifiably marked or come with a particular label (e.g. reform oriented mathematics teacher, traditional mathematics teacher), yet community membership is constituted by the forms of competence that it requires (Wenger, 1998). For a mathematics teacher, community membership may come in various levels. For example, a mathematics department focused exclusively on improving standardized test scores may determine competence by closely following district curriculum maps that mirror achievement tests, providing students with tests that appear in form quite closely to the achievement tests, or focus instruction on the specific skills students need to perform well on

achievement tests. However, individual mathematics teachers may identify more closely with other foci of mathematics instruction that are not widely accepted in their school setting, but are shared between teachers at the district, state, and national levels. The ways in which teachers participate in these communities, which may hold contrasting views of effective mathematics teaching, partially constitutes who they are as mathematics teachers.

For mathematics teachers involved in a community exclusively focus on improving test scores, the extent to which teachers view themselves as accountable to test scores provides an illustration of their community membership. Additionally, these same teachers may make use of resources such as practice tests, prior test scores, and drill and practice exercises. Thus, the extent to which teachers are able to use these resources towards the goal of improving standardized test scores constitutes in part their membership within the community.

Learning Trajectory

Trajectories for learning focus on the idea that identity formation is an ongoing process of becoming (Wenger, 1998). These trajectories include past, present, and anticipated forms of participation. As an example, consider that mathematics teachers have different views about their job. Some see their job as their chose profession, seeking to improve based primarily on “being good at” their profession. Others see improvement in their performance as a way to engage in leadership roles, such as a curriculum specialist or a principal. Yet others have even more contrasting views of their job, seeing it as a way to pay bills and/or be off when their own children are out of school. Improvement for the latter teachers is primarily based on required professional development attendance to keep their job and opportunities for additional monetary awards (e.g., a master’s degree or stipend for professional development). Thus, the various

trajectories that individuals take gives meaning to their engagement in their practices and the identity they are developing (Wenger, 1998). Yet, progression of their careers as mathematics teachers is just one trajectory.

As mathematics teachers enter the profession, they most often do so after some field based experiences that involve observations and practice teaching. These settings give new teachers the opportunity to develop and apply skills in the context of real classrooms. Universities often use these opportunities for teachers to connect educational theory and the realities of school life. By engaging in field based experiences, teachers have opportunities to see and learn from more knowledgeable members of the mathematics teaching profession. Yet, by viewing more experienced teachers, they also get an image of the histories of mathematics teaching as a “way of life” – they provide images of what is “possible, expected, and desirable” (Wenger, 1998, p. 156) in classroom practice. Thus, experienced mathematics teachers provide images of the past and offer possibilities to future practice. While this period of indoctrination into the practice of mathematics teaching often focuses on new and early career teachers, seasoned teachers often revert to earlier points along this trajectory as they encounter significant changes in their work, such as moving to a new school or changes in school leadership.

Nexus of Multimembership

Individuals belong to multiple communities of practice, both past and present (Wenger, 1998). For teachers, these communities include their teacher preparation programs, schools settings in which they teach, as well as broader communities of teachers at the district, state, and national levels. Additionally, who they are is not wholly defined by their communities at work. Teachers’ identities are constituted in part by their families, religious affiliations, hobbies, and

other non-work related affiliations. Teachers may act and participate in very contrasting ways across multiple communities, yet the forms of participation in each influence other communities. Thus, understanding mathematics teachers' identities is in part based upon teachers' reconciliation of the various communities to which they belong to form a consistent identity across boundaries.

Often, mathematics teachers feel tension between who they want to be as mathematics teachers and who they feel they have to be. This is in part to mathematics teachers' identification with varying communities and the goals and expectations associated with those communities. From my previous examples, teachers may be members of departments or schools that value an exclusive focus on improving standardized test scores, centering on skills and procedural knowledge of mathematics. These same teachers may be members of a professional development community that values reform oriented teaching practices that focus on conceptual understanding alongside skills. Thus, the extent to which an individual teacher is able to reconcile their various forms of participation in these two communities partially constituted who they are as mathematics teachers. This may take the form of an integration of the two goals in instructional practices. For instance, teachers may select tasks that embody reform minded ideas where students have opportunities to develop conceptual understanding, yet also incorporate test-taking strategy days or other ways deemed appropriate for improving standardized test scores. In this sense they reconcile who they are as mathematics teachers by negotiating an identity that in part satisfies the requirements constituted by both communities.

A Relation between the Local and the Global

Being a mathematics teacher is constituted by both local and global enterprises. Local communities, for instance, include mathematics departments within schools, grade level departments, and local schools, while global communities consist of larger collections of educators, such as the National Council of Teachers of Mathematics (NCTM). Even more generally, mathematics teachers are members of a global community of educators. Our global communities are often more public (Wenger, 1998) and thus the identities formed are more transparent. A mathematics teacher has certain aspects to their identity based upon their membership in the broader community of educators. Likewise, as local communities of practice engage in their work, it is often the case that they place their practice in the context of broader schemes. For instance, mathematics teachers attempting to enact reform-minded approaches in their classrooms often look to place their own activities in the broader sense of effective ways of teaching as outlined by NCTM (1989, 1991, 1995, 2000; NRC, 2001), or identifying with a broader constellation of communities (e.g., a regional or national organization of educators). In this sense, teacher may ask themselves, “In what ways am I preparing students to function in the outside world?” or “What is the role of the school in preparing students for their professional lives?” Thus, the extent to which they place their work in the broader scheme partially constitutes who they are as mathematics teachers.

The following sections further delineate these five characteristics of identity in terms of learning opportunities for mathematics teachers. Within situative perspectives, learning occurs through active participation in and a sense of belonging to communities of practice. Changes in the ways people participate in communities of practice involves changes in their positions within

the communities. These changes in position within the community correspond to the development of new identities within the community, which are link new opportunities for learning (Kazemi & Franke, 2004). Thus, the ways in which individuals identify with certain communities represents both the extent to which new knowledge leads to new identities and the motivation for new learning (Nasir, 2002). The view of identity taken for this study is highly contextual and built upon teachers' participation in the practice of mathematics teaching and learning. Subsequent sections utilize each characterization of identity to illustrate various opportunities and contexts for identity construction. One such context is professional development.

Situating Professional Development in the Context of Teachers' Work

A view of identity that focuses on the individual in relation to their social structures calls attention to the situated nature of teachers' construction of this identity. The vast majority of research on improving teaching is cognitive in nature, focusing on the acquisition of specific forms of knowledge (Sowder, 2007). This makes sense, since research indicates that the acquisition of mathematical knowledge related to teaching has positive impacts on student achievement (Hill & Ball, 2004; Hill, Rowan, & Ball, 2005). However, researchers have now considered how teachers' specific contexts influence their instructional practices. The SummerMath and Cognitively Guided Instruction programs provide examples. The SummerMath project involved a two week summer institute where teachers gathered outside the school setting to investigate grade level specific mathematics content (Schifter & Simon, 1992; Simon & Schifter, 1991). Professional development leaders utilized constructivist approaches to teaching. During the following school year, ongoing support was provided for teachers in their

classrooms in the form of course planning, co-teaching, demonstration teaching, and reflecting on lessons. Supporting teachers as they attempted to implement constructivist approaches developed deeper understanding of the mathematics content they explored (Simon & Schifter, 1991). The Cognitively Guided Instruction (CGI) project (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989) also included summer workshops for teachers outside the school context. During these workshops, teachers were introduced to new ideas regarding children's thinking regarding addition and subtraction concepts. Similar to the SummerMath program, many CGI teachers also received follow-up support during the school year. The ongoing support in the contexts of teachers' instructional practices provided a mechanism for shifting participation in the practices of teaching. Using Wenger's (1998) view of identity, this shift in participation denotes a change in identity.

Another strategy for incorporating teaching contexts in professional development is for teachers to bring their experiences with them to the professional development (Putnam & Borko, 2000). For example, the University of Colorado Assessment Project (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997) introduced teachers to standards based materials and activities and asked teachers to incorporate them into their classroom practice. Teachers then returned to the professional development group to discuss their experiences. The researchers found that situating teachers' activities in their classroom context brought about greater instructional change (Borko et al.).

These studies, when viewed from a situative perspective, bring to light the idea that much of what we think and do is "intertwined" within the contexts in which learning takes place (Putnam & Borko, 2000). Therefore, the classroom becomes a powerful context for

understanding the access to certain forms of participation for students and teachers. The summer workshops in the SummerMath and CGI projects provided an opportunity for teachers to break free of the bounds they felt within their institutional setting, and therefore allowed teachers to experience teaching in new ways. Conversely, situating the ongoing support for teachers' development within the classroom challenges teachers to integrate these new ideas in the classroom. The use of multiple contexts seen in the SummerMath and CGI projects might provide a useful model whereby teachers are introduced to research-based ideas outside the classroom context, yet are supported when those ideas are incorporated into teachers' instructional strategies. However, using the classroom as a context for trying new instructional strategies is just one way of bringing classroom experiences to professional development activities. Another way to situate teachers' learning is to examine the tools and artifacts used in classroom instruction.

Tools and Artifacts in Support of Teacher Learning

Within situative perspectives, the cultural tools and artifacts that people use as they participate in social practices are a critical aspect to understanding the complexity of learning (Nasir & Hand, 2006). The ways in which individuals use these tools and artifacts in practice points to the negotiated experience of individuals within the community, which provides insights to their identities as mathematics teachers. The characterization of identity as a negotiated experience involves the processes of participation and reification (Wenger, 1998). For a mathematics teacher, the ways in which they use tools and artifacts (e.g. student work, curriculum materials, lesson plans, calculators, and manipulatives) reifies who they are as mathematics teachers. Thus, using artifacts from classroom practice in professional

development, in particular samples of student work, provide another way of developing an identity connected to their practices as mathematics teachers.

The CGI project serves as an example of using student work. Research on CGI is based on the hypothesis that if teachers listen and understand students' ways of reasoning about mathematics and then use this knowledge to inform instruction, then students will have a better mathematics education than if they did not (Carpenter, Fennema, & Franke, 1996). During summer workshops, professional development leaders introduced teachers to research-based ideas about students' thinking regarding addition and subtraction concepts. The word problems used by the workshop leaders and participating teachers were primarily situated in children's mathematics activities (Carpenter et al., 1989). Thus, while the workshops were not situated within their instructional practices, their work involved artifacts, in this case student work from these word problems, which were common aspects to all of the teachers' instructional practices. Using activities designed for K-12 students in professional development settings is not unique to CGI.

Three complimentary ways in which student work can be used in professional development are: (a) as a resource for strengthening teacher knowledge; (b) as a mechanism for developing a professional community focused on inquiry and; (c) as a way to provide evidence of student learning (Little, 2004). Using student work from their own classroom also makes public teachers' classroom practices, which denotes a shift in identity that values communication and critical reflection of instructional practices. When teachers use students work as a tool for understanding students' thinking they "can extend what [they] learn about the mathematical

thinking of their [students] and the ways in which they use what they learn to inform their practice” (Warfield, 2001, p. 137).

Another tool from classroom practice includes curriculum materials. Many researchers have argued for the use of curriculum materials in professional development since research indicates that the use of standards-based curricula can support teacher learning in professional development activities (Brown, Stein, & Forman, 1996). For example, Schifter, Russell, and Bastable (1999) stated that “innovative materials can aid teachers in rethinking their mathematics programs; indeed, we are convinced that curriculum must be thought of as a vehicle supporting ongoing teacher development, especially with regard to teachers’ mathematical understanding” (p. 31). Studying the ways in which teachers use those curriculum materials in their own classroom provides another situated view of their learning.

Teachers’ use of curriculum materials can be described in two ways: (1) the intended use by curriculum developers, and (2) the ways in which teachers modify and translate the textbook for use in instruction (Remillard, 2000). The latter of these two uses can be referred to as the *enacted curriculum* (Ball & Cohen, 1996), since teachers have abstracted the concrete form of the written materials through a process which is negotiated between teachers, students, and materials within a specific context. We might consider the enacted curriculum to be an example of reification of a cultural tool – suggesting a pedagogical approach taken through the negotiation process. Wenger (1998) used the concept of reification to discuss the process and the product of the tools developed and shared in practice. Using Wenger’s ideas in the classroom would suggest that reification captures not only the concrete forms such as textbooks and other tools teachers’ may use in their practice, but also abstractions, such as symbols, which may be

interpreted in contradictory ways among and between various communities. In this sense, an artifact that is common across many communities is made into an artifact of a specific community in a way that either enables or limits students' access to certain mathematical ideas. Thus, the ways in which a tool is reified in practice provides evidence of learning (or lack thereof) among the members of the community. Research on teachers' use of curriculum materials indicates that adopting reform oriented textbooks will not change teachers' instructional practice unless teachers are supported with professional development that emphasizes changes in teachers' orientations and beliefs about mathematics teaching and learning (Remillard, 2000; Remillard & Bryans, 2004). Thus, this suggests a relationship between the identities teachers construct as they participate in the practices of teaching and their beliefs about mathematics teaching and learning.

Case-Based Experiences as Trajectories and Relations to Broader Communities

Two integral aspects to forming an identity are mathematics teachers' learning trajectories and their relationships to local and global enterprises. Trajectories involve where mathematics teachers have been and where they are going. Cases of mathematics instruction provide images of teaching episodes that often portray reform-oriented instructional practices. Teachers can view these cases in relation to their own practice, refining the trajectories they set for themselves as mathematics teachers. Viewing these more experienced members of a community (in this case, the community of mathematics teachers) not only acts as a source of information about mathematics teaching, but also these cases act as "living testimonies to what is possible, expected, [and] desirable" in mathematics instruction (Wenger, 1998, p. 156).

Cases of mathematics instruction also highlight a global enterprise of mathematics teaching, making salient the dilemmas of classroom teaching and/or focusing on specific aspects of mathematics teaching and learning. Crafting an identity involves an interplay between mathematics teachers' local communities and their common enterprises with global goals and values of mathematics instruction. With these two aspects of identity in mind, cases of mathematics instruction can serve a pivotal role in constructing the identities of mathematics teachers. Namely, research on cases of mathematics instruction indicates that their use in professional development can bring about changes in teachers' beliefs, practices, and focus on student learning (Barnett & Friedman, 1997). Additionally, using cases of mathematics instruction to study episodes of mathematics teaching not only provides teachers the opportunity to increase pedagogical content knowledge, but also mathematics content knowledge (Sowder, 2007).

Cases allow individual teachers to develop trajectories and recognize the relationships without experiences with teachers in their local communities. In fact, thus far the literature discussed has attended to the situated nature of teacher learning in terms of situating opportunities within individual teachers' instructional practices. However, in capturing teachers' identities, it is also important to consider the local communities of mathematics teachers to which teachers belong. This brings into focus not only the opportunities for learning, but also the local establishment of norms, values, and beliefs associated with particular communities.

Professional Teacher Communities

The use of a situative perspective in examining teachers' identities requires a level of analysis different from the cognitive perspective. While traditional cognitive theories focus on

the individual and the external forces acting on the individual, the use of situative perspectives and a group level analysis attend to a set of questions that bring the focus onto the “social structures that are within the scope” of teachers’ engagement (Cobb et al, 2003, p. 15). Thus, in constructing a situated view of mathematics teachers’ identities, it is necessary to account for these social structures by analyzing the communities to which they belong. Recent research in mathematics education professional development has focused on these professional teaching communities (Little, 2002; Wilson & Berne, 1999).

Communities of practice are described as lived organizations in which members share a joint enterprise, a mutual relationship, and ways of reasoning (Wenger, 1998). Tools and artifacts work in support of the community by providing images of communities’ histories, as well as constrain and afford certain ways of being within the community. The value of this construct is that it brings together “theories of social structure that give primacy to institutions, norms, and rules, and theories of situated experience that give primacy to the dynamics of everyday existence and the local construction of interpersonal events” (Wenger, 1998, pp. 12 – 13). Communities of practice define the appropriate ways for people to act and work together, including the use of tools and artifacts in support of that work. They also determine what is valuable and desirable with regards to the specific community, which yields a certain perspective for individuals within the community (Wenger, 1998). Thus identity within the community consists of the extent to which an individual displays the competencies associated with that community.

The communities of practice framework utilizes a unit of analysis for examining identity that takes into account the taken-for-granted aspects of school life as well as the explicit ways of

acting and reasoning that characterize the professional teaching community (Cobb et al., 2003), yet is not so broad as to include broader communities that may not share the same goals, practices, and orientations towards their work. Engestrom (1998) characterized a focus on these communities as middle level analyses, connecting the structures of districts and schools to the instructional practices teachers take:

The middle level consists of relatively inconspicuous, recurrent, and taken-for-granted aspects of school life. These include grading and testing practices, patterning and punctuation of time, uses (not contents) of textbooks, bounding and uses of the physical space, grouping of students, patterns of discipline and control, connections to the world outside the school, and interactions among teachers as well as between teachers and parents. (p. 76)

This middle level is not so narrow to focus on individuals, but not so broad as to miss the contexts that are within the engagement of teachers' practices.

Several researchers (e.g., Franke & Kazemi, 2001b; Stein, et al., 1998) have used the communities of practice framework to analyze teachers' practices as they become members of established professional teaching communities. Both Franke and Kazemi and Stein et al. used Lave and Wenger's (1991) notion of *legitimate peripheral participation* to denote learning as shifts in participation to more active involvement within the community. Franke and Kazemi used the communities of practice framework to reconceptualize their work in the CGI project. The focus of their work centered on the evolutionary process of teachers learning, noting the ways in which tools from practice constrained or afforded opportunities for learning within a community focused on mathematics instruction. Using the communities of practice framework allowed the researchers to examine teachers' knowledge of student thinking as they interacted with one another in both informal (such as the playground or cafeteria) and formal settings (e.g. workgroup sessions). They note that their previous work was more static in characterizing teacher

growth and that using this new view allowed them to “capture the evolutionary character of teacher learning” (Franke & Kazemi, 2001, p. 56).

The QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning) project focused on improving mathematics instruction for middle grades students in economically disadvantaged areas. Teachers in each of the QUASAR schools worked with a university partner to implement new curricula and teaching strategies, with a focus on developing communities among the mathematics teachers and their support staff. In areas where teachers were able to develop communities, teachers’ practices improved through the use of tasks that were more cognitively demanding and required students to justify their thinking (Borko, 2004). Students in the schools where teacher communities developed as a result of professional development showed significant growth in their problem solving and communication abilities (Stein, Silver, & Smith, 1998). Thus, the justification for developing professional teaching communities is that they provide an ongoing forum for teacher learning (Grossman, et al., 2001). However, the development of these communities is challenging and lengthy. Developing the norms of participation that support a critical analysis of teaching is one of the most important aspects of a successful learning community, yet is often the most difficult to promote (Borko; Wilson & Berne, 1999).

Nickerson and Moriarty (2005) noted several aspects to the development and strength of learning communities: (a) teachers’ relationships with administrators; (b) teachers’ work centered around a shared vision; (c) teachers’ development of a shared respect among teachers and administrators; (d) teachers providing leadership; (e) teachers’ strong content and pedagogical content knowledge; and (f) teachers’ beliefs that all students can learn mathematics.

The nature of teachers' conversations was indicative of whether or not professional development was able to cultivate a professional teaching community.

The extent to which these communities are forming and the nature of the interactions of the individuals who make up the communities can be analyzed in terms of the discourse that takes place in the community. Additionally, discourse within the community provides insights into the identities that individuals hold, through the ways they interact and participate with others in the community, as well as the extent to which they embody the norms, values, and beliefs of the community. Thus an important role for teacher educators is to establish trust among members, while creating a balance between honoring individuals' ideas and critically examining the work of teaching to foster effective discourse within the community.

When professional development brings together diverse groups of teachers, they each bring unique types of knowledge and expertise. The variety of experiences helps to create meaningful conversations and new ways of thinking about teaching and learning (Putnam & Borko, 2000). Unfortunately traditional discourse communities have not valued communication that centers on critical reflection and analysis of teaching practices. The notion that individual teachers find their own "style" of teaching is representative of the idea that teaching is an individual practice, isolated from others (Ball, 1994). Several studies (e.g., Saunders, Goldenburg, & Hamann, 1992; Thomas, Wineberg, Grossman, Myhre, & Woolworth, 1998) have focused on the use of discourse in professional development and found changes in teachers' use of discourse as a pedagogical strategy in their own classrooms. Both of the above cited research projects focused on the idea that their work was a joint enterprise between teacher educators and participating teachers.

This sense of individual style noted by Ball is not limited to inservice teachers. Traditionally, teacher education programs have focused on the development of individual knowledge and skills deemed important for teaching (Putnam & Borko, 2000). Recently, teacher educators have proposed new ways of looking at learning to teach. For example, Hiebert, Morris, and Glass' (2003) *experiment model* focuses on the base knowledge teacher need to have, but goes beyond to ways in which teachers contribute to the knowledge base on effective lessons. Teachers' communication of their reflective thinking through critical analysis of individual lessons is at the core of the model. Additionally, preservice teachers' field-based experiences form a discourse community where the novice teacher is "enculturated" into the professional teaching community (Putnam & Borko, 2000). Both ideas focus teacher preparation on investigations situated in the practices of teaching and learning, rather than skills and knowledge.

Multiple Communities Concerned with Teaching and Learning Mathematics

Despite its usefulness in understanding culture and context, using a communities of practice framework can also create challenges since mathematics teachers are members of multiple communities, including grade or department, school, and district. Thus, situating teacher learning calls for approaches that account for the multiple communities in which teachers engage. Teachers' membership in a particular community is only a part of their identity. For instance, a teacher in a community of practice within a professional development program may participate in ways that are central to that community. They may demonstrate deep knowledge of reform practices, call attention to tasks that require high levels of cognitive demand, or profess beliefs consistent with the vision set forth by NCTM. However, when viewed in their school

community, they may participate in ways that seem inconsistent with their participation in the professional development community. The teacher may often speak to what mathematics students are not capable of doing, select tasks and instructional strategies that do not afford students the opportunity to engage in meaningful tasks that develop conceptual understanding, or demonstrate a narrow view of what constitutes effective practices. Therefore, there is no apparent unifying element to their identity as a mathematics teacher, yet neither are they completely fragmented (Wenger, 1998). The ways in which teachers reconcile their different forms of membership serves as the nexus of their identity as a mathematics teacher. Research that takes into account the multiple communities in which teachers engage provides the context for their participation and their reconciliation of various forms of membership.

The work of Stein and Brown (1997) and Cobb et al. (2003) serve as the primary examples of studies that have situated teacher learning within multiple contexts, including their local mathematics teacher communities and broader school and district communities. Both studies used sociocultural approaches to examine the ways in which teachers' institutional contexts influenced their attempts to improve their mathematics instructional programs. Cobb et al. used Wenger's characteristics of the interconnectedness of various communities: (a) *boundary encounters* – joint activities between two or more communities; (b) *brokers* – people who bridge two or more communities; and (c) *boundary objects* – tools and artifacts shared among communities. In Cobb et al.'s study, the researchers worked with middle school mathematics teachers in a district which recently adopted a reform curriculum textbook alongside a more traditional text. The goal of their work was to assist teachers in implementing the reform

curriculum in a way that was consistent with the vision of the reform documents (e.g., NCTM, 2000).

Cobb et al. identified three specific communities which influenced mathematics teachers' instructional practices: (a) a mathematics leadership community, (b) a school leadership community, and (c) a professional teaching community. The mathematics leadership community consisted of the district mathematics coordinator, mathematics curriculum specialists, and several mathematics teachers that worked peripherally in this community. The school leadership community consisted of the principal and assistant principals, along with several teachers working peripherally. Lastly, the professional teaching community consisted of the participating teachers in the study. The researchers indicated that the professional teaching community took approximately 18 months to form using the characteristics outlined by Wenger as a basis for comparison. In identifying and characterizing these communities, the researchers noted that the goals, values, and beliefs related to mathematics teaching and learning were misaligned and that at least a portion of their work as mathematics teacher educators was to work towards aligning the various communities.

In contrast to Cobb et al. (2003), Stein and Brown's (1997) focus in the QUASAR project was on teachers' growth within established communities and how the institutional context afforded certain opportunities for teachers to enhance their practice. In constructing a view of identity, taking into account the multiple communities in which teachers engage makes salient the ways in which teachers' school settings profoundly influence their instructional practices (Cobb, 2007). For instance, Stein and Brown utilize a communities of practice framework to analyze teacher learning in a school with established reform-minded teaching strategies. Yet, in

analyzing teacher learning within another school, they adopt an assisted performance framework as the development of a community of teachers with reform oriented goals was slower to develop. Stein and Brown attributed the differing goals of each school to differences in school culture prior to and including the time for the professional development. By shifting their analytic lens, they were able to capture teacher learning in different ways, including the role professional development providers have in incorporating other mathematics education stakeholders (e.g. principals, district administrators, curriculum specialists) into professional development activities.

Both Cobb et al. and Stein and Brown noted the strong influence of school level leaders, such as principals on the instructional practices of mathematics teachers. Within the broader communities of school and district, principals strongly influence the pedagogical approaches taken by mathematics teachers, yet they have a limited understanding for the reform movement in mathematics education (Price & Ball, 1997). Additionally, principals and district administrators have their own set of concerns and agendas, which impact the resources made available to classroom teachers. By setting the stage for collaborative reform efforts between principals and teachers, other more informal sources of assistance become available to mathematics teachers. Senger (1999) found that teachers' ability to change their beliefs about learning and teaching mathematics as well as their ability to change their instructional practices is in part constituted by their access to other teachers as sources of support. Senger notes that teacher change is a recursive process and that long term change is dependent upon the encouragement and critical analysis of teaching by other teachers as well as school

administrators. Thus, by shifting the established norms and expectations within schools, changes in instructional practice can take place by virtue of a climate for sustainable reform.

The alignment of the norms and values of school contexts with the values associated with reform oriented mathematics teaching is integral in achieving changes in instructional practices – even when teachers’ ideas about teaching and learning may be reform minded. Focusing on inconsistencies in teachers’ beliefs and instructional practices, Raymond (1997) noted that although a teacher may express views that students learn best by problem solving and that they should have opportunities to discover mathematics for themselves, classroom observations indicated highly traditional teaching practices. Raymond noted that the resources made available to the teacher, her concerns regarding managing the classroom, and her perception of what and how she was compelled to teach created inconsistencies between her professed beliefs about mathematics teaching and learning and the actions she took in the classroom. Hoyles (1992) reconciled these inconsistencies by viewing teachers’ beliefs as situated. Thus the inconsistencies apparent in the study by Raymond are actually consistent when taking into account the constraints that particular contexts place on teachers’ views of mathematics teaching and learning.

Traditional and Reform Oriented Views of Mathematics Teaching and Learning

Research regarding the beliefs that mathematics teachers hold indicates that even beginning teachers have strongly held beliefs about the role of teachers and students, how students best learn mathematics, the purpose of schooling, and what mathematics students should know (Thompson, 1992). These beliefs are important since they strongly

influence the instructional decisions teachers make. Correspondingly, beginning teachers' identities have largely developed from their own experiences as students and are typically characterized as traditional-minded identities related to mathematics teaching and learning, grounded in a behaviorist perspective (Borasi & Fonzi, 2002). This perspective focuses the teacher's role as one of telling and describing mathematics concepts. Mathematics concepts consist of established facts and techniques transmitted from teacher to student. Effective mathematics instruction relies on the extent to which teachers are able to reduce students' confusion by decomposing a task into a set of steps that will ensure students arrive at a correct solution (Battista, 1994). Students practice mathematics problems similar to those demonstrated by the teacher, working until they master the specific skill. Students see the teacher and the textbook as the mathematical authority in the classroom.

Conversely, reform oriented instructional practices rely on a constructivist perspective regarding teaching and learning (Davis, Maher, & Noddings, 1990) and are consistent with the vision for teaching and learning in the NCTM Standards (1989, 1991, 1995, 2000) documents. The constructivist perspective shifts the focus away from direct instruction described above and onto ways in which teachers can facilitate learning activities that require significant cognitive demand, where students work to develop conceptual understanding while also learning procedures and skills. Students' learning is built upon their prior knowledge and constructed through social interactions with other students and the teacher. Knowledge is validated through negotiation in communities of practice (Borasi & Fonzi, 2002) and is based upon the contexts in which the knowledge is

held. Figure 2 (adapted from Borasi & Fonzi, 2002) illustrates the difference between traditional and reform oriented instructional strategies in terms of knowledge, learning, and teaching.

Teaching and learning in reform oriented classrooms is significantly different than in traditional classrooms. The *Professional Teaching Standards for Mathematics* highlights the shifts needed to transform mathematics classrooms into those proposed in the Standards documents:

1. toward classrooms as mathematical communities – away from classrooms as simply a collection of individuals;
2. toward logic and mathematical evidence as verification – away from the teacher as the sole authority for right answers;
3. toward mathematical reasoning – away from merely memorizing procedures;
4. toward conjecturing, inventing, and problem solving – away from an emphasis on mechanistic answer-finding;
5. toward connecting mathematics, its ideas, and its application – away from treating mathematics as a body of isolated concepts and procedures (National Council of Teachers of Mathematics., 1991, p. 3).

Traditional Instructional Practices	Reform Oriented Instructional Practices
• Knowledge is a body of established facts and techniques. • Learning results from acquiring isolated bits of information and skills through listening, watching, memorizing and practicing. • Teaching is the direct transmission of knowledge from teacher to student.	• Knowledge is socially constructed through human activity, shaped by context and purposes. • Learning is a generative process of making meaning. Prior knowledge, context and purpose play critical roles. • Teaching is creating a learning environment conducive to inquiry, setting up problem-solving situations to make sense of mathematical concepts.

Figure 2. Comparison of traditional and reform oriented instructional practices.

The need for such broad changes in instructional practices derives from the view that traditional practices lack the cognitive demand to develop deep conceptual understanding and the reasoning, problem solving, and communication skills students need to be competitive in the workforce (Silver & Stein, 1996). Traditional practices have largely focused on computational fluency, not the “big picture”, connection-making sense of mathematics that encompasses mathematical understanding (Conference Board of the Mathematical Sciences., 2001; National Research Council., 2001). In contrast, reform oriented instructional practices focus on students communicating their mathematical ideas by making and testing conjectures, justifying their thinking using multiple representations, and respectfully challenging the ideas of others. By selecting tasks that force students to communicate their thinking in these ways, teachers help students to make connections between new ideas and previously learned material. Additionally, students in reform oriented classrooms develop a sense of autonomy as learners of mathematics – moving away from the teacher and textbook as authorities. Many of these ideas are evident in the CGI classrooms discussed earlier. CGI teachers select tasks that provide them rich information about how students are thinking mathematically, basing future instruction on this information (Carpenter, et al., 1989). Central to CGI and reform oriented practices in general, is the extent to which students’ thinking is made public depends upon the classroom environment established by the teacher and the openness of the task to allow for multiple strategies when solving the problem (Franke, Fennema, & Carpenter, 1997).

Relationships among Identity, Community, Context, and Instructional Practices

The literature suggests that the contexts of teachers’ work highly influence the extent to which teachers are able to teach using reform oriented instructional practices. In part, these

contexts include district, school, classroom, and professional development communities. Since these communities are, to various extents, concerned with the teaching and learning of mathematics, they are central to the identities that mathematics teachers form. The culmination of teachers' participation in these communities represents their identities as mathematics teachers. The identities that teachers hold are projected in concrete ways through their classroom instructional practices. Figure 3 provides an illustration of the relationships among these various elements.

This study focuses on four contexts (professional development, district, school, and classroom) of identities in practices, which are represented as aspects of identities in practice. Over time and through participation in communities of practice, teachers develop some consistent forms of participation across communities, which results in a core identity that is strongly linked to beliefs about mathematics teaching and learning. However, this relationship is dynamic. Core identities also influence future participation in specific contexts, thus the relationship is bidirectional and constantly evolving over time.

Summary

Situative perspectives shift the focus away from individual cognition and onto ways in which individuals participate in cultural practices. Thus the contexts for the construction of an identity are fundamental in understanding what kind of identity is constructed. Several contexts for identity construction are evident in the literature: professional development, classrooms, schools, and districts. Therefore, to provide a complete view of identity construction and the impacts on instructional practices, an analytic lens that captures the ways in which mathematics

Contexts of Identity in Practice

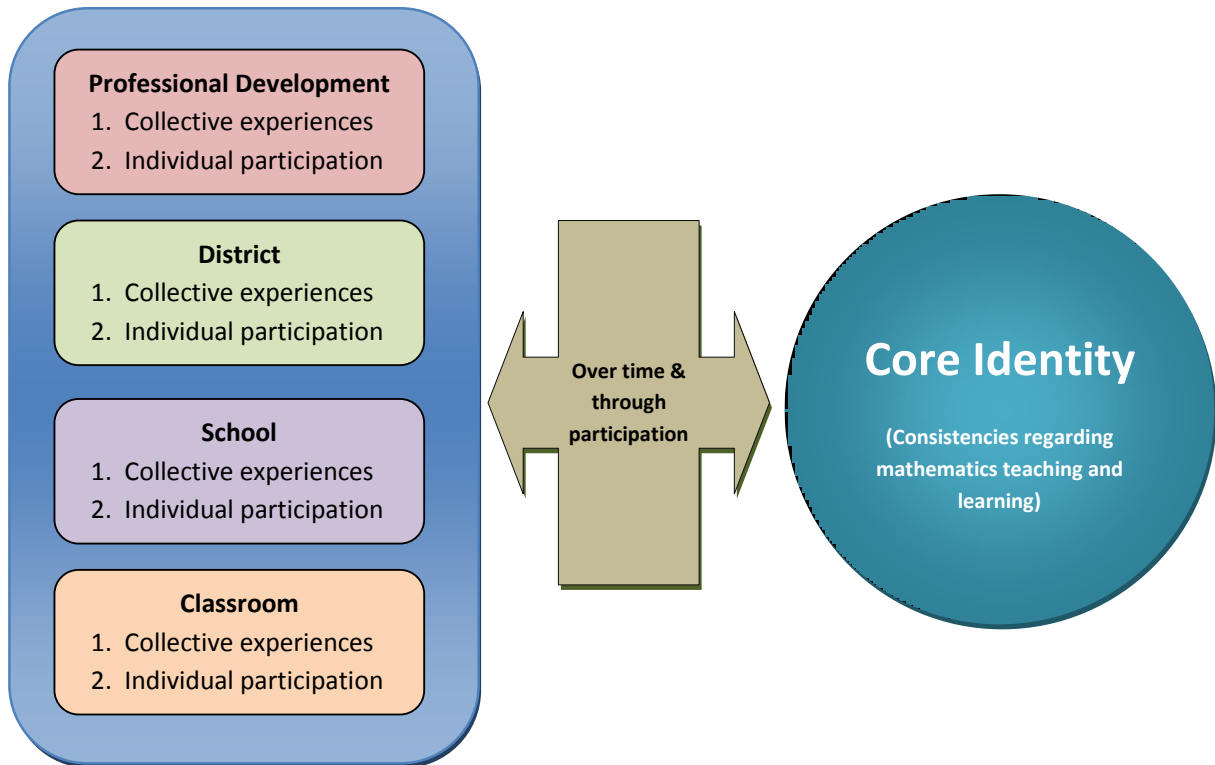


Figure 3. Relationship between identities in practice and core identity

teachers participate in these various communities is necessary. The construct of identity, defined in a way that is parallel to participation in communities of practice, captures these complexities.

The professional development context consists of opportunities for teachers to connect their instructional practices within schools to the content of professional development activities. Often times this involves the use of tools and artifacts from classroom practice, such as samples of students work and curriculum materials. Additionally, the use of cases of mathematics instruction connects the formation of identities to instructional practices by focusing on teachers' learning trajectories within particular communities and in relation to broader practices of mathematics instruction. By connecting the professional development setting to the classroom context, teachers are better able to incorporate the activities used in the professional development into their classroom practices.

Other professional development programs focus on the formation of communities of practice or the analysis of existing communities. The value of these communities in the construction of teachers' identities is that communities of practice define the acceptable ways of teaching mathematics and the appropriate ways tools and artifacts (e.g., curriculum materials, calculators, manipulatives, student work) are used in and to inform instruction. Thus, understanding the nature of these communities and individuals' positions within them provides an image of their identities as mathematics teachers. However, these communities must not only be viewed in isolation, but in relation to one another. Teachers' participation, their knowledge, and their beliefs are intertwined within the various communities to which they belong. Therefore, contradictions in knowledge and beliefs may become evident as mathematics teachers move from one context to another. The ways in which teachers reconcile these contradictions in

various communities into an identity of themselves constitutes in part who they are as mathematics teachers.

The identities that teachers form in these communities impact their core identities regarding mathematics teaching and learning and the pedagogical choices they make in the classroom. Traditional instructional practices follow the behaviorist views of learning in which knowledge is transferred from the teacher to the student through direct instruction. In contrast, reform-oriented teaching relies on a constructivist view of learning, where the teacher selects tasks that build upon students' previous understandings and requires students to make connections among mathematical ideas. Despite evidence of the shortcomings of traditional instructional practices, the majority of classrooms today include teachers with traditional identities regarding mathematics teaching and learning and instructional practices that mirror those identities.

CHAPTER III

Methodology

This study was designed to examine mathematics teachers' identities within their district, school, classroom, and professional development communities in relation to their core identities regarding mathematics teaching and learning. Additionally, this study sought to connect teachers' identities to their instructional practices. Consequently, the following questions guided this research:

1. How are teachers' core identities reflected in and how do teachers' core identities contribute to their participation in professional development (online courses), district, school, and classroom communities
2. How are teachers' instructional practices consistent/inconsistent with their identities as mathematics teachers?

Chapter III discusses the research methodology used to address these research questions. Using a situated view of identity calls attention to the contexts in which teachers' practices take place; therefore, I discuss a research strategy that best incorporates these contexts. In this study, I drew on seven of eight teachers who participated in a two year professional development program. Therefore, the contexts for participating teachers' practices include a two year professional development project, in addition to the schools and classrooms in which they work. The following paragraphs describe in detail the research design, sites and sample used in this study, data collection and analysis techniques, and techniques used to ensure validity.

Research Design

Situative perspectives call attention to the highly contextual nature of teacher learning. Thus, a research design that incorporates these dynamic contexts was essential in understanding the development of mathematics teachers' identities and their relationship to their instructional practices. One advantage to a case study is the contextual nature of the knowledge gleaned from this approach to inquiry (Merriam, 1998). Thus, the approach used in this research was a qualitative case study design. Yin (2003) defined case study as a research strategy that investigates a phenomenon situated within contexts that are important to the topic of the study. The phenomenon of interest in this study was the evolution of mathematics teachers' identities and beliefs that support reform practices, investigated within the contexts of their schools, classrooms, district, and professional communities.

Merriam (1998) highlighted the notion of a case as a bounded system. Thus, case study was appropriate in this context since all teachers were bounded by their participation in the professional development program and their practices within the school district as middle grades mathematics teachers. Yet, the teachers were also bounded in differing ways. Since the focus of the study was on the development of identities related to mathematics teaching, individual teachers were bounded by their own forms of participation and non-participation in school, district, and professional development communities, as well as their individual classroom settings. Therefore, I collected data from seven of the eight teachers (one did not agree to participate) to select four teachers to investigate in greater detail, each selected teacher representing a specific case. I used these four cases to highlight contrasting images of their identities as mathematics teachers and their instructional practices. After characterizing the

individual teachers, I turned my attention to theorizing about the relationships between characteristics of their identities and their instructional practices.

Using a pragmatic view, I attuned my approach to the problem or “burning question.” The problem at hand in this instance was one of identity construction in the contexts of districts, schools, classrooms, and professional development. Given the focus on the contextual situations of the schools, districts and that of the professional development program, I focused my attention on the perceptions of participants in their situated environments as being relevant to both their work and the study. It is for this reason that this study focused on qualitative methods that attune the research to the communities of schools, districts, classrooms, and the online courses. These tenets align with Maxcy’s (2003) account of pragmatic views of research that value the social and historical contexts, along with the pragmatic stance that the researcher has the freedom of choice when designing research methods that best fit the problem at hand.

Context and Participants

To address the research questions, this study visits participating rural Appalachian middle grades mathematics teachers one year after completing a professional development program consisting of four online courses in mathematics education. In 2005, two university researchers secured a sub-grant from the Appalachian Mathematics and Science Partnership (AMSP), a National Science Foundation Award project, with the goals of “eliminat[ing] the achievement gap in science and mathematics in the Central Appalachian region and build[ing] an integrated elementary, secondary and higher education system in this underserved region” (Appalachian Mathematics and Science Partnership, 2007). Eight teachers from four schools within one rural Appalachian school district completed the courses that were designed to increase their content

and pedagogical content knowledge. The professional development program consisted of four blended format (synchronous online, asynchronous online, and face-to-face) courses over a two year period from August 2005 to May 2007. The four courses were Rational Numbers, Algebra, Geometry, and Probability and Statistics.

Professional Development Course Design

The courses were designed to include synchronous, asynchronous, and face-to-face instruction. Centra software provided the synchronous component. This software allowed users to speak “live” with other members of the class, indicate agreement with a statement using a check or an “x”, ask questions, share a whiteboard space for collaboration with other class members, text chat, and share applications from their local computers. Each student was provided headphones, a web camera, and a Notetaker. The Notetaker permitted students to share their handwritten work online through the application share feature. Additionally, other applications including Geometer’s Sketchpad, the library of virtual manipulatives website (nlvm.usu.edu) and several other interactive websites, such as NCTM’s *Illuminations* (illuminations.nctm.org) were used for instruction by either using the application share feature in Centra or by asking teachers to complete an activity on the website and return to the whole class via the Centra software.

Blackboard served as the asynchronous software for the course. With Blackboard, instructors posted course documents, assignment directions, and external links on a Blackboard course website for students to access remotely. This software also contained a digital drop-box for submission of assignments and the capability of sending individual or group e-mails. The discussion threads available on the Blackboard site provided the online environment for teachers’

reflections on class assignments. Face-to-face class meetings took place the first and last class sessions of each course. Additionally, the instructors would visit specific schools, signing on to teach class from that school. Occasionally, the participating teachers asked to meet face-to-face with the teachers for special class meetings.

To create communities of learners, professional developers required teachers to “sign on” for class at the same location as another teacher. While teachers “signed on” to class with their own individual computer, they did so from their school computer lab so as to create a site-based cohorts consisting of 2-3 teachers. In addition, Centra permitted us to assign “breakout groups” across cohorts so that teachers at one school could enter into discussions with teachers at another site. Instructors alternated between using the Centra breakout across site discussion groups and using discussion groups that were site-based. The class activities used encouraged collaboration and communication among teachers.

Professional Development Activities

Situative perspectives highlight the notion that the classroom is a powerful context for teacher learning (Borko, 2004). As a result, online course instructors purposefully planned, adapted, and created course activities that used tools and artifacts from teachers’ classroom practice, as well as activities that could easily translate to the teachers’ classrooms (Cady, 2007).

Thus the course design centered on the following activities:

1. Using Standards-based curricula to enhance teachers’ mathematics content and pedagogical content knowledge (Ball, 1996; Beckmann, et al., 2004; Reys, Reys, Beem, & Papick, 1998)
2. Using cases of middle grades mathematics instruction to expand teachers’ conceptual

- understanding of mathematics and to reflect on pedagogical decisions mathematics teachers make (Merseeth, 1996; Stein, Smith, Henningsen, & Silver, 2000)
3. Examining student work in order to increase teachers' flexibility in mathematical thinking and the ways in which they use student work to guide instruction (Franke & Kazemi, 2001a; Wilcox & Jones, 2004)

The Connected Mathematics Project (CMP) curriculum (a Standards-based curriculum) used for the courses forced teachers to take the role of the students in developing understanding of a particular concept. For instance, in many activities multiple representations were required when solving problems, justifying solutions, and communicating their thinking about a particular concept. Real-world contexts promoted connections to other content areas. The *Investigations* sections in CMP supported the use of collaborative groups and inquiry-based practices (Cady, 2007). As teachers completed these activities, they also reflected on their role as a teacher – how students might approach these activities and how they might use them in their own classrooms.

Cases of mathematics instruction (Boaler & Humphreys, 2005; Smith, Silver, & Stein, 2005), where teachers used reform oriented mathematics instruction, supplemented the CMP curriculum. These cases provided opportunities for rich discussions and reflections upon the pedagogical decisions made by middle school mathematics teachers. Instructors selected both written and video cases with the teachers. The following questions (and others similar to them) focused teachers' thinking regarding the cases:

1. What pedagogical decisions did the teacher make (when to ask for clarification, when to refocus, etc.)
2. What impact did this decision have on students' understanding?

3. What mathematics content knowledge would you expect to see?
4. What mathematics content knowledge did you observed?
5. Identify the teachers' mathematical practices. (Practices refer to the specific things that successful mathematics learners and users do. Justifying claims, using symbolic notation, and making generalizations are examples of mathematical practices.)
6. What mathematical know-how (beyond content knowledge) did the teacher have that provided evidence of expertise in learning and using mathematics?
7. Create a 2-column chart for this case study. Label column one Students' mathematical understanding. Label column two evidence of students' understanding.
8. After reviewing the case study, complete the chart, providing examples of students' mathematical understanding and the evidence you found in the case study that supports your conclusion of understanding.

In addition, teachers were required to bring to class examples of their students' work. Collaboratively, teachers examined these examples to determine students' mathematical understanding and the creation of a plan for instruction that would deepen the students' mathematical understanding. The CGI project provides an illustration. Research on CGI is based upon the premise that students have a great deal of intuitive knowledge of mathematics that can serve as the basis for instruction, particularly in the primary grades. Thus, the teachers' role becomes one of listening to and understanding students' ways of reasoning about mathematics, then using this knowledge to inform instruction (Carpenter, et al., 1996).

Research

Several lines of research permeated the professional development program. They centered on measuring changes in mathematics content and pedagogical content knowledge, changes in teachers' beliefs regarding the learning and teaching of mathematics, changes in teachers' epistemological beliefs, and the cultivation of a professional teaching community. Although data analysis is ongoing, findings suggest increased pedagogical content knowledge, specifically related to the use of mathematical language.

District Context

This school district is in the Appalachian region of the Southeast United States. Over the last several years, the district has actively perused grant funding to improve mathematics and science education in the district. Specifically, they have sought ways to deepen the mathematics and science knowledge of K - 12 teachers. The district also emphasized the integration of the subject areas by allocating instructional time for integrated mathematics and science laboratory investigations in one middle school. Additionally, district leaders have used area resources to bring elements of the local community into the school curriculum.

School Context

Three teachers participated from Carter Middle School. Carter is the smallest of the three schools in the county district. There is one mathematics teacher for each grade level, 6 – 8. The school is also the most economically disadvantaged in the study, with 66.5% eligible for free or reduced lunch. The school had three principals over the past three school years, leaving little continuity within the school in terms of managerial styles, expectations of students and teachers, and organizational features such as daily scheduling. Due to a lack of consistent leadership,

teachers reported taking a more central role of determining how the school functions. For instance, mathematics and science teachers introduced and implemented the idea of an integrated mathematics and science lab each day for every student, where the math and science teachers come together to teach an additional class that incorporates topics from their individual math and science classes. This idea was born out of mathematics and science teachers' participation in several professional development activities that were funded by the Application Mathematics and Science Partnership. A new principal, however, shifted the focus away from mathematics and science, and onto all academic areas – calling the new dedicated time “academic core” or AC.

Teachers in the school are organized by grade level, yet report seeking bonds between other mathematics and science teachers in the school. The mathematics teachers in the school are quite familiar with the instructional practices of the other mathematics teachers through conversations regarding mathematics teaching and direct observations associated with coursework in the online classes. The teachers at Carter appear to have taken it upon themselves to improve mathematics teaching and learning and want to be seen as leaders in terms of integrating mathematics and science. Recently, they have sought opportunities to share their work with teachers in the elementary school that feeds Carter.

Two teachers participated from Rose Middle School. Rose is the largest of the middle schools in the county district. The school has also seen a change in principal in the last few years; however, the new principal was an assistant principal at the school, providing continuity within school level leadership that was not evident at Carter. When the four online courses began, another principal was in place that strongly encouraged (or informally required)

participation by several of the mathematics teachers in the school. Three of the five teachers from this school that took the first course completed all four courses. One of these three teachers declined to participate in the study. In addition to participation in the courses, the current principal has sought other ways to improve mathematics instruction in the school. Currently the school is organized around grade levels, but is changing the format for the coming school year to organize around content area. Additionally, the school plans to use an “academy” model to place students in mathematics class. The plan includes regularly assessing students in mathematics and placing them in classes according to their performance on these assessments. Remedial mathematics students would be placed in mathematics classes with other remedial students to work on “basic skills” that they were unable to complete on the assessment. Ability grouping is also used for more advanced students. The mathematics department head reported that he and the principal see this as a way to improve students’ mathematics scores on the state achievement test. The mathematics department has a common planning time to discuss issues related to mathematics instruction, but reported using this time for individual planning or individual tasks. The mathematics department head, on occasion, meets with the mathematics teachers when there is something specific to discuss. For instance, the mathematics teachers met to discuss items that should be placed on the student assessment at each grade level.

Lawrence Middle School was the final school from the county district included in the study. Originally two mathematics teachers from Lawrence participated in the professional development. However, one teacher left the district the final semester of the online courses. The remaining teacher described Lawrence as “our own little Mayberry.” Many of the teachers at Lawrence are former students. This tight knit community provides substantial support to the

school through the parent teacher organization. Currently, teachers at Lawrence are organized by grade level, but will shift to being organized by content the year following this study.

Sampling Strategy

Eight teachers comprise the population from which the sample was drawn. Seven of the eight teachers completed the four courses in the professional development program and all eight completed the final three courses. Of those eight teachers, seven agreed to participate in this research project. I selected the four cases based upon maximum variation (Glaser & Strauss, 1967) of the participating teachers' views of mathematics teaching and learning, school culture, area of licensure, mathematics background, and the various instructional strategies participating teachers used in the classroom. Using this technique yields "important shared patterns that cut across cases and derive their significance from having emerged out of heterogeneity" (Patton, 1990, p.172). Table 1 includes the criteria for selecting the three teachers.

Reflexivity Statement

I was a graduate research assistant in the Department of Theory and Practice in Teacher Education at the University of Tennessee during the time of this study. My work as a graduate assistant was to assist in developing, teaching, and evaluating the four courses developed for the

Table 1. *Criteria for Sample Selection*

Criterion	Description
Instructional Practices	The extent to which reform oriented practices are used in classroom instruction
Views of mathematics	Beliefs about how students best learn math, role of the teacher
School culture	Leadership styles, size, local community
Licensure	Licensure area (K-8, 4-8, or 7-12) and the content area of the license

professional development program experienced by the seven teachers participating in the study. In addition, I was responsible for gathering and coding data related to the participants in this study. Some of the data collected while participants were involved in the program include participants' course assignments, reflections on classroom tasks, audio data from course meetings, Blackboard posts, middle school students' work from participating teachers' own classrooms, and interview data. Additional contact with these participants has taken place at various professional development opportunities that I have attended. Therefore, prior experience with these participants influences how I view them as a member of the professional development program and as a classroom teacher. Most likely, my prior experience with the participants will narrow my view of them in terms of their practice and participation in the district, school, and professional development communities. Conversely, this prior experience allows me to gain entry into their classrooms, as well as utilize the rapport established during the professional development program.

My work as a mathematics teacher and graduate student strongly influences my views of their teaching practice. While as a classroom teacher I was knowledgeable of reform practices that value the social construction of knowledge, opportunities for students to develop conceptual knowledge through exploration of concepts, use of multiple representations, and justification of solutions, I incorporated these ideas sparingly in my own classroom. I would categorize myself as having a behaviorist approach to practice – viewing my instruction as an explanatory variable and their learning as a response variable. Simply stated, I used direct instruction methodologies and viewed their merit on the basis of student achievement on a test that predominantly focused on skills and procedures.

My attempts at reform began to appear more in line with reform oriented teaching during my last year in the classroom and have developed much more since entering the doctoral program. Shifts in my thinking are now related to attunement to the ways in which students identify with mathematics, their participation in mathematics as a human endeavor, and views of community on multiple levels (including classroom, school, and out of school contexts). These ideas inform my observations and what I am attuned to noticing as a researcher. Since I place value on these new (to me) views of teaching, I am more likely to notice these in others' practices and, as a consequence, less likely to notice other aspect of their practice. For example, my mathematics teaching experiences have been exclusively in urban contexts; therefore, I may not be attuned to noticing particular issues that take place in rural teaching situations.

Data Collection

I collected three types of data suggested by Yin (2003) for this study: documents, interviews, and field notes from observations. The following paragraphs delineate the specific data collected for each type.

Documents

Since the tools and artifacts in support of teachers' instructional practices are significant in understanding teachers' identities, this studies relies heavily on documents that incorporate these artifacts in characterizing teachers instructional practices. The primary source for documents in this study is the Scoop Notebook (Borko, Stecher, Alonzo, Moncure, & McClam, 2005). The Scoop Notebook consists of artifacts related to key features of classroom practice, such as instructional materials and strategies, classroom learning activities, and the classroom teacher's students' work. The notebooks have shown significant promise for representing what

teachers and students do in the classroom (Borko et al.). For the purposes of this study, the documents incorporated in the Scoop Notebook include: (a) lesson plans, (b) lesson reflections, (c) samples of student work, (d) feedback or comments on student work, and (e) quizzes and tests. These documents primarily take the form of photocopies and written reflections. I asked teachers to collect these artifacts over five to seven days of instruction during one class period.

Interviews

Semi-structured interviews (see Appendixes A and B) serve as the primary source for understanding teachers' participation in district, school, and professional development communities. Interviews of participants also provided insights into their instructional practices and the perceived influences of the online courses on teachers' instructional practices. I conducted two interviews with the participating teachers. The goal of the first interview was to capture as much of their identities as mathematics teachers as possible, in addition to their beliefs about mathematics teaching and learning. The first interview inquired about the participants' views of the online coursework, their classroom practice, school cultural norms, their views about mathematics teaching and learning, and their participation in school, district, and professional development communities. Table 2 organizes the interview questions around the five characteristics of identity as outlined by Wenger (1998) (see Chapter II for a detailed description of this view of identity in terms of mathematics teachers):

1. *Negotiated experience* – we define who we are by the ways we experience ourselves through participation as well as by the ways we and others reify ourselves.
2. *Community membership* – we define who we are by the familiar and the unfamiliar.
3. *Learning trajectory* – we define who we are by where we have been and where we are going.
4. *Nexus of multimembership* – we define who we are by the ways we reconcile our various forms of membership into one identity.

Table 2. *Relationship between Interview Questions and the Theoretical Framework*

Characteristic of Identity	Interview Question(s)
Negotiated experience	3, 4, 8, 9,
Community membership	3, 4, 8, 9
Learning trajectory	1, 2, 5
Nexus of multimembership	8, 9, 10
Relation between the local and global	1, 2, 6, 10
Beliefs about mathematics teaching and learning	6, 7

5. *Relation between the local and global* – we define who we are by negotiating local ways of belonging to broader styles and discourses. (p. 149)

Additionally, the last line of the table includes the questions that address participants' beliefs about mathematics teaching and learning.

I conducted the second interview after the final classroom observation. The goal of this interview was to gain information regarding the instructional practices and how teachers talked about their role and the students' role in the classroom. In this interview, I asked teachers to reflect upon the lesson I observed with regards to the mathematical ideas and tasks presented, their pedagogical strategies, and their assessment of their students' mathematical thinking. The second interview protocol is contained in Appendix B.

Observations

Two classroom observations for each teacher supplemented the data collected from the Scoop Notebooks and informed the researcher of the classroom and school norms, including the participation of the teacher in the school community. Observations provided information regarding questioning and assessment techniques, the mathematical tasks presented, and the materials used during the lesson. I used a modified version of the Oregon Teacher Observation Protocol (Wainwright, Flick, Morrell, & Schepige, 2004) used by the Appalachian Mathematics and Science Partnership's Partnership Enhancement Program (PEP) evaluation. This

observation protocol aligns with both the Scoop Notebook and the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics., 2000) with regards to the extent to which participating teachers use reform oriented mathematics teaching. Thus, this alignment serves to triangulate each data source. Appendix C includes the observation protocol and Appendix D includes the template used for collecting field notes.

I collected data over the course of one month. Table 3 includes the schedule for data collection.

Data Analysis

These data were used to develop general descriptions of teachers' instructional practices, their views of mathematics, and their school culture. Using this thick description in conjunction with information regarding their area of licensure and mathematics background, I selected maximum variation cases for in-depth study. I conducted *within-case analyses* (Creswell, 2007) of each case (for this study, each case consisted of one teacher) followed by a comparative analysis across the communities in which teachers participate. This type of analysis allowed for a comparison of teachers' identities to their participation in specific communities and yielded a description of the teachers' instructional practices in relation to their identities. The Scoop Notebooks and classroom observations represented a significant portion of the characterizations

Table 3. *Schedule for Data Collection*

Data Collected	Timeline
Obtain informed consent	Mid February, 2008
Deliver Scoop Notebook templates	Mid February, 2008
Schedule 1 st Interview	Mid February, 2008
Conduct 1 st Interview	Late February, 2008 – March, 2008
Conduct Observations/2 nd Interview	March, 2008
Collect Scoop Notebooks	March – April, 2008

of teachers' instructional practices and were analyzed according to the following a priori codes:

1. *Collaborative grouping.* The extent to which the series of lessons uses student groups to promote the conceptual learning of mathematics through nontrivial tasks.
2. *Structure of instruction.* The extent to which instruction is organized around conceptual understanding of content and enacted in ways that build on students existing understanding.
3. *Multiple representations.* The extent to which teachers use and require students to use multiple representations (e.g., pictures, graphs, symbols, words, real-world contexts) to illustrate mathematical ideas.
4. *Hands-on.* The extent to which students have access to and use concrete instructional materials and tools to represent mathematical ideas.
5. *Norms of communication.* The extent to which the students are expected to communicate with other students and the teacher mathematically. The mathematical “voice” of students in the classroom.
6. *Explanation and justification.* The extent to which students are expected to explain and justify their thinking.
7. *Problem solving.* The extent to which the series of lessons provided students opportunities to solve complex problems that allow for multiple solutions and/or multiple paths towards the solution.

8. *Assessment.* The extent to which formal and informal assessment was used to improve student learning by furnishing information to the teacher regarding students' understanding.
 9. *Connections.* The extent to which the series of lessons allowed students to connect ideas to previously learned material, other subjects, and the world around them.
- (Borko, et al., 2005)

To supplement this deductive approach, I used an inductive approach to develop data-grounded codes when analyzing teachers' identities and making comparisons across contexts. The data-driven codes related to teachers' identities were subject to peer review by another researcher. I provided the researcher with a list of data-driven codes and 76 interview excerpts. Her initial coding of the data resulted in 88% agreement between her coding and mine. After further discussion, we agreed on 75 of 76 interview excerpts, or a 98.7% agreement. In using these codes, I first looked for elements of teachers' core identities, or those aspects of their identities that were relatively consistent across each context. To enhance credibility, I provided each of the four teachers' selected for in-depth study a one to two sentence description that included their core identities as mathematics teachers and asked them if they felt it was a fair characterization of them. Two of the four (Katie and Morgan) agreed with the entire statement, one teacher (Leigh) agreed, but slightly elaborated in ways that were consistent with her identity, and the other teacher failed to respond. Following characterizations of their core identities, I looked for aspects of teachers' identities specific to each community that would further illuminate their core identities. Finally, I used Wenger's notion of identity to look for relationships between their instructional practices and their identities. Since this study focused

on the complexities of views, experiences, and relationships of participants, I placed a larger emphasis on views, values, beliefs, assumptions, and ideologies of individuals. In doing so, this process involved making decisions about categories throughout the process, recognizing the influence of the researchers' values and priorities in the process, and suggesting that the conclusions drawn are always incomplete.

Credibility of Research Findings

To ensure the credibility of the research findings, I drew from several validation strategies described by Creswell and Miller (2000). These are outlined below.

1. *Triangulation*. Data were triangulated through the Scoop Notebooks, observations, and interviews.
2. *Peer Review*. Peer review was with another researcher (as mentioned above).
3. *Clarifying researcher bias*. A reflexivity statement is included in the proposal and dissertation project.
4. *Member checking*. Once interviews were complete, I discussed the findings via email with the participants to ensure that their responses were accurately portrayed.
5. *Thick Description*. I generated a thick description of the context of the study to allow readers to determine transferability.
6. *External Audits*. The dissertation committee served in this capacity.

Summary

In Chapter III, I presented the research methodology used in this study. The case study approach was appropriate since the phenomenon of interest is related to the process of

implementing instructional strategies suggested in professional development in the contexts of their work as mathematics teachers. Data collected for this study served to highlight these contexts of teachers' work. Additionally the interview questions illuminated aspects of teachers' participation in district, school, and professional development communities – a pathway to their identities as mathematics teachers. Observational data served to triangulate the characterizations of practice gleaned from the Scoop Notebooks. I used an inductive approach to generate themes regarding teachers' identities and a deductive approach to characterize their instructional practices.

CHAPTER IV

Within-Case Analyses: Results and Discussion

The analysis for this study focused on two research questions: (1) How are teachers' core identities reflected in and how do teachers' core identities contribute to their participation in professional development (online courses), district, school, and classroom communities? and (2) How are teachers' instructional practices consistent/inconsistent with their identities as mathematics teachers? Chapter IV provides answers to both questions from a within-case analysis perspective. In this chapter, there are four cases representing the four teachers selected for in-depth analysis. The teachers' selection was based on contrasting views of mathematics teaching and learning, school culture, area of licensure, mathematics background, and the various instructional strategies participating teachers used in the classroom. Table 4 summarizes each of the seven teachers in terms of these criteria and indicates the four teachers chosen as cases for analysis.

Table 4. *Participating Teachers in Relation to Selection Criteria*

Teacher	Views of mathematics	School culture	Area of licensure	Mathematics background	Instructional strategies
Katie*	Values collaboration, communication, students' ownership of ideas	Small school, strong teacher leadership, high principal turnover	K-8	Limited mathematics background, intended on being a reading teacher	Approaching reform
Leigh*	Emphasizes need for practicing mathematics	Small school, strong teacher leadership, high principal turnover	K-9	Strong mathematics background, intended on being a mathematics teacher	Predominantly traditional
Morgan*	Values students' opportunities to "experience" mathematics, wants to provide opportunities for students to collaborate	Large school, consistent school leadership, hierarchical leadership style	K-6 modified special education	Weak mathematics background, no prior intention of teaching mathematics	Traditional with "differentiated instruction"
Tyler*	Sees mathematics as "training the mind to think," values fast answers over process and justification	Large school, consistent school leadership, hierarchical leadership style	7-12	Equivalent to undergraduate degree in mathematics	Traditional
Jennifer	Values an inquiry – based approach to teaching, where students are active and hands-on with content	Small school, strong teacher leadership, high principal turnover	K-8 science	Limited mathematics background, primarily responsible for teaching science	Approaching reform, regularly uses questioning to enhance student thinking
Carson	Reports seeing the utility of math in students' lives and value of students' ownership of ideas	Continually referred to school as "professional" environment	5-8	Significant coursework in mathematics	Traditional
Marsha	Sees mathematics as "precise" with right and wrong answers	Small school, hierarchical leadership style	K - 8	Limited coursework in mathematics	Blend of traditional and reform practices

* Indicates teacher chosen as case for analysis

To provide maximum variation in the cases, I selected two teachers from a small school with strong teacher leadership and two teachers from a large school where teachers have the perception of a hierarchical leadership style. Within each of the selected schools, I chose one teacher using predominantly traditional instructional strategies and one teacher using or having a vision for using reform-oriented instructional strategies to represent the four cases. Therefore, Katie, Leigh, Morgan, and Tyler represent for four cases selected for in-depth analysis. There were also pragmatic reasons for not selecting the remaining three teachers. Jennifer is a science teacher whose only responsibilities for mathematics instruction occurs in an integrated mathematics and science course which she co-teaches. Carson and Marsha are the only teachers from their respective school included in the study, thus making it difficult to make comparisons to other mathematics teachers in the school, an important aspect of the comparative analysis in Chapter V.

Each of the four selected cases begins with a description of teachers' core identities, that is, those elements of each teacher's identity that are relatively consistent across multiple contexts (Gee, 2000). In this study, those contexts are taken as the school district community, the school community, the classroom community, and the online course community. Using Wenger's (1998) notion of identity necessitates a focus on the ways teachers participate in each of these four communities, which may be quite different from context to context. Therefore, following a description of teachers' core identities is a delineation of how these core identities are reflected in these communities and how these communities influence teachers' identities through their participation. These descriptions highlight the similarities in teachers' participation across the four communities and draw attention to inconsistencies in participation in relation to the goals,

values, and beliefs of each community. This level of analysis addresses question one from a within-case analysis perspective.

Since a primary focus of this study is understanding the ways in which these identities are a reflection of and an influence on teachers' instructional practices, each case includes a description of instructional practices for each teacher using a priori codes and a framework provided by Borko et al. (2005). To analyze the relationship between these instructional practices and the identities that teachers hold, I used Wenger's (1998) characteristics of identities in practice, which involve following dimensions:

Negotiated experience – we define who we are by the ways we experience our selves through participation as well as by the ways we and others reify ourselves.

Community membership – we define who we are by the familiar and the unfamiliar.

Learning trajectory – we define who we are by where we have been and where we are going.

Nexus of multimembership – we define who we are by the ways we reconcile our various forms of membership into one identity.

Relation between the local and global – we define who we are by negotiating local ways of belonging to broader styles and discourses. (p. 149)

A more detailed account of Wenger's characteristics in terms of mathematics teachers is provided in Chapter II. This level of analysis serves to address question two of the research project from a within-case analysis perspective. Characterizations of teachers' identities and their instructional practices were gleaned from the three types of data collected in this study: interviews, observations, and a modified version of the Scoop Notebook (Borko et al.).

The Case of Katie Williams

“Tell me what you want to tell me, but I’m gonna do what I think is best.”

Core Identity and Community Participation: Research Question One

Katie's core identity involves a sense of autonomy for making mathematics instructional decisions (evident in her opening quote) and a value of communication and collaboration in learning mathematics. Also important in understanding her core identity is the importance she places on students' ownership of mathematical ideas. The following paragraphs provide further detail on these findings regarding her core identity, which becomes more evident it is discussed within the context of each community.

Katie was a sixth grade mathematics teacher in her third year of teaching at Carter Middle School during the time of this study. Katie is highly qualified in reading, math, and science through testing. When she graduated from her teacher education program, she planned to be a reading teacher; however, a program that provided loan forgiveness for teaching mathematics and science prompted her to look for a job teaching mathematics, which she found at Carter. Katie's sense of autonomy for making instructional decisions is an important part of her core identity as a mathematics teacher as it provides her the freedom to make instructional decisions with little concern for how those decisions might be perceived by others. These instructional decisions focused on two pedagogical aspects: mathematical communication and ownership of mathematical ideas. These two aspects also shaped her participation in each of the four communities included in this study.

All three data sources provided evidence that Katie values communication in mathematics classrooms. For instance, when asked during the interviews about her image of an effective mathematics teacher, she described a teacher that engages students in mathematics tasks and provides opportunities for students to talk about mathematics with one another, which is evident in the following comment.

I see a teacher who's got the kids engaged. They may have manipulatives out, depending on what the topic is. The kids are engaged, there's a little bit of teacher-led instruction. There's a lot of student-led instruction. A lot of group work. There's a lot of talk about math going on, and the kids are developing ideas and they're getting it.

In concert with her focus on mathematical communication, Katie also sees value in students' ownership of mathematical ideas. Katie noted the benefits of providing students opportunities to investigate mathematical ideas for themselves, supporting those investigations with discussions about mathematics.

I think that if they can discover something on their own – for example, an algorithm for, say dividing fractions, or something to that effect, that they are more likely to remember it. I think that if they can discover an algorithm on their own, that they are more likely to remember it and it has more value to them. That tends to be really difficult with a lot of things. So, I try to use a lot of questioning and a lot of discussions. I think they learn best if they feel comfortable in their environment and feel comfortable to say whatever they need to say.

Katie saw herself at the beginning stages in making communication and collaboration a regular part of her mathematics classroom because she saw weaknesses in the types of tasks she selected and the questions she used to support students' understanding of a particular mathematics topic when she stated during an interview that all she needed was more “experience,” that it “just comes with time.” However, she felt these weaknesses could be remedied with more experience in teaching mathematics.

In addition to providing opportunities for students to communicate mathematically and gain ownership of mathematical ideas, she also stated that being a good mathematics teacher involved reducing complicated tasks to more manageable pieces that students could understand.

You have to be able to break things down and if someone is really good at breaking things down and putting them into words that kids understand, I think math is a really good place for them. You don't have to break things down as much when you're talking about reading or social studies.

These elements of Katie's core identity become more evident across each of the four communities: the classroom, school, district, and online course communities. The following sections further describe teachers' core identities within each context, highlighting forms of participation that are both consistent and inconsistent with their core identities.

Classroom Community

Katie's core identity was evident through classroom observations. She created a culture of communicating mathematical ideas through the use of collaborative groups. While lessons began with some teacher-led discussion, collaborative work on a task or series of tasks followed. Katie used questioning throughout the lesson to elicit students' mathematical thinking. However, most justification centered on students' use of procedures and not why those procedures made sense in the context of the problem. Despite the focus of explanations on procedures, Katie's classroom environment and her practices encouraged communication. For instance, in a lesson reflection in the Scoop Notebook, she noted the number of misconceptions that arose out of a discussion on graphing bivariate data, highlighting the benefits of providing opportunities for students to talk about mathematics.

Despite the value Katie had for students' opportunities to communicate with one another and the value she placed on students' ownership of mathematical ideas, both characteristics of her core identity, Katie saw her role shifting from providing students opportunities to investigate mathematics to one of modeling, explaining, and breaking down difficult ideas when she noted student misconceptions or difficulties with particular concepts. She stated that students expected her to provide answers when they ask questions, often refusing to engage in the problem solving process.

[Students] want you to give them answers. Well, what's the answer, what's the answer, and they're more interested in the answers than they are in the process.

Thus, when students struggle with mathematics in her classroom, it appears to be normative that their confusion is alleviated by teacher-led instruction. Katie provided the following in a lesson reflection in the Scoop Notebook.

I feel like I could have done a better job with this lesson. It was surprising to hear some of the misconceptions they had. I think the next time I teach this lesson I will create some form of a worksheet that will provide more guidance to students as they work through the problem. In addition, I will help students get started with each problem.

Classroom observations further triangulated this finding. When several students stated they did not understand a particular problem, Katie immediately got the attention of the students and provided one or more examples to the class – detailing the steps needed to solve the particular problem. The following is an excerpt of an observer comment I made during a classroom observation.

As Katie stated, “when you see the word ‘was’ think equal” there was a significant reduction in task demand. The students’ strategies generated some interesting solutions I overheard that could be used to generalize [the process of writing equations]. The teacher took hold of the task from students rather than continuing the approach. When she takes this from students, they appear to be disengaged.

Katie suggested that, in part, her frustrations regarding students’ willingness to problem solve arise out of their lack of number sense and prerequisite knowledge. Therefore, Katie sees much of her instructional time spent on teaching students the “basics,” such as adding and multiplying, making it a challenge to teach her sixth grade curriculum in a way that she feels best supports students’ conceptual understanding – including communicating mathematically.

Highlighting her core identity of autonomy for mathematics instructional decisions, not only did Katie establish classroom norms that aligned with her focus on mathematical communication and students' ownership of mathematical ideas, she also utilized curricular resources well beyond the adopted text, such as CMP and NCTM developed materials. Despite the district adoption of a conventional mathematics textbook, Katie obtained a classroom set of the Connected Mathematics Project (CMP) curriculum (the middle grades Standards-based curriculum used in the online courses) and used it regularly for instruction. This was evident during observations of Katie's classroom.

Katie begins the lesson by asking students to gather the required material for the class from their table, which included a calculator and the classroom set of CMP. (Field notes, March, 5, 2008)

In addition to the curriculum materials Katie selected for instruction, she also sequenced curriculum topics around ideas that she felt connected conceptually, highlighting her sense of autonomy for making instructional decisions. She provided the following example.

If you went in order of the textbook, you would hit decimals and decimal operations, and then a few chapters later, you might talk about fractions, and then several chapters later, you talk about percents. Well, that just doesn't make any sense. It doesn't tie it together at all.

Katie's efforts to select curriculum materials that encourage the use of discussion and that focus both on students' conceptual and procedural understanding was in contradiction with her selection of problems and tasks for assessment. For example, the unit test on variables and patterns that Katie included in her Scoop Notebook consisted predominantly of problems that required only single numerical answers. A few problems were in real-world context, but the context was not needed to solve or justify the solution nor the mathematics used to arrive at that

solution. Katie's feedback on this assessment consisted of marking answers correct or incorrect and providing a percentage score.

Katie's sense of autonomy for making instructional decisions also extended to occasions where visitors entered the classroom. As a part of several professional development projects, Katie reported having observers in her classroom regularly. These observers included district and school-level leaders, a university professor, and the regional Mathematics and Science Partnership (MSP) coordinator. Despite being stakeholders in mathematics instruction, Katie had little concern for their presence in the mathematics classroom.

When somebody comes in to observe my classroom, they're just there. They're just another body in the room. I'm not really concerned with them; I'm more concerned about the kids.

School Community

Throughout the interviews, Katie repeatedly noted the high level of support for mathematics and science instruction within the school. Through several different AMSP grant initiatives (including the online courses), mathematics and science teachers in the school have regularly worked together to plan instruction, reflect on teaching, and provide professional development for other teachers. Katie attributed much of the teacher collaboration within the school to these professional development opportunities.

I feel like it's helped me develop closer relationships than I would have otherwise. It's more of a friendship than just a professional colleague relationship.

The conversations between mathematics and science teachers, especially those between Katie, the sixth grade mathematics teacher, and Leigh Smith, the seventh grade mathematics teacher, regularly centered on the teaching and learning of mathematics. I asked Katie to describe a

recent conversation between the two. She recalled a conversation they had regarding being open to the various approaches students take when solving a problem.

I think it is important to be open to the fact that there's different ways to work a problem, and I know Leigh and I have had discussions about this, that as long the kids can explain why they did something, if it's not exactly the same as what we've done, then that's okay ... as long as they can explain why and it works every time.

Despite her sense of autonomy for mathematics instruction, she noted the value of talking with others about mathematics and about teaching mathematics. In addition to conversations regarding teaching and learning mathematics, Katie felt a sense of comfort and openness to critiquing mathematics teaching between herself and Leigh Smith. She cited one example where she and Leigh discussed Leigh's pedagogical choices for division of fractions.

Instead of just saying to do an opposite operation like with multiplication, she teaches them to multiply by the reciprocal, which is the same thing, but we've had conversations about, "Well, why do that? That seems more confusing. Why do we, why do you go there, why?"

Katie stated that Leigh taught students to multiply by the reciprocal, rather than focusing on what constituted the whole, which Katie saw as central to students' conceptual understanding.

Katie's strong sense of autonomy for making instructional decisions may in part be due to the changes in school-level administration since she arrived at Carter. In discussing the strong relationships between math and science teachers in the school, Katie noted that administrative changes have required teachers to rely on one another more.

The administration changes so much, so, you kind of have to lean on your colleagues.

This sense of reliance on oneself and other mathematics teachers has given Katie pedagogical freedoms she might otherwise not have been afforded. Despite teachers' reliance on one another

for support, Katie noted that each of the mathematics teachers in the school have their own style, suggesting a view of mathematics teaching as an individual act with multiple ways of being effective.

I think we all, all three of us are good math teachers. We just have different styles.

Katie felt that as long as standardized test results were positive, then the individual instructional practices teachers take would not be in question. This view of instructional practices was common across the teacher participants from Carter.

District Community

Katie noted a strong sense of support at the district level for alternative views of mathematics teaching, explaining her sense of autonomy for making instructional decisions. Her involvement in multiple professional development projects has provided her opportunities to be an active participant within the school district, such as grant writing and co-leading professional development projects in the district. These opportunities resulted in her having the following perception of the district priorities for mathematics instruction.

That's one thing I liked about [our school district] when I student taught here is I felt like they were more open to allowing their teachers to develop a curriculum. As long as you were sticking to the dictated state standards, the way that you went about teaching them, anything goes as long as it makes sense and you're achieving. I just kind of feel like they trust us as professionals and as long as they feel like when they come in the room ... lessons are being taught, things are getting accomplished, kids are learning, that we're doing what we're supposed to be doing, we're doing our job.

Despite the support of alternative strategies for teaching mathematics, Katie noted that district administrators continued to rely on standardized assessments to determine students' mathematical knowledge and teaching effectiveness.

I think that the kids are judged on their math knowledge based on their test scores and not necessarily what they can say in conversation or whether they could explain something or not. More on whether they circled the right answer.

Taken in relation to her core identity, Katie's value of communication becomes evident in her critique of the use of standardized tests as she explicitly noted how standardized tests do not measure students' abilities to talk about mathematics. However, despite her critique, Katie uses those same test results to indicate the effectiveness of mathematics instruction at Carter.

Online Course Community

Katie characterized the mathematics teachers who participated in the professional development as enthusiastic, wanting to improve their classroom instruction, open to new ideas, and innovative. Other participants in the professional development felt Katie embodied much of the characteristics she placed on the group as a whole. During interviews, several teachers specifically commented on Katie and her willingness to use the pedagogical approaches suggested in the online courses. The following are representative of some of the comments made.

- I think definitely through our working [through the online courses] Katie has really taken off with Connected Math.
- When [Katie] did her presentation on her teaching, it was just awesome, the way that she was interacting with her kids, the way she presented the material, the way they were able to explore before they actually did the hands-on, definitely different atmosphere than ours is.
- I know that Katie Williams does the Connected Math a lot. She has that working pretty good.
- [Katie is] coming up with some new strategies that are gonna be very productive.

Despite the lack of an apparent set of shared goals for participants in the courses – some solely wanted graduate credit, some were compelled to participate, and yet others saw a need to

improve their instructional practices – Katie entered the courses with very specific goals for herself.

I came in knowing that I didn't want to be the kind of teacher that I had as a math student, but not knowing quite how to do that. The classes really helped me focus and to figure out how to achieve the goals I wanted to achieve – using real world learning to get kids to learn, to use investigation and questioning and not just be a lecturer and take notes kind of teacher.

Thus, Katie's goals for herself were in alignment with the goals established by university personnel when designing the courses.

Katie's core identity was manifested again when she spoke of the online courses in one of her interviews. She suggested she enjoyed the open-ended mathematics tasks and the sharing of solution strategies among participants.

Just listening to ... all the different approaches teachers had. It was really helpful to see all of those things, how other people thought, even if we arrive at the same answer, just the different roads everybody took to get there.

Katie also saw value in conversations that centered on the organization of curriculum topics that would best support students' mathematical understanding. Regardless of the nature of the conversations, Katie, as well as the other participants, saw more value in discussing mathematics and pedagogical approaches than other activities that were a part of the classes, such as reading cases of mathematics instruction or journal articles on mathematics teaching and learning.

Katie's Instructional Practices

Interviews, observations, and the Scoop Notebook provided information regarding Katie's instructional practices, which appeared to be moving toward reform-oriented approaches to mathematics instruction. A priori codes from Borko et al. (2005) were used as a general framework when discussing her practices. The following paragraphs provide further elaboration.

Katie used a standards-based curriculum, CMP, which focuses on conceptual understanding and connecting mathematics topics, as the primary resource for instruction. She did, however, often slightly modified the structure of her instruction to fit the time frame of her class or supplemented with resources she developed on her own. These modifications meant the curriculum's focus on conceptual understanding was sacrificed for problems that focused primarily on practicing procedures. Her use of CMP and the modifications she made were evident in the Scoop Notebook. Each of the four lessons included in the Scoop Notebook involved activities from CMP. In a lesson reflection she commented on a modification she planned to make to one of the lessons.

The next time I teach this lesson I will create some form of a worksheet that will provide more guidance to students, ...helping them get started with each problem.

When she did not provide opportunities for students to develop the conceptual understanding she valued, she was critical of herself in her reflections. For example, she made the following statement in a reflection in her Scoop Notebook.

I created a worksheet that was setup in an outline format. The purpose of this [worksheet] was to help students organize their answers. I feel it would be more beneficial to them if they had more time to experiment and develop ideas about patterns and equations.

Whether using CMP or other instructional materials, Katie used collaborative grouping as a regular part of classroom instruction. Typically, lessons began with some teacher-led instruction to set the stage for the lesson, followed by collaborative work in groups of two to four on a task or series of tasks. Sitting at round tables encouraged students to work together and share ideas. This collaboration appeared to be normative, as students appeared comfortable asking questions of one another and defending their solutions to others in their group. The

following descriptive notes from a classroom observation are illustrative her use of collaborative grouping.

Students sit in groups while the teacher gives directions for the task. Once she reads the goals, students move on to the cooperative activity using calculators, each other, and the teacher as resources. The students seem accustom to this instructional pattern.

Once students had opportunities to work collaboratively on a task or series of tasks in collaborative groups, Katie returned the students to whole-class discussion. In this whole class discussion, Katie used questioning to elicit how students arrived at a particular solution, but most justification centered on students' use of procedures and not why the procedures made sense in the particular context of the problem. For instance, during a classroom observation, Katie asked students the following question when writing equations.

When we are [writing equations] what symbol do we think of when we see "is?"

For instance, when Katie asked students to explain how they solved for an unknown in a linear equation, the student said, "We multiplied the number times six then we subtracted from 100."

Katie saw this justification as sufficient for explaining how students arrived at the solution, even though the problem was set in a context which provided opportunities to explain why those procedures made sense. Most justifications centered on procedures used when solving problems and typically only one solution path was presented, although multiple solution paths were possible for problems presented in class. Katie often used these conversations to gain information about how students were thinking about the mathematics in the lesson. For instance, Katie described the misconceptions that became evident during a discussion on writing linear equations. Since most classroom conversations focused on procedures, her assessment of

students' progress was limited to verifying that students had the correct procedures for solving a particular problem.

Although the whole class discussions seen in observations focused on procedures and single numerical solutions represented with symbols, data collected in the Scoop Notebook indicated that students had opportunities to represent mathematical ideas using multiple representations. For example, in a lesson focused on analyzing graphs and tables, students collected data, recorded the data in a table, graphed the data, then "told a story" of the data. Another example of students' opportunity to use multiple representations occurred during an observation of a lesson on probability. Students conducted multiple trials of coin flips and rolling a die to determine probabilities of particular events. Thus it appears that students did have opportunities to engage in tasks that required them to use multiple representations to communicate their thinking and make connections among various ideas, even though discussions focused on a single solution and the procedures to arrive at that solution.

It was evident that Katie connected mathematics to the real world when she had students collecting data and conducting experiments in class. However, Katie did not make apparent the connections to previously learned material or other subject areas during observations or in the Scoop Notebook. Since Katie focused whole-class discussions on procedures, connecting mathematical ideas was not a central part of those conversations.

Discussion of Katie's Identity in Relation to Her Instructional Practices: Research Question Two

The following analysis of Katie's identity is framed around each of the five characteristics of identity noted by Wenger (1998). Centrally important to this analysis is understanding the ways in which this identity unfolded in Katie's instructional practices.

Therefore, I use those characteristics to discuss how Katie negotiated a mathematics identity within the contexts of her work as a middle grades mathematics teacher.

Negotiated experience. During interviews, every teacher identified Katie as having instructional practices that aligned with those suggested during professional development; thus, many referred to Katie as the “best” teacher involved in the professional development. Placing a label on Katie, such as “reform-oriented” or “a standards-based teacher” and affirming her as the best indicates the value the online course community placed on the pedagogical approaches suggested in professional development. In other words, by referring to Katie as the best teacher in the group, the participating teachers indicated that the pedagogical choices she made were those that were most valued by the community. Katie was keenly aware that her instructional practices aligned most closely with those suggested in professional development. As such, the labels used to describe Katie reinforced the pedagogical decisions she made and encouraged her to more centrally participate in the instructional practices valued by the online course community.

Wenger (1998) described identity as a “layering of events” (p. 151) involving participation and reification, an ongoing process of experiences and their social interpretations. In this sense, the labels applied to Katie’s instructional practices take on a deeper meaning in terms of her participation in the online course community. Katie’s pedagogical approaches valued by others in the online course community allowed her to become a model for what is possible and desirable in the mathematics classroom. Yet, the online course community to which Katie belonged did not completely constitute the reification of Katie’s identity as a mathematics teacher since she also participated in other communities, such as the professional teaching

community at Carter. Katie's participation with two other Carter teachers involved in the professional development included a level of open dialogue and critique of their collective instructional practices that created images of Katie as central to mathematics instruction at Carter and the "go to" person for pedagogical knowledge related to mathematics.

Community membership. Membership within a community of practice consists of the extent to which an individual is competent in the practices of that community. Thus, an individual's identity is the extent to which the individual is able to (a) engage others in the community; (b) understand and take part in the goals, values, and beliefs of the community; and (c) use the resources to go about the work of the community (Wenger, 1998). As a teacher at Carter Middle School, Katie had access to a community of practice that valued ongoing discourse and critical reflection of the instructional practices used at the school. The professional teaching community at Carter saw those elements of communication as critical towards meeting their shared goal – improving mathematics achievement at the school. Katie functioned as a central member of this community, evident in the fact that she embraced co-planning and co-teaching episodes in her own classroom.

Katie's membership also extended into broader communities as well. While Katie was not central to the district's vision of mathematics instruction in terms of curriculum planning or textbook adoption, she saw a common vision with the district community. Katie's view of the district as supportive of her efforts to experiment with various curriculum materials and instructional strategies as a way of improving student achievement was critical in her success in incorporating the pedagogical approaches suggest in professional development. Yet, success using these pedagogical approaches also meant being familiar with the resources with which to

experiment. Therefore, being a central participant in the online course community meant that not only was she able to interact meaningfully with the other teachers in the online courses, but also use the curriculum materials, manipulatives, and other resources effectively in the mathematics classroom. Similar to Nasir's (2002) findings with mathematics students, Katie acknowledged that her participation in the online course community brought about new knowledge that led to a new identity regarding mathematics teaching and learning and motivation for future learning.

Learning trajectory. As mathematics teachers enter the classroom, they carry with them histories of mathematics instruction. These histories are built upon teachers' experiences as students in mathematics classrooms, preparation programs for teaching mathematics, and local (e.g., a school) and global (e.g., mathematics teachers, generally) expectations for mathematics teaching. These histories provide images of expected, potential, and desirable forms of mathematics instruction. Although Katie noted doing well in mathematics, her focus on teaching language arts while in her teacher education program perhaps limited her opportunities to identify with being a mathematics teacher. This K-8 generalist preparation may have allowed Katie to create her own unique identity, free of others' ways of defining effective instruction.

Equally important as her past is Katie's vision for her future in terms of mathematics teaching and learning. Katie noted taking the online courses not for graduate credit or for hours needed to fulfill district professional development requirements, but to learn about alternative ways of teaching mathematics. Additionally, Katie noted a desire to continue seeking learning opportunities that might help her improve her instructional practices. Therefore, Katie's learning trajectory consisted of continued opportunities to engage in communities that value and encourage approaches to mathematics instruction that are consistent with reform documents in

mathematics education (NCTM, 1989; 1991, 1995, 2000; NRC, 2001). In this sense, Katie has opportunities to act as a *broker*, spanning and linking multiple communities of practice.

Nexus of multimembership. The participating teachers in this study are members of multiple communities of practice, some communities contributing significantly to their identities as mathematics teachers, while others did not. In attempting to focus on communities that hold significant potential for influencing mathematics teachers identities, this study centers on four such communities, namely, district, school, classroom, and online course communities. The nexus of multimembership consists of experiences in communities of practice which influence mathematics teachers' identities and the work of reconciling those identities into an identity that is more consistent across community boundaries. While the work of reconciliation is highly social, taking place while functioning within communities of practice, the nexus itself may be very personal (Wenger, 1998). For example, despite the limited value of state achievement tests as a measure of students' knowledge of mathematics in the online course community, Katie recognizes the value of the test in her school and district communities as not only a measure of students' knowledge, but also of teaching effectiveness. Thus Katie must manage these conflicting values in her participation in both communities. The ways in which Katie goes about reconciling these views is unique to her and provides an image of the sense of power over the instructional decisions made in the classroom, an important part of her core identity. In this particular instance Katie noted both the weaknesses of the test in terms of students' opportunities to communicate their thinking and the benefits of the test in terms of representing the positive changes in mathematics instruction at Carter, thus allowing her to justify the use of her selection

of instructional materials and pedagogical approaches that would support students' learning of mathematics.

In another instance, Katie reconciled the district's adoption of a conventional mathematics textbook with the value placed on standards-based materials presented in the online courses by focusing on the district's support of innovative approaches to mathematics instruction. In doing so, Katie was able to satisfy both the districts expectations for mathematics instruction and her own desire to select materials that encourage communication and students' ownership of mathematical ideas. Katie's statement of "tell me what you want to tell me, but I'm gonna do what I think is best" is important for understanding her work towards reconciliation. Katie determined what is "best" based on two parts of her core identity: communicating mathematically and students' ownership of mathematical ideas. Thus, while Katie is accountable to each of the communities of practice in which she participates, her work towards reconciliation focuses on aligning the various priorities of communities with those elements of her practice she seemed unwilling to relinquish.

Relations between the local and the global. Katie recognized connections of her practice to broader communities of mathematics teachers. Katie began attending a local mathematics teacher association and participated in a National Council of Teachers of Mathematics regional conference. Thus, by attending these events, Katie had opportunities to connect her practice to those outside the district. By doing so, she had opportunities to reaffirm the pedagogical choices she made and become aware of new possibilities for mathematics instruction. By participating in these broader communities Katie was privy to broader and more public visions of mathematics instruction, placing her instructional practices within those broader visions.

Summary of the Case of Katie Williams

Katie's preparation as a K-8 generalist and the reading/language arts focus in her teacher education program, may have afforded her a view of mathematics teaching and an identity that differed from the other teachers in the study. Katie entered the online courses open to a different view of mathematics teaching, but did not have a concrete image of how that might play out in the mathematics classroom. She quickly took on an identity that was consistent with the goals, values, and beliefs represented in the online courses. This identity, which focused on mathematical communication and ownership of mathematical ideas, not only impacted her instructional practices, but the ways in which she participated in each of the four communities. As such, these elements became important aspects of her core identity as a mathematics teacher.

Katie's evolving identity towards reform-oriented approaches to mathematics instruction led to her being labeled as the "best" by participating teachers in the online courses. Katie's awareness of others' perceptions reinforced the pedagogical decisions she made. Additionally, the professional teaching community at Carter, of which Katie was a member, further reinforced her value of communication through the teachers' own open dialogue and critique of instructional practices and also laid the foundation for future teacher learning at Carter. Lastly, although Katie did not participate centrally in the district community, she perceived their support of reform-oriented approaches to mathematics instruction and felt comfortable rarely using the district-adopted textbook. Perhaps most important was the alignment Katie perceived of the goals, values, and beliefs of each community in which she participated, which yielded an identity that was consistent with her selection of pedagogical approaches.

The Case of Leigh Smith

“I don’t know if they think I’ve changed a whole lot with my style, but enhanced I think would be a better word.”

Core Identity and Community Participation: Research Question One

The case of Leigh Smith begins by describing several findings regarding her core identity as a mathematics teacher, which centers on mathematics content and the need for practicing mathematics to be successful. These two characteristics became important aspects of her core identity as a mathematics teacher. The following paragraphs provide further detail on these findings regarding her core identity and become more evident as they are discussed within the context of each community.

In contrast to Katie, who adopted many of the pedagogical approaches suggested in the online courses, Leigh did not adopt these same practices. As Leigh stated, she enhanced the instructional practices she initially developed at a large, urban Midwest school district during the two years prior to beginning at Carter. The year she began teaching at Carter coincided with the beginning of the online courses. Leigh held a K – 8 teaching license, but in the state where she obtained initial licensure, she could also teach ninth grade mathematics due to additional mathematics coursework and a passing score on a teacher’s content knowledge test. Also in contrast to Katie, Leigh intended on becoming a mathematics teacher during her teacher preparation program and had nearly enough undergraduate mathematics courses to obtain a bachelor’s degree.

Leigh’s identification with mathematics content was evident in her participation and characterizations of each of the four communities, and therefore was a significant part of her core

identity as a mathematics teacher. For example, Leigh stated that the best classroom teaching involved “knowledge and interaction. Knowledge for the subject area, interaction with their students that makes the students want that knowledge.” Additionally, in the online course community, Leigh categorized herself and others in the courses as “math geeks” – using the term affectionately to describe those that had a passion for the subject. In addition to a strong background in mathematics, Leigh expressed love of doing and teaching mathematics during interviews. Leigh stated that she enjoyed showing students real world connections to mathematics – finding utility in the concepts learned in the classroom.

I love math. I’ve always loved math. Math’s my passion. Math is just everywhere. I could do math all day. [Mathematics plays] a role in every part of [a student’s] life. They don’t see it as a role until you point it out to them. They don’t see what they do every day as having math until they are shown it. They hear that they’re not gonna use it, but they really are using it and it’s just coming across and dissecting their day.

Another part of Leigh’s core identity as a mathematics teacher is the need for personal responsibility in practicing mathematics to be successful. In Leigh’s view, success in mathematics required significant practice. Expectations for students to practice mathematics, and thus having success in mathematics classrooms, involved multiple levels of support, including community, school, and classroom expectations for practicing mathematics. Therefore, unless both the community and school share this view of mathematics, they may be seen as devaluing the importance of the subject. This was evident in the following interview excerpt:

There’s so much practice involved. We can’t get as much done. So they’ve gotten the practice in the classroom, they go home and have the practice, they come back, they have more practice so it’s continuing so they don’t lose it the minute they walk out of my classroom. And we’ve gotten so far in the direction of handholding that we can’t expect them to do any homework. I don’t see the

same results because I have to spend so much time going back to what they're not getting because they won't do anything if you're not standing over them.

Leigh's passion for mathematics content and the need for students to practice mathematics in order to understand that content, two elements of her core identity, were evident in her participation in each of the four communities. The ways in which this core identity played out across each of the four communities is the focus of the following sections.

Classroom Community

Since mathematics content was a significant part of her core identity as a mathematics teacher, she saw Leigh's mathematics class focused on procedural oriented tasks that most often lacked a context, selecting problems that encouraged students to quickly find single numerical answers. Leigh saw herself as the authority in the classroom and felt she had to control the learning environment. This meant that students participate by observing Leigh model problems, then practice problems similar to those solved by Leigh. Her focus on procedural oriented tasks aligned with her view of mathematics learning requiring significant practice. Drawing on observational data, practice for Leigh involved solving multiple problems that are similar to one another until students learn the procedures involved in solving the problem. The following sequence during a probability activity was representative of the ways students participated in Leigh's classroom.

Leigh: We are going to look at things where outcomes change each time. Get out your bucket [of Snap Cubes] and take a few of each color.

Leigh: Remember the big rule with manipulatives is that we have to stay together or we can't use them. (*Observer comment: Leigh calls attention to students having them follow an example of removing black cubes continually without replacement.*)

Leigh: Three out of eight, two out of seven, one out of six. What if I want to find the probability that all these things happened, what would I need to do?

Student: Multiply

Leigh: Good (*Observer comment: Several students raise hands to ask questions. Leigh calls on students to gather the same number and type of cubes. She does three more examples, requiring students to model her selection. Leigh assigns problems from book. Students work quietly even though they are organized for collaborative grouping.*)

In the opening quote used to characterize Leigh, she chose to use the word “enhanced” when asked how her instructional practices had changed as a consequence of taking the online courses. This meant that she occasionally assimilated selected new tasks into her existing set of instructional strategies. For example, Leigh included a lesson on `permutations and combinations that required groups of students to work together to form “human permutations and combinations” in the school gymnasium. The same lesson included using snap cubes as a manipulative for multiple tasks involving combinations and permutations. In this lesson, Leigh reflected on the value of the types of conversations she was able to elicit.

I expected the conversation regarding examples of permutations and combinations to go a little quicker than it did, but it was a really good discussion with rich ideas and I chose to let the conversation continue. [The task and the ensuing discussion] created a rich background for students to grasp the formula without hesitation.

Leigh commented on how much the students enjoyed the lesson and the task she selected for homework – playing a permutation game with their parents at home. Additionally, she noted the fluency with which students were able to identify and solve problems that involved permutations and/or combinations. However, as indicated in the above sequence, this was not the norm from analysis of observations and the Scoop Notebook.

Leigh’s task selection for the lesson on permutations and combinations serves as an example of her enhancement of instructional practices, which entailed selecting tasks that were

consistent with the approaches suggested in the online courses, yet maintaining her core views of mathematics teaching and learning by limiting the incorporation of such tasks. As I prompted her to identify elements of her instructional practices that had changed, she stated the following:

Maybe [I use] more questioning that I had previously been to make sure that everything's clear. I don't use [CMP materials] quite the same way as Katie does, but I put them into my classroom as well.

Leigh's comparison of her use of CMP to Katie's use underscores Leigh's knowledge of the instructional practices used by other teachers at Carter. The relationship among the mathematics teachers at Carter and Leigh's participation in their collaborative efforts provides another view of Leigh's identity.

School Community

Leigh described the mathematics teachers at Carter as “always striving to learn” and willing to work together to improve mathematics instruction at the school. Through their work together, the mathematics and science teachers in the school had opportunities to co-plan and co-teach lessons with one another. Leigh saw these opportunities as beneficial for students since each teacher brought different ideas and ways of approaching a particular concept. Despite the high level of collaboration among mathematics and science teachers in the school and their ongoing participation in professional development activities, Leigh stated that teachers in the school that do not teach mathematics and science are unfamiliar with their work towards improving math and science instruction at the school. Although the math and science teachers enjoyed a high level of collaboration, Leigh followed Katie in her description of the instructional practices mathematics teachers take in the school.

I think we're all very different actually. I mean, even though there's three of us, I think we're very different. We all meld well together, but as far as the way we

teach and our styles, I think there's a lot of difference between the three of us. I think it's just our personalities. I don't know that it would be good or bad [if we were all the same]. I think the kids get to see different ways of math being presented and know it's all okay and they're gonna get some styles they like more and some less and that's okay. You know, because they'll come to find what they can learn best in as well, I think. I mean, most of us have had a teacher that sometimes this is the kind of teacher we seem to meld better with than others.

Despite the varied instructional strategies, Leigh concurred with Katie in stating that their varied pedagogical approaches are justified since standardized test results indicated their students performed well.

Leigh saw Carter as a parent-driven school that limited her ability to teach mathematics in a way she saw as necessary for student success. For Leigh, the community that Carter served did not value education; thus, she felt her efforts to encourage students to regularly practice mathematics to ensure learning was not supported by parents, evident in the following interview excerpt.

It's very parent-driven and when they're not happy about something, it kind of limits what we do. For instance, with the homework or things such as that. It kind of limits [what we can do] in the classroom.

Leigh did not, however, note these same limitations with her instruction in the integrated mathematics and science course. The mathematics and science teachers at Carter designed and implemented a separate course that integrates mathematics and science topics. This course provided additional opportunities for teachers to work collaboratively. Leigh strongly valued the opportunities she had in the integrated course as it provided her an opportunity to show students the utility of mathematics.

That's the great thing about our sci-math lab that's been awesome too, is we really are able to take anything we can use in the classroom and just show them. And then you know, suddenly they're going down the street or they're in a store and they'll be like, "Oh yeah, I can figure that out." You know, we've done a lot

recently with sales tax and discounts and for the kids to come back and say, “Yeah, we went in the store the other day. This was on sale and I was able to figure it out before we got to the register.” I mean, that’s the kind of cool stuff, something they really can use.

However, her integration of other subject areas and the outside world was often limited to the integrated course. Observational and interview data indicated that she attempted to use more student-centered activities in the integrated course.

District Community

Leigh articulated a district vision for integrating mathematics and science instruction, evident in the support for the integrated mathematics and science course. She also stated that the district had a broad vision for creating a comfortable learning environments in mathematics classrooms, evident in the following statement.

I think [the district] wants high quality programs, high quality teaching in place for our students. I don’t think it is something specific. I think it is a feel of a math class ... you walk in and you see math on the walls, you see the students working, and you see the environment ... Creating an environment where kids feel comfortable trying the math.

Both Leigh and Katie perceived the district as lacking a specific vision for what mathematics instruction should look like, yet saw the district as encouraging teachers to improve their practice in a variety of ways through available professional development initiatives.

Leigh contrasted what she felt was a broad vision for reform with the very specific vision for mathematics instruction at the previous school district in which she worked. Leigh noted her previous district’s reliance on the state achievement test to determine academic success. While teaching there, Leigh commented that she felt pressure to align her classroom grades with the outcomes of the state achievement test. She stated during interviews that improving mathematics instruction in her prior district was a priority and centered on ways to improve standardize test

scores, which meant increased time for practicing mathematics. This took the form of an additional mathematics classes for some students, but impacted all students through increased accountability for success in mathematics.

The big mindset in the district I came from is our superintendent came out and told us if they can't pass [the state achievement test], they better not be passing your class. I mean, she truly wanted a reflection of what they knew to be their grade. [Our focus] was [on] trying to bring up the district's math scores, which we did significantly that year. But that was one thing they had decided to create, one semester instead of art or band or whatever, the kids came to me and we just did problem solving for a semester during their related arts' time.

The vision for improving instructional practices in this prior district appeared to be consistent with her core identity, focused on mathematics content and practice mathematics to ensure success.

Online Course Community

Leigh described the teachers in the online courses as caring people who were genuinely interested in improving mathematics instruction. She saw those in the online courses as having a shared goal for learning about teaching mathematics. Like Katie, Leigh highlighted the benefits of communicating with teachers from around the district during the online courses, as evident in the following statement.

There was tons of math knowledge just floating around so it was great to get together and be able to talk to other people who have a passion for something as much as you do. That was the neatest thing about the courses is you had math teachers from everywhere, all in our district, all getting to sit and share ideas and realize that there's one problem, but we're seeing it eight different ways and that really helps. Because when you are able to say, "Well some of my students are probably seeing it this way or this way ..." You had ideas on how to approach the same thing.

Evident in the previous quote is the value Leigh had for discussing mathematics with other teachers. However, she did not afford these same opportunities for students to discuss

mathematics in her classroom. Many of the discussions in the online courses centered on tasks from CMP, which Leigh noted as having a limited influence on her instructional practices. She compared the influence on her instructional practices with the influence she perceived the courses had on Katie.

I think definitely through working [on mathematics in the online courses] Katie has really taken off [with] Connected Math. I think the courses just made me aware, aware to look at things from many angles. I think that's a hard thing. We start to see things in one way, especially when we've been teaching the same thing for a couple of year. And we start to see it as this and we forget to look at it from different perspectives and I think that helped me a lot.

Thus Leigh saw value in discussing mathematics content with other mathematics teachers since her core identity focused on mathematics content as well. Although Leigh provides somewhat tepid statements regarding the influences the courses had on her instructional practices and the opportunities she provided for students to discuss mathematics content, she did note the benefits the online courses had on her relationship with Katie, evident in the following statement.

[The courses] helped me get to know Katie. I didn't really know her at all before the courses and really got a comfort level working with her and we're able to work very well together, which helps in transitioning the kids from the sixth to the seventh [grade], having the cohesiveness.

Therefore, inconsistencies exist in how Leigh participated in the online course and school community in comparison to her participation in the classroom community.

Leigh's Instructional Practices

Borko's (2005) framework guided the analysis of Leigh's instructional practices, which were gleaned from interviews, observations, and the Scoop Notebook. The analysis suggests Leigh's instructional were traditional with practices could be considered largely traditional, outlined in further detail in the following paragraphs.

All data sources indicated that Leigh relied heavily on teacher-led modes of instruction. Typically, Leigh presented a lesson, modeling ways for students to solve a particular problem. Students then worked to solve problems similar to those solved by Leigh. The following lesson reflection included in the Scoop Notebook describes her use of a manipulative to demonstrate differences in independent and dependent events was representative of her teacher-led mode of instruction.

I like to break concepts into simple building blocks whenever possible. I decided today I would use the manipulatives as a demonstration. The demonstration seemed to be effective to differentiate between independent and dependent events. We did many examples and the idea seemed to stick. The trickier part was the mutually exclusive. I used the tiles (I added numbers to the tiles) and for most of the students it seemed to create an understanding, but for a few they seemed to get stuck up again on the title so we talked about what the words of the title actually mean. Then we did more examples to reemphasize. This seemed to help those who were stuck. Overall, it was a satisfactory lesson.

Despite the fact that Leigh had a classroom arrangement similar to that of Katie, with groups of two to four students sitting at round tables throughout the room, students worked on assigned problems individually. Collaborative grouping was not a regular part of students' participation in mathematics classes. It appeared normative for students to speak only when called upon individually. However, during one classroom observation, students worked in pairs with Snap Cubes to investigate differences between independent and dependent events. Leigh stated that this lesson was the first time she had used the Snap Cubes (Field notes, March 12, 2008), which served as the only concrete material used during observations or lessons included in the Scoop Notebook. Despite students' opportunity work in pairs on the activity, many students continued to work individually (Field notes, March 12, 2008).

Students also had opportunities to work with one another creating human models permutation and combination situation in a lesson included in the Scoop Notebook. These collaborative activities were not typically used in Leigh's classroom, as four of the five lessons included in the Scoop Notebook required students to work independently of one another. When students did complete collaborative work in class, the teacher provided a sample problem prior to group work, and then required student groups to do a similar problem or construct a similar model (Field notes, March 12, 2008). Therefore, as students worked individually or in groups, students followed problems modeled by the teacher and did not extend the skills she addressed, answer higher level questions, or make connections among broader concepts.

Data indicated that Leigh often used multiple representations to explain ideas. For example, when demonstrating how to solve for the surface area of a particular solid, Leigh related the formula for finding surface to a series of two dimensional pictures of that solid, connecting the symbolic formula to a pictorial representation (Field notes, March 5, 2008). The use of multiple representations was largely restricted to demonstrations made by Leigh, the source of mathematics knowledge in the classroom, rather than students. However, during the two collaborative grouping sessions mentioned above, students had opportunities to model mathematical ideas using Snap Cubes and "human permutations." Leigh used these activities for initial exploration of ideas. Subsequent problems in the human permutations lesson that students solved in class and those problems Leigh assigned for homework required only single numerical answers, not the use of a variety of representations to solve or justify the solution. During classroom observations, this was evident as students asked questions about problems Leigh assigned for classwork and homework. In fact, Leigh's selection of tasks/problems

generally did not require extensive justification. She did expect students to explain their procedures for solving problems, but did not expect students to elaborate further on why those procedures made sense even though the problems were set in typical probability contexts (playing cards, books on a shelf, number cubes, spinners, and marbles in a bag) that may have provided a way of talking about the solution beyond procedures. There was no evidence to suggest that Leigh provided problem contexts that connected to previously learned material or other subject areas in this series of lessons.

The assessment instruments Leigh used closely aligned with her selection of tasks and expectations for students' explanations. For example, the test Leigh made for her unit on permutations and combinations, which she included in the Scoop Notebook, consisted of multiple problem contexts and two problems that required students to explain their thinking or create problem situations on their own. However, the vast majority of problems on the test required only single numerical solutions.

Discussion of Leigh's Identity in Relation to Her Instructional Practices: Research Question Two

The five characteristics of identity noted by Wenger (1998) frame the following analysis of Leigh's identity. Identical to Katie, central to this analysis is understanding the ways in which this identity unfolded in Leigh's instructional practices, thus affording and/or constraining certain ways for students to participate in the mathematics classroom.

Negotiated experience. Leigh entered Carter Middle School at a time when district leaders made significant professional development opportunities available. Through these professional development experiences, Leigh constructed a mathematics teaching identity that

reflected her participation in the professional development projects, in the school community, in the mathematics classroom, and the reification of those collective experiences. Other teachers at Carter referred to Leigh as the expert in terms of mathematical knowledge, serving as support for the two other Carter teachers involved in online courses. It was important to Leigh for others to value the mathematical knowledge she had – her passion for mathematics was a significant part of her core identity as a mathematics teacher.

Coupled with her passion for mathematics was expected rigor in doing mathematics, which, for Leigh, entailed students practicing skills and procedures by solving a multitude of similar problems. Despite the value that Leigh and the other mathematics and science teachers at Carter had for Leigh's knowledge of mathematics, her comments regarding the school community seemed to indicate she felt school leaders and parents did not similarly value this knowledge – even though state achievement scores indicated Leigh's "success" in the classroom. Negative incidents, such as the conflicts Leigh had with school leaders and parents, bring identity to the focus (Wenger, 1998). Based upon her interview, it was clear that the very essence of who Leigh was as a mathematics teacher came into question as her core identity came into question. Rather than focusing on the ways in which she might improve her practice, Leigh found fault in students' willingness to practice mathematics to be successful. Additionally, the challenges Leigh faced with parents and the school principal hindered her willingness to take risks in the classroom.

When Leigh's emphasis on practicing mathematics was challenged by school leaders and parents, Leigh sought refuge in her relationships with other mathematics and science teachers at the school. The Carter teachers' professional trust and openness to a variety of instructional

strategies effective for student learning provided Leigh support when challenged by those outside the math teaching community. Although they may not have valued her instructional practices for themselves, they considered her approaches to be successful since her standardized test score results were positive. As such, Leigh's remained somewhat entrenched in traditional modes of instruction, incorporating student-centered activities on occasion.

Community membership. Similar to Katie, Leigh had access to a community of practice at Carter that valued ongoing discourse and critical reflection. However, Leigh's utilization and participation in this community differed from Katie. Leigh saw the community as a resource for integrating mathematics and science content, particularly in the integrated mathematics and science lab, where as Katie saw the community as a resource for her efforts to integrate standards-based teaching practices. As such, while Katie made use of Leigh as a resource for mathematical knowledge, Leigh relied more heavily on the science teacher who co-taught the integrate mathematics and science lab for real world connections to mathematics.

Leigh's identity in the context of the school is a reflection of the ways in which she engaged the community of practice at Carter. Leigh participated in the community in ways that allowed her to retain her instructional practices and incorporate outside activities. However, incorporating some reform-oriented materials was important in understanding her progression as a mathematics teacher (Nasir & Hand, 2006). Leigh's apparent "cherry-picking" of activities from CMP was consistent with her interpretation of enhancing her instructional practice subsequent to professional development opportunities and is apparent in her statement of not changing her instructional practices, but "enhancing" them.

As Leigh made the comparison between her previous school district and the district she taught in during the time of this study, it was evident that her core identity aligned well with the vision for mathematics instruction in her previous district. Leigh taught a mathematics class in her previous district that was developed to assist students struggling in mathematics. This class provided Leigh opportunities to encourage additional practice solving problems. Furthermore, her reliance on state achievement tests as an indicator of teacher effectiveness may come from her participation in this past district. The belief that classroom grades should reflect state achievement scores seemed to be reflected in her highly structured, teacher centered instructional practices. Leigh's perception of a lack of such a specific vision in her current district perhaps allowed her to further retain her past mathematics teaching identity.

Learning trajectory. Leigh reports that her success as a student of mathematics, both at the K-12 and university level, gave her sense of confidence in mathematics. Therefore, when Leigh decided to become a teacher, she intended on teaching mathematics, particularly middle grades mathematics. While the oft used adage "teachers teach as they were taught" may or may not hold true, Leigh's strong identification with traditional approaches to teaching mathematics was undoubtedly connected to her view of how she learns best. For example, she described taking copious notes when learning new ideas, whether or not she foresaw using those to gain understanding later. Leigh used that same vision in her own mathematics classroom, requiring students to take detailed notes of her lesson.

Identity is, in part, integrating past experiences, such as Leigh's experiences as a student of mathematics, and anticipated future experiences (Wenger, 1998). In an interview Leigh stated that professional goals did not include teaching middle grades mathematics, but teaching

mathematics at the high school or college level. Since her future trajectory did not include teaching middle grades mathematics, Leigh had little need in identifying with being a middle school teacher, which might include general pedagogical approaches appropriate for adolescents (such as those promoted by the National Middle School Association [NMSA], *This We Believe*, 2003), or even more important, approaches specific to the mathematical education of adolescents. Consequently, the identity formed by Leigh as she participated in district, school, and professional development communities was what Wenger (1998) referred to as a *peripheral trajectory*, one that does not lead to full participation in a community of practice, but still is significant enough to influence one's identity. Although she participated in the online courses and several other professional development initiatives in the district, Leigh's comments regarding her participation focused on mathematics content, a significant part of her core identity. This peripheral participation was evident in her instructional practices through her use of curriculum materials in support of students' learning and classroom mathematical norms, which included predominantly teacher-led activities supplemented with the occasional use of student-centered activities.

Nexus of multimembership. Leigh's work towards reconciling the various goals, values, and beliefs of the four communities resulted in an identity that was more of a reflection of her past experiences as a student and novice teacher than her ongoing opportunities at Carter. The critical dialogue evident in the community at Carter, developed through teachers' participation in the professional development projects, fostered an expectation for continued improvement and experimentation with mathematics instruction. Based on conversations with university faculty responsible for teaching the online courses, Leigh was open to the critical reflection and

experimentation needed for the vision of standards-based instructional practices to materialize at Carter. However, as Leigh felt increasingly constrained by parents and the school principal from what she saw as students' lack of "personal responsibility" for learning mathematics, she reconciled her participation in the communities quite differently. Leigh appears to have reverted to an identity that was more consistent with the identity she formed during her first two years of teaching in another district. This may be apparent for two reasons. First Leigh felt successful in that district, so taking on an identity consistent with their vision validated that her instructional approaches were valued, even if not in the current school. Second, by limiting reflection and experimentation, she restricted further critique of her instructional practices.

Relations between the local and global. Much of the work of reconciliation for Leigh centered on comparing the local community of practice to broader practices elsewhere, namely, her experiences in another school district. Yet she also participated as a member of NCTM. Like Katie, Leigh attended NCTM meetings, finding value in the ideas presented and resources she could use in her classroom. Yet, her affiliation with being a middle grades mathematics teacher was limited, since her professional goals didn't include continuing to teach middle school math. Therefore, Leigh had little need to consider the ways in which her practice connected to broader practice of mathematics instruction at the middle school level.

Summary of the Case of Leigh Smith

Leigh saw herself as a content specialist over an expert in pedagogical approaches appropriate for adolescent learners. As those pedagogical approaches were called into question, Leigh continually noted students' unwillingness to practice mathematics, another important aspect of her identity as a mathematics teacher. Leigh's past district played an important role in

forming this identity. She stated that in her former district, state achievement scores and the alignment of those scores to students' performance on classroom assessment instruments determined teaching effectiveness. As such, Leigh developed instructional practices that centered on teacher-led, procedural oriented activities that she felt would help students develop the skills necessary to do well on the test. Leigh's preparation as a mathematics content specialist also influenced her identity and the ways she participated in each community. She valued being recognized as an expert in mathematics at Carter and, to a lesser extent, in the online course community. The value she placed on being knowledgeable about mathematics rather than on pedagogical approaches appropriate for adolescents further reinforced her use of conventional approaches to mathematics instruction.

As she participated in the online courses and the evolving professional teaching community at Carter, she increasingly valued collaboration and discussion with other mathematics teachers. However, it did not appear that Leigh regularly used this as a pedagogical tool in her classroom, even though she noted the benefits of doing so. Additionally, Leigh attempted to incorporate selected activities from CMP and other reform-oriented materials on occasion. By doing so, she was able to retain her existing identity as focused on mathematics content and personal responsibility for practicing mathematics while satisfying the local expectations of mathematics instruction among the participants in the professional teaching community at Carter. It appeared as though Leigh was attempting to further incorporate reform-oriented approaches to mathematics instruction until the school principal and parents challenged her, after which she appeared to revert to an identity that was wholly consistent with her prior teaching position.

The Case of Morgan Roberts

“Just these three years of teaching, I’m seeing – to teach math, we have to do it differently. We just have to do it differently.”

Core Identity and Community Participation: Research Question One

Morgan’s core identity involved providing students opportunities to explore mathematics and asking questions that elicit discussion and support students’ explorations, which become evident within each of the four communities. Although Morgan felt that mathematics should be taught differently, her lack of experiences as a mathematics teacher made it difficult for her to articulate how mathematics should be taught. This lack of experience as a mathematics teacher stemmed from the fact that she was a K-6, modified special education teacher and in her third year of teaching at the time of this study. She reported not having a strong mathematics background or a preference for teaching mathematics due to her preparation as a special education teacher. However, Morgan was asked to teach resource mathematics her first year at Rose. Due to her assignment as a resource mathematics teacher and to strengthen her knowledge of mathematics and teaching mathematics, the school principal asked her to participate in the online courses during her first year of teaching. In addition to using the online courses to bolster her knowledge, Morgan reported a desire to gain highly qualified status in all subject areas and planned to take a series of content knowledge test that would grant her that status in her state.

Morgan reported that in her second year of teaching, a new principal decided that learning disabled students’ scores on achievement tests would be improved if students participated in inclusion classrooms; therefore, Morgan’s role in the classroom was relegated to support for the regular classroom teacher. Thus, she lacked the authority for making pedagogical

decisions when teaching in inclusion classrooms. In her role as an inclusion teacher, Morgan served as support in two mathematics classes, with another teacher in the online courses.

Morgan described this secondary role during an interview.

A lot of times there's no planning at all, whatsoever, no planning whatsoever. I don't know a lot of times where the students are. [The regular classroom teacher] has said things where I know for sure that she needs and wants that complete control.

As a special education teacher, Morgan's knowledge of the difficulties her students have with learning mathematics and the fact that she taught multiple subject areas brought a unique perspective to the online courses and this study. She could articulate how students struggle with mathematics and compared ideas regarding teaching and learning mathematics with teaching and learning in other subject areas. This comparison is evident in the following quote.

There are so many things you can do with writing that there's more than one way you can do it. In the sense that – in comparison to math, there's only one answer in math. And I think there's a big fear with kids. They just hate math. They said that more than once in math class. And it's getting them to love it and to like it and to feel like they can do it. I love that challenge. I don't find that so much in any other subject.

Morgan had general ideas regarding instructional strategies that would support students' understanding and alleviate their fears of mathematics. These general ideas include giving students' opportunities to experience mathematics, as indicated by the following interview excerpt.

I think a lot of [learning mathematics is] experiential, just experiencing it ... which we just don't do – we don't give them a chance to think beyond the box, like, "Okay, here's your problem. What are the different ways in which you can solve it?" And I think what happens is that students don't see that they have the ability to do that. They say, "How do I do this?" basically. "What's my formula? How do I plug it into a calculator? How do I get the answer?" They don't see – okay, "Here's your time to explore. Here's your problem. Think of all the different ways you can solve it." for that matter. I don't think they're ever given

that opportunity as much. And I think from the exploration phase, you're going to get questions. You're going to get concerns. You're going to get really where they are in their level of development with math.

Thus, a key element of Morgan's core identity was providing opportunities for students to explore mathematics which supports students' view of mathematics as significant in their lives and helps motivate new learning. This value on exploring mathematics included problem situations in students' everyday lives.

I see math totally different now. I see it as an experiential thing, something they're going to be using in everyday life, and that we have to focus on that, teaching that, and we're teaching that to the students because they don't see it as anything practical than adding and subtracting, and as I may never use this in my life. [Students say,] "This is stupid, dumb. I don't even know why we do math." They've got to see the need and significance for math for it to be motivational to them.

In conjunction with her value of exploring mathematics, another key element to Morgan's core identity was her value of questions that elicit discussion and encourage students to explore mathematics. Her value of questioning to support meaningful classroom discussion was evident in her statement describing effective mathematics instruction.

There's a lot of interaction and discussion being done about the problem, a lot of questions, good, quality questions being asked, the students really have to think. So I see a lot of that. I don't see just problems on the board and let's figure them out. I see a lot of discussion, interaction, open material. The struggle [is] finding the right questions to ask, understand the material to the point that I can ask higher level thinking questions. That's my goal for myself, is to be able to know the material so well that I'll be able to provide questions like that.

Classroom Community

Although Morgan had a general vision for effective mathematics instruction evident in the preceding quote, she had difficulty articulating a more specific model of how this might play out in her own classroom. The fact that she was a special education teacher in the inclusion

classroom and not seen by the classroom teacher as a co-teacher meant that she was not responsible for the pedagogical decisions in the classroom. Therefore, since she was not responsible for mathematics instruction, it was difficult to find evidence of her core identity in her classroom community. Since the regular mathematics teacher made instructional decisions, Morgan's experiences during the two years she worked with this teacher were quite different. She described her first year as an inclusion teacher as highly structured and traditional.

[Students] come in; [they] have five practice problems. Everybody knows that everybody gets their same set. It's more routine. They do them. They move on to the instructional level, practice homework. That's how the structure was every single day. Fridays were tests. A few kids like doing that. So it was very structured, and I think that's probably a way a lot of math classes are. This is a concept; let's teach it. Here, you practice it. Do the homework, move on to another skill.

Morgan stated that this was typical of mathematics instruction at Rose Middle School. Typical mathematics instruction at Rose also included a reliance on the textbook as the sole source of mathematics content and pedagogy, moving from the first section of the book to the last section of the book by the end of the school year.

[Teachers at Rose] go right straight from the book and right from the book from cover to cover. They go through the whole book by the end of the year. They go on. They push through. Get it or not, they're pushing through.

In contrast to this first year, Morgan summarized her experience in the mathematics classroom during the second year with this teacher as lacking the structure evident during the previous year. In an introduction to her Scoop Notebook she stated,

This year teaching has taken a different twist for me. We are trying differential learning. What I take this to mean is that teacher/s in the room will introduce the beginning of a chapter to the class. I never really know when this was going to happen. Planning was very difficult and the time we did get to talk, it was about progress for a student and getting grades. I was often confused about what was expected and this was due to the lack of time for communication.

She provided more details contrasting her experiences in this differentiated classroom during an interview.

The way I teach now it seems is, “Where are you? What do you know? This is what we’re working on, but do you know how to do it?” If they can’t even add decimals, we have to go back to adding numbers. If they can’t add three digits, we gotta go back to adding two digits, one digits, wherever they are, and saying, “Let’s master that skill and move on.” That’s how I feel like it’s different. And now, just trying to teach them different methods, so they can get it. And I think with my kids learning disabled, a lot of them in math, or just have a real low self-esteem, or just have – just been pushed through for whatever reason it seems like, I’m having to teach totally different. It’s not a whole group discussion; although, I think they could benefit from that, I’m sure. I’m sure they can do it, but I think if we got up today and taught fractions, I think 25% of the class would get ‘em. The other 75 doesn’t even know the multiplication tables. So it’s 60 minutes of whirlwind. You walk in the door, and you start in the back. “Got what you’re working on? Get it out. Where are you? Any questions? Moving on. Got a pencil? Got paper? Where’s your eraser? Need this sharpened?” And you’re doing that throughout the whole class, until the end of that 45 minutes.

Lessons included in the Scoop Notebook and classroom observations indicated that students completed individual seatwork throughout class time. Each student worked to complete a packet of worksheets which focused on one skill or similarly related skills. Once that student completes the packet, they move on to the next packet of material. The teacher determines a grade based up the number of items a student correctly answers in the packet. Morgan and the regular classroom teacher walk around the room, managing behavioral issues and answering students’ questions. The following descriptive notes from classroom observations highlight Morgan’s role in the classroom.

Students enter the room and sit at desks that are arranged in rows. The teacher [Morgan] passes out folders to students and asks them to begin working on the packet of worksheets inside. A few students comply, but most continue to talk to students in the vicinity or are up and moving around the room. The teacher walks around the room, redirecting behavior and working with individual students. (Field notes, March 27, 2008).

This is in sharp contrast to her core identity as a mathematics teacher, which focuses on asking questions that elicit discussion and allow students to explore mathematics.

After an observation, Morgan commented that teaching mathematics in this manner was draining and ineffective at giving students opportunities to explore mathematics. Her comments during interviews regarding students' dislike for mathematics was evident during observations as well – I noted four students who openly stated their dislike for mathematics, with several more students in agreement. Thus the value that Morgan placed on exploration and discussion as a way of improving students' self-efficacy and attitudes towards mathematics was in contrast with her experiences in the mathematics classroom. The opening quote used to capture Morgan's views of mathematics teaching and learning – the need to approach mathematics instruction differently – was consistent with her conflicting values and experiences.

School Community

As previously stated, Morgan described mathematics instruction at Rose as traditional with a reliance on the textbook. She further stated that mathematics teachers focused on basic mathematics, noting the deficiencies that even the regular education students had in knowing basic multiplication and division facts. She described the instructional practices of sixth and seventh grade teachers as “methodical” – moving slowly so students do not fall behind. Morgan contrasted this type of instruction with the instructional practices of the eighth grade teachers at Rose where teachers' pace is faster in an attempt to prepare students for high school. She provided the following description.

The eighth grade is different. They go through the whole book by the end of the year. We're only on chapter four, maybe. Some of them are on chapter six.

There are maybe 12 or 13 chapters in the book or more, so we're at a pace with the kids. They go on. They push through. Get it or not, they're pushing through.

When asked to describe which of these two approaches she saw as better, she noted the benefits of each. For instance, Morgan commented on the knowledge of students and the knowledge of pedagogical approaches that best supported adolescent learning of the seventh grade mathematics teacher. She also saw the importance of the mathematical and "technical" knowledge of an eighth grade mathematics teacher, Tyler Hill, and his ability to challenge students mathematically. Her impressions were based upon these teachers' reputations within the school, not on observations or mathematical conversations she had with these teachers. Morgan noted that she did not share the common planning time that the mathematics department at Rose had. Despite the origins of her impressions of mathematics instruction at Rose, Morgan did state that she felt she had opportunities to work collaboratively with other teachers in the school. However, the description of these collaborations centered on students' scores on particular tests or quizzes and homework assignments, not on students' mathematical understanding.

[I talk to other teachers about] what their assignments are, what they did in class, any homework due, how my students are doing that they would have in their class, so and so's struggling ... they're not doing this, that and the other, and I'd have to call the parent, confront the child, stuff like that.

She also felt that opportunities to discuss mathematics teaching with other teachers in the school were lacking. When asked about those opportunities Morgan stated the following.

I have no planned time with them. You could probably ask the other ones that actually have planned time with math, but I don't – nope, never have had a planning session yet.

Despite established school norms for focusing on basic facts, particularly for the learning disabled students that she teaches, Morgan sought to incorporate the pedagogical approaches and curriculum materials suggested in the online courses. When incorporating these ideas in her resource classroom during her first year of teaching, she reported encountering the following from the school's principal at that time.

When I first came to [the online courses], I thought they were great because I could see the potential. And I actually saw other teachers teach in that – I don't want to say in that way, but the whole idea of interaction and discussion and questions and answers and only having a few problems to do, and then having them figure it out, going into groups. And I guess I tried it my first year here, and I remember being observed, and [the principal] just telling me that that's too over their head. They can't – they're not there. Just teach it basically. Just teach 'em what they need to learn. And so that was discouraged. [She] said, "I understand that you're learning those things, but your students probably aren't there yet." And I took that in consideration. She's probably right. They probably weren't there yet. They didn't even have the basics down. So I don't know. I don't know. So I was kind of discouraged from using that material. So I haven't even picked it up since. [I thought CMP was] good stuff.

Morgan described this principal's vision for mathematics instruction as focused on teaching the established curriculum and covering the state objectives. Asked if other teachers in the school had successfully used CMP, she stated the following.

I don't know. I think they go right straight from the book and right from the book from cover to cover. That's the impression I get. And I don't know why all this money and time and energy was spent on classes, and it was a good course, and it made sense, so why is it so hard to incorporate it into school?

When asked to address the question she posed regarding the difficulty in incorporating reform-oriented materials, she stated the difficulties in satisfying the local school's expectations for assessment with the ideas regarding assessment evident in the CMP curriculum.

How do you really successfully assess CMP stuff unless you're doing group work and observations and whatever they turn in? You have to have tests, and you have to have grades. And it seems like what we do is practice, practice, test,

practice, practice, test, because you only have nine weeks, and you have to at least produce eight grades is what they're telling you. You have to at least eight grades to average. They're big on that, big on the assessing.

Consequently, Morgan found difficulties in meeting both the expectations of the local school and in implementing the materials within the online courses, which she felt were effective. This is evident in Morgan's core identity, which consisted of a vision for reform-minded mathematics instruction, but lacked a concrete focus due to a lack of authority for making mathematics instructional decisions at Rose.

Morgan's interest in CMP was evident as she talked about others in the online courses and their use of standards-based approaches to instruction. In particular, Morgan commented on video clips she saw of Katie Williams teaching a lesson. During an interview, Morgan was asked why she thought Katie was able to incorporate the approaches suggested in the online courses and others not. She described several different elements, including classroom design and class size, apparent in the following comments.

I think [Katie] didn't have the class load that we have. I don't think she has the class structure. I don't think she has seven – I don't know what they have over there, but I don't think they have seven changes of classes, and I don't think that – I'm not sure what grade level she teaches, but it seems like the kids were smaller. And the classroom itself was kind of bigger, and it had tables, individual tables, that she was able to work with the students on, where they could do group learning. We have desks, and we have pretty crowded rooms, not real conducive to group work, especially that kind of group work where they had to get it. I felt like she had a smaller class, and that it was more interactive. I think we have more behavior issues. I don't know. I wonder if they have as many behavior problems as we do. I wonder. You're going to have more behavior problems just because there are more kids. And that influences your ability to teach a lot of times, if you're managing other things.

Thus, for Morgan, incorporating the pedagogical approaches suggested in professional development required more than an individual teacher's decision to do so, it was also contingent

upon peripheral support for adequate space, desks, and reduced class size that might provide a conducive environment for standards-based approaches to instruction.

In addition to logistical constraints, Morgan noted the influence that students have on the pedagogical choices teachers make. Morgan stated that students at Rose do not come to school with expectations for mathematics instruction that are aligned with standards-based approaches, thus making changes to classroom and school norms for mathematics instruction difficult. These ideas were evident in the following statement.

[Standards-based approaches are] not taught [at the] younger ages, for whatever reason, needing it or not needing it. So when it gets to this grade level, they have no idea how – the students don't know how to perceive it. I'm not sure the teachers know how to really teach it to students who don't know how to perceive it, if that makes sense. This is a different way of doing math, so if you come into a classroom, it would take you a good year for the students to feel comfortable enough to question math, to really explore it, to get it where it needs to be, I think.

As a part of the school's efforts to improve mathematics instruction, each of the special education teachers at Rose planned to focus on one content area the school year following this study. Given Morgan's participation in the online courses and her experience as a resource mathematics teacher, Morgan anticipated the school principal placing her in the mathematics department. Regarding the opportunity to focus exclusively on mathematics, Morgan stated the following.

I am finding that math is a real struggle for students. They're afraid of it. They don't like it. I don't see them seeing a significance in their everyday life with math, which it's a huge, huge part of their life, always will be, and I'm even more shocked about what they don't know. And I think because of those reasons I'm more geared to going that direction because I think I can help more – I can have a bigger impact, I think, in the math department.

Morgan was unsure if she would gain the pedagogical authority needed to plan instruction in the classroom, but did see a possibility for returning to resource mathematics classes – giving her

sole responsibility for mathematics instruction. When asked how she might plan mathematics instruction, she stated the following.

I think I'll be on the remedial end of things, so I'll have a lot more flexibility with materials. I don't think I'll necessarily going to have to stick to the curriculum book, to the curriculum that they provide. I'll have to stick with the standards, granted, but I think I'm going to be a lot more freedom with what I – what kind of material I can use. And I think the CMP will be definitely things I'll be pulling from a lot.

Online Course Community

Morgan did not hold views of mathematics teaching and learning that were consistent with the perception she had of others' views in the online courses. While Morgan held reform-oriented materials, such as CMP, in high regard and felt they could be used in the district, she noted that others in the online course community saw those materials as an idealistic vision given the realities of their specific teaching situations.

The impression I got was that they were really good teachers, but they were also sensing the need to teach very, very basic math to a lot of kids because they just weren't ready for that higher level thinking of math. That's the impression I got. So even though they had a great grasp on it, I'm not sure if they were able to trickle it down to their students.

Morgan saw the teachers' views regarding students' deficiencies with mathematics as a common belief among participating teachers. She stated that teachers in the professional development had a "genuine concern" for these deficiencies, but did not see CMP and other curriculum resources offered during the online courses as a mechanism for remedying those deficiencies. Conversely, despite the views of others in the online course community, Morgan's core identity focused on students' opportunities to experience mathematics was, in part, a product of her experiences in the online courses, evident in the following statement.

I think the exploration piece, the way they say it should be taught, that spoke to me. I saw the significance for that. I liked the material because it was even challenging for me to look at it and read it as far as having to start my way of thinking about math. Because when I got [CMP], you start reading the investigation, it takes it on so many other different levels developmentally. Instead of saying “Here are your five problems, work them,” it took a problem and made you understand it. If you did not understand the problem by the end of the investigation, you didn’t get it. It was clear as day. It went over and over that same concept in a hands-on way. So by the end of it, you knew how to do that. And why and how, which I don’t think kids see. They don’t see the why and the how. They just say, okay, here it is.

Morgan’s engagement in mathematics tasks during professional development provided her opportunities to develop a core identity that valued these explorations. Morgan felt that if teachers worked to solve the mathematics tasks used in professional development, they could then take those tasks for use in their own classroom. Unlike Leigh and the characterizations Morgan made of others in the online courses, Morgan did not note students’ work ethic or inability to perform basic computation as an impedance to using reform-oriented materials in the classroom. In fact, in the Scoop Notebook, she seemed to place responsibility for students’ poor performance in and attitudes towards mathematics on teachers and teaching.

After this year with sixth grade students, special education and regular education, I am beginning to realize how much they either don’t retain, use, or are taught. I am not putting the blame on anyone, but I wonder why they struggle with math so much. I think we are not asking the right questions.

District Community

Morgan was an outsider in the district community, a non-participant in the district level decisions made regarding mathematics instruction. Morgan indicated that she saw the district as mandating what mathematics is taught, which curriculum materials to use, and which pedagogical approaches were appropriate. She saw this as a significant hurdle in incorporating reform-oriented materials, evident when she said the following.

I think you have a lot of boundaries. Because you purchase curriculum books that are fairly new to this county, and you have to use them. The district expects you to follow the textbook, definitely. They put money and time. And where do you incorporate CMP material into that? I'm sure you can. I'm just not sure if it gets done. That takes extra planning above all that. There's no clear thing out there to do that, so if you're assessing these standards, then you need to do these activities in CMP, and then you need to develop a test that [covers the same standards], so the district level can see that you're [covering the standards].

Morgan stated that the district carried their own set of ideas and expectations that aligned with state achievement tests and state standards and did not include teachers such as herself in the decision-making process regarding mathematics content or the curriculum materials used to support students' understanding. Consequently, Morgan had somewhat limited knowledge (in comparison to Katie and Leigh) regarding the district's priorities for mathematics instruction.

Morgan's Instructional Practices

The same set of a prior codes were used to analyze the instructional practices of Morgan, keeping in mind that as the inclusion teacher in a general education mathematics classroom, the instructional practices were determined by the mathematics teacher. The following sections describe the instructional practices that took place in her inclusion classroom.

According to Morgan, the regular mathematics teacher used a form of differentiated instruction in the inclusion class. The regular mathematics teacher developed packets of materials that she felt built sequentially, that is, topics she felt students needed to know before moving on. Students began the year on the same packet, but moved to subsequent packets individually once the regular classroom teacher felt they had demonstrated mastery. Based on lessons included in the Scoop Notebook, the packet consisted of a variety of skill driven exercises that did not promote higher order thinking, ask higher level questions, or encourage students to extend ideas presented in the packets. Those skill driven exercises contained no

opportunities for students to explore open-ended problems, or problems that might have connected to the outside world through real world contexts. Additionally, the packets included no activities where students used hands-on materials.

Throughout class time, students worked independently on their own packet of material. When students attempted to assist one another, Morgan and the regular classroom teacher redirected them to their own packet (Field notes, April 4, 2008). It appears that students worked individually the vast majority of the time; there was no use of collaborative grouping during classroom observation or data included in the Scoop Notebook. Since students worked on the packet individually throughout the entire class, mathematical representations consisted of those representations provided by the problem on the worksheet and the student's response to the problem; they were not privy to the representations created by other students. Based upon the lessons included in the Scoop Notebook, some problems did require students to draw pictures, such as representing fractional parts using a circular model. However, neither teacher represented mathematics ideas in various ways to the students, or supported or encouraged students' use of multiple representations in solving problems.

The lack of communication between students and between the teachers and the students limited the ways in which students might justify or explain their thinking, since students were expected to work quietly at their seat. Additionally, the nature of the problems did not foster opportunities to explain or justify students' thinking beyond the use of procedures. Since whole class instruction was not used, students did not have opportunities to explain their thinking to the class. As both the regular classroom teacher and Morgan moved around the room to work with individual students, they asked students questions that focused on students' use of procedures.

Morgan's reflections in the Scoop Notebook indicated her focus on ensuring students understood procedures for solving problems.

[The students] understood that [when subtracting] one would subtract right to left. I then asked them to check the two numbers (usually in the ones column, unless decimals), and determine which one was bigger – the one on top or the one on the bottom. The students decided that if the number on top was bigger, they could subtract. If the number on top was smaller, they had to borrow from the number that was to the left of the number. I explained that when borrowing the number, you are taking one away (one on the left) so the number has to be marked out on one less is placed on top.

The regular classroom teacher assessed students by calculating a percentage correct on their completed packets of worksheets, which was a part of the Individualize Education Program (IEP) of the learning disabled students in the classroom (Field notes, March 27, 2008). In contrast, Morgan made a number of informal assessments regarding students' misconceptions as she moved throughout the room working with individual students. On a number of occasions, Morgan noted that students' knowledge of mathematics was often superficial and lacked conceptual understanding, which she determined by asking students questions about what they knew and how they knew it. For instance, during a classroom observation, Morgan asked the question "How do you know?" eleven times when students provided her with a solution to a particular problem. Additionally, Morgan differentiated between students' knowledge of skills versus conceptual knowledge in a reflection in the Scoop Notebook.

My biggest shock was that my students who were either learning disabled in math or not, did not know how to compute simple two digit subtraction problems. The "concept" of subtraction is necessary in understanding when and how to use this skill. Do they know how to use it in a supermarket? How to know which item is a better buy? I am not so sure. I think the next step to computing correctly is finding out how it fits into their everyday lives. That will take more reflection time and focus on word problems that they can actually relate to.

Discussion of Morgan's Identity in Relation to Her Instructional Practices: Research Question Two

The following section contains the within-case analysis of Morgan Shilling's identity in relation to her instructional practices. Again, I framed this discussion around Wenger's (1998) characteristics of identity and used both Morgan's vision for mathematics instruction as well as evidence from classroom observations to highlight relationships between her identity and her instructional practices. Using her vision for mathematics instruction as providing opportunities to explore mathematics and asking questions that support those explorations is of particular importance to this case, since Morgan does not have primary responsibility for mathematics instruction at her school.

Negotiated experience. Morgan was the only special education teacher involved in the online courses. Morgan did not hold the same knowledge of mathematics as other teachers in the courses; however, her experiences with special education students provided an alternative perception of students' ability to engage in rich mathematics tasks. Consequently, she did not share the same views of students' deficiencies as others in the online courses. Therefore, her participation in the online course community and in the school community when conversations took place regarding mathematics was peripheral. Particularly in the school community, Morgan was viewed as an outsider with regards to mathematics instruction, which maintained her status as primarily a special education teacher rather than a teacher of mathematics. Yet, through her participation in the online courses and her reflections on her own teaching practices, Morgan began to develop a distinctly mathematical identity that defines effective teaching as providing

opportunities for students to explore mathematics and asking questions that elicit discussions around the exploration.

As Morgan attempted to enact her vision of effective mathematics teaching in her self-contained classroom during the first year of the online courses, the school principal “jolted” her evolving identity as a mathematics teacher by discounting her attempts to use standards based approaches to instruction. Furthermore, Morgan saw the organization of Rose Middle School, such as the number of instructional periods in a day, number of students in each class, and the available classroom materials as inhibiting standards based approaches. Therefore, Morgan’s evolving identity as a mathematics teacher focused on reform oriented approaches to mathematics instruction worked in contrast to the school community’s value of conventional approaches to mathematics instruction. In this sense, Morgan’s participation in the school community was reified by others who limited her responsibilities for mathematics instruction and maintained her status as a special education teacher rather than a teacher of mathematics. By doing so, Morgan reverted to instructional practices she knew to be acceptable for special education students at Rose and mathematics students at Rose, generally. Additionally, as Morgan worked in an inclusion mathematics classroom the last two school years, she participated not as an expert of mathematics teaching and learning, but as a special education teacher – a sort of “extra pair of hands” for managing the classroom. Through these experiences and their corresponding reifications of her role in each community, the identity specific to mathematics teaching and learning Morgan developed in the online courses was in contrast to the ways she participated in the classroom and school communities. As Morgan takes on

responsibilities related to mathematics teaching, she relies on the expertise of those she sees as *actual* mathematics teachers rather than her evolving knowledge of mathematics and pedagogy.

Community membership. Central to community membership is the extent to which an individual is able to engage in the practices of that community (Wenger, 1998). Since Morgan's instructional responsibilities included multiple subject areas and advanced knowledge of teaching students with disabilities, Morgan's expertise did not always align with the competencies of others in the online course community that exclusively focused on mathematics teaching and learning. Yet, through her participation, Morgan gained knowledge of mathematics and the resources and tools used to support students' understanding of that knowledge.

Morgan lacked a set of experiences as a mathematics teacher to participate in the online course community in the same ways others in the teachers did, which may have worked to her advantage in developing a reform-oriented view of mathematics instruction. Morgan's comments that the other participating teachers found students to have significant gaps in prerequisite knowledge and felt the need to teach the "basics" provide an instance where participation as purely a mathematics teacher in the community may have been a disadvantage for incorporating standards-based instructional practices. Since Morgan failed to identify with others' experiences as mathematics teachers, she did not view mathematics teaching as necessarily focused exclusively on skills and procedures. Thus the extent to which Morgan engaged the online course community may have been central enough to become knowledgeable in and about mathematics teaching, yet not engaged in ways that allowed her to take on the other teachers' view of mathematics teaching necessarily focused on procedurally oriented tasks.

Given her experiences in the online courses, which fostered an identity specifically as a teacher of mathematics, Morgan desired to be a part of the mathematics department at Rose rather than a member of the special education department. Morgan's vision for mathematics instruction differed from the rest of the mathematics teachers in the school. Consequently, Morgan's desire to become a member of the mathematics department so that she might reach students in ways that others had not been able to do. However, those currently in the mathematics department did not view Morgan as a participant. This was evident in Morgan's role in the inclusion classroom and comments made by the department chair as he discussed mathematics instruction at Rose – Morgan's name was notably absent as he discussed the instructional practices of the regular mathematics teacher with whom Morgan worked. The mathematics department at Rose had a shared planning time and used this time to conduct their department meetings. Morgan did not share this common planning time, and thus was not able to take part in these meetings. As the school planned to organize around content areas rather than grade level the following school year, new opportunities may exist for Morgan to become a valuable member of the mathematics department in the eyes of all concerned with mathematics teaching at Rose.

Learning trajectory. Morgan began the online courses without what she described as a “math preference.” Morgan also noted that she did not have a strong math background, but began teaching resource mathematics because a mathematics resource teacher was needed when she came to Rose. As a result of her limited experiences with mathematics, Morgan had few opportunities to engage in instructional practices that were aligned with her view of mathematics teaching and learning. For Wenger (1998), a community of practice holds a “field of possible

trajectories” (p. 156), which denotes an expected identity. Thus, Morgan’s “field of possible trajectories” was relatively unknown and based solely on her experiences as a student of mathematics and limited opportunities to work in support of other mathematics teachers. So as Morgan participated in the online courses, she remained open to a vast array of possible instructional practices, uninhibited by a set of expectations of what it meant to be a mathematics teacher. Morgan’s vision for mathematics instruction then became more closely aligned with the vision set forth in the online courses than the practices established by other mathematics teachers in her school.

Morgan’s critical reflection of her instructional practices was important to understanding her learning trajectory as well. She recognized weakness in her knowledge of mathematics and saw those weaknesses as inhibiting the kinds of instructional practices she would like to have. This was particularly evident as she critiqued the types of questions she was able to ask that would support students’ conceptual understanding of mathematics. To alleviate those weaknesses, Morgan planned to become highly qualified in mathematics so that she might have a better understanding of mathematics content and greater credibility among mathematics teachers at Rose. Thus, Morgan established a personal trajectory that included greater participation in mathematics instruction at Rose, as well as improved fluency with utilizing standards based approaches to instruction.

Nexus of multimembership. Morgan’s work towards reconciling her participation in multiple communities was not harmonious, which Wenger (1998) noted is often the case. Morgan found conflicting values in the online course community and her school community. She saw the school community as attempting to meet the demands of the district community in

terms of curriculum alignment and achievement test scores. In meeting these demands, Morgan saw it necessary for mathematics teachers at Rose to focus on basic skills that students lacked, textbook coverage, and regular assessment that indicated students' mastery of particular topics.

Morgan contrasted these school priorities with the pedagogical approaches suggested in professional development. Through her participation in the online courses, Morgan developed a view of mathematics teaching as focused on opportunities for students to explore mathematical ideas and asking questions that elicit discussions about those explorations. She saw the curriculum materials used in professional development, CMP, as supporting her vision of effective mathematics instruction. However, as she attempted to enact her vision and the CMP in her classroom during her first year of teaching and the first year of the professional development, the former school principal commented on special education students' inability to solve such problems. This experience forced Morgan to confront her conflicting values and reconcile her participation across the multiple communities in which she engages. Morgan did so by relegating CMP to an abstract vision for mathematics instruction, unattainable given the current state of affairs at Rose. In particular, Morgan's role as a special education teacher failed to give her opportunities for making instructional decisions in the mathematics classroom and the credibility for making non-normative choices regarding mathematics content and pedagogy at Rose Middle.

Morgan's comment that she saw a need to "do things differently" highlights both the private nature of reconciliation and the individualized practices at Rose. While Morgan carried with her the need for changes in mathematics instructional practices, she did so surreptitiously – it was her own way of managing her conflicting values for instruction and also remaining openly

uncritical of others' instructional practices. Mathematics instruction at Rose was highly privatized and critiquing others' instructional practices would most likely have been met with significant contempt. Until Morgan gains authority for mathematics instruction either by teaching resource mathematics classes or gaining highly qualified status in mathematics, her instructional practices will most likely remain unchanged.

Relations between the local and the global. Part of the work of members of a community of practice is relating their practices to broader issues and relationships (Wenger, 1998). Perhaps more so than any other participating teacher, Morgan placed mathematics instruction in the broader contexts of schooling and education. This may be due in part to her identification with being a special education teacher and her responsibilities for teaching multiple subject areas to students with a variety of special needs. By doing so, Morgan constructed an identity that allowed her to contrast students' experiences in mathematics classrooms with other subject areas and incorporate a holistic view of educating students to function in society, particularly those classified as having learning disabilities. Morgan's reflective nature and attention to these broader issues and relationships afforded her opportunities to connect the priorities of the online courses with the academic needs of the students for which she is responsible.

In spite of her increased identification with mathematics teaching, Morgan had yet to seek opportunities to participate with other mathematics teachers in professional meetings and conferences focused on mathematics teaching and learning. However, she did note the benefit of participating in such events and expressed an interest in doing so, particularly after her instructional responsibilities became exclusively focused on mathematics the following school year. Morgan limited her engagement in professional organizations focused on mathematics

instruction despite seeing clear benefits highlights the newness of her identity as a mathematics teacher and her struggles to situate this evolving identity in multiple communities of practice.

Summary of the Case of Morgan Roberts

Morgan developed an identity that valued students' opportunities to experience mathematics and teacher questioning that might support students' understanding, which was in contrast to her perceptions of others in online course and school communities. Whereas other teachers felt that students' lack of knowledge of basic skills necessarily focused their instructional practices on procedures and skills, Morgan's experiences as a special education teacher gave her the perception of a need for changes in mathematics instructional practices, evident in her opening quote. At Rose, Morgan noted continually seeing students disenfranchised from the mathematics classroom and saw conventional approaches to mathematics instruction providing little benefit to improving students' status as learners of mathematics. However, the former school principal's failure to accept her use of CMP as the chosen instructional materials for her resource mathematics class limited her mathematics teaching identity to a vision for mathematics for what could take place in a mathematics classroom. Additionally, other mathematics teachers at Rose failed to hold similar views for instruction and continued to view her as a special education teacher rather than a mathematics teacher. Morgan had yet to act on what she felt might be pedagogical approaches that would support students' understanding of mathematics.

The Case of Tyler Hill

“I tell them ‘I’m not making you like math, but I want you to be able to work, to learn how to work, because unfortunately, you’re gonna have – after you get out of here, many more classes of math.’”

Core Identity and Community Participation: Research Question One

Tyler’s core identity as a mathematics teacher involves a focus on mathematics content over pedagogical approaches. Additionally, Tyler sees mathematics as a subject that “helps train [the] mind to think.” The following paragraphs provide further detail on these findings regarding his core identity and become more evident as they are discussed in relation to the classroom, school, district, and online course communities.

Tyler Hill, the only 7 – 12 licensed mathematics teacher included in this study, was knowledgeable about much of the future mathematics content that students might encounter, both at the high school and college level. Evident in the opening quote, Tyler’s participation in each community focused on this mathematics content as a way to prepare for future courses in mathematics. Therefore, Tyler’s focus on mathematics content was a significant aspect of his core identity as a mathematics teacher. This focus on mathematics superseded concerns for reform-based mathematics instruction and focused his instruction on challenging students mathematically.

Tyler initially taught in a high school for three years prior to coming to Rose Middle School and was in his third year as an eighth grade mathematics teacher at Rose during the time of this study. Tyler entered college intending to major in Engineering, but decided to teach mathematics due to positive experiences tutoring and teaching while obtaining his undergraduate

degree. Hesitant to work in a middle school, Tyler was persuaded by the Rose principal and by the opportunity to teach Algebra to advanced students.

[The principal at that time] kind of sold me on the middle school student, and I tried to give it a shot, and I like teaching algebra. She said they had an algebra class [available when I interviewed].

During his second year at Rose, the school principal asked Tyler to take on the role of mathematics department head. Tyler reluctantly took on the role after being at the school just one year, but reported doing so because he was the only teacher interested in the position and also was the only mathematics teacher in the school that was licensed 7 – 12. Although he stated that he enjoyed teaching at the middle school level, Tyler envisioned a possible return to teaching high school mathematics.

I may go back and try to get in high school later on, go on and change. [Five to ten years from now] I think I still want to be in the classroom. I still want to be teaching. Again, I'm not sure if I'll still want to be a middle school teacher, or if I want to try to go back up to teach high school. It's still up in the air. I've enjoyed being here.

In addition to a focus on mathematics content, another part of Tyler's core identity as a mathematics teacher was his view of students' relationship with mathematics. Tyler reported being a strong mathematics student while in school and enjoying his opportunities to informally teach mathematics, yet he also stated that he did not enjoy learning mathematics as a student. Rather Tyler saw mathematics as a subject that "helps train [the] mind to think." Thus, for Tyler, mathematics teaching involved providing opportunities for students to develop cognitive attributes that may be distinctly non-mathematical. Tyler noted on several occasions the need for mathematics teachers to recognize that many students dislike mathematics, indicative in the following statement he made during an interview.

Math is a hard subject, because they either like it or they don't, and the majority of them do not like math. I don't like doing math skills, and they don't. They're not up to speed with their multiplying, and so, it's a tough subject to teach, especially at this age.

Tyler made several other statements in which he noted deficiencies in students' mathematics backgrounds. Tyler stated that students that are successful in his class have "mastered the basics," which, in turn, helps students develop an affection for mathematics. Conversely, students who do poorly have deficiencies in their prerequisite knowledge, carry a dislike for mathematics, and lack the work ethic to do well in the mathematics classroom. Tyler saw poor work ethic having a strong influence on the nature of instructional practices, evident in the following statement.

You want [students] to learn. So, knowing that you're helping them, perhaps for their future motivates me a little bit. But, I'm saddened to see some students now who aren't doing any of it. [They] come to class and lay their heads down and are not putting forth any effort.

Effort, for Tyler, meant that students worked to solve practice and homework problems that required them to use the mathematics modeled by Tyler. He provided the following description of how students learn mathematics in his classroom.

[Students learn math] by doing, by doing the work, by doing the problems. I can be up there, and I can show them an example, and they look and then do it.

Classroom Community

During an interview, Tyler commented on the shock he had teaching middle school mathematics during his first year at Rose. He stated that he quickly realized that he had to "do things differently." I asked Tyler to comment on what he saw as different in the middle school compared to his experiences teaching high school mathematics. Tyler noted the differences in

classroom management between middle and high school, such as remembering to bring necessary supplies to class and managing the emotional needs of adolescents.

I guess [a difference is] the chaos. I guess the day to day what's going on in the classroom. The classroom environment. Kind of the management was definitely different, I think. One thing that you really need to do, this goes for probably any subject. You need to keep them busy. They need to know what to do, and I still have students going to class and they don't have paper out, like come on, we're almost done with this. So, they don't bring books to class, still, but the majority know what to expect. Know that I want to get started after I take roll.

He did not comment on differences regarding pedagogical approaches or the sorts of mathematics norms that he established. To probe for information regarding his role in the classroom, I asked Tyler to contrast his pedagogical approaches with others in the professional development classes. He mentioned only one person by name, Katie Williams, suggesting that her teaching was different than his, noting that she incorporated more of the reform-oriented practices suggested in the courses than did he. He offered several explanations for the differences, which included smaller class sizes, fewer students with which to work, and a classroom arrangement (e.g. arrangements of desks, use of round tables) which he saw as more conducive to reform-oriented practices.

I know that Katie Williams does the Connected Math a lot. She has that working pretty good probably because she has smaller, not a smaller number of students to work with, but that type of curriculum, that's how it's set up. Where here, it's a little bit more difficult, you've got a larger number of students, and perhaps how the classroom layouts are and with the kind of desk and tables you've got.

Tyler's view of his role as a mathematics teacher was consistent with the observational and document data collected. Tyler routinely worked through a series of problems, then provided opportunities for students to solve similar problems. As students completed a problem, students raised their hands to signify they had completed the problem and were prepared to

provide the answer. Tyler quickly called on several students to provide their solution prior to validating whether the solution was correct. It was clear that Tyler valued answers over process and speed over depth. Tyler noted that he established a classroom community similar to others in the school with the exception of his regular use of technology in the classroom. Tyler often used a SMART Board for classroom instruction, providing definitions and examples, and then used an electronic writing device to solve the examples. The following lesson reflection from a lesson on measures of variation included in the Scoop Notebook describes a typical classroom lesson.

This lesson demonstrated how to find the measures of variation. We discussed the main definitions such as range, lower quartile, upper quartile, interquartile range, and outliers. We talked about how this describes the distribution of data and that knowing how to find these terms will help for tomorrow's lesson in creating box and whisker plots. I think the lesson was okay, nothing exciting. At the end of the lesson, most of the students were able to find all the vocabulary terms. I gave a quiz on this lesson and most students did well. The one thing students struggled most with was determining the outliers. I showed them examples and gave them step by step instructions but they still struggled. The students have difficulty working problems that have multi steps. I would like to figure out a better way of presenting this to students what would help them remember how to find outliers.

Tyler's view of learning mathematics as a way of "training the mind to think" and also for preparing students for future courses in mathematics was evident as he stated the importance of learning the content of the lesson was so that students could do the mathematics in the following lesson – creating box plots. Additionally, Tyler commented on the difficulties students had with solving problems that have multiple steps involved. Tyler attempted to alleviate those difficulties by demonstrating several examples and providing students with a set of steps to follow.

Despite the relatively consistent nature of his description of mathematics teaching and learning and the observational data collected in his classroom, Tyler did comment on what constituted effective mathematics teaching and the mismatch with what takes place in his mathematics classes. For example, Tyler described the following as effective mathematic instruction.

Probably having all the students engaged. Working through, working maybe a problem, maybe, I don't know, perhaps they got the group thing worked out, having the students talk within their group, mathematically, and maybe present to a class, but I think having all the students engaged and on task and working through some kind of a, maybe activity.

When asked to compare himself to this hypothetical effective teacher, he stated the following

I would definitely not be up there. I'm not really trying to find an activity for each lesson. If I was up there, I would have some kind of, I don't know investigation or activity, having all the students engaged, and I'm really not there. I don't know if this is bad or not, I mean, I enjoy, I love teaching math. I enjoy it. I try not to take much home. I really like that to be family time.

This quote suggests that Tyler placed value on task selection and recognized limitations in his selection of tasks as compared to his view of an ideal teacher. The apparent conflict between what he thinks he should do and what he does is justified by saying he doesn't want to interfere with family time, so he teaches mathematics in a way that he feels is easiest.

School Community

As previously mentioned, Tyler viewed his role as mathematics teacher as similar to other mathematics teachers in the school. He did note that two teachers in the school had shifted their roles as mathematics teachers as they attempted to integrate a form of differentiated instruction in their classrooms. Tyler noted that mathematics teachers in the school considered those two teachers' efforts to differentiate instruction to be positive and that their instructional practices

placed the responsibility for learning on students. In fact, Tyler reported that he would like to begin incorporating those strategies into his mathematics classroom.

Right now, they've taken on the unbelievable role what they're doing, and [those two teachers] set this up with doing individualized instruction, where each student must pass this section before he goes on to this section, and she's got folders and notebooks for each chapter. So, each student in her class might be on ten different, ten or twelve different lessons. I think that that's really putting students, student-centered focus on. I'm hoping kind of incorporate that with what we're doing next year.

Although Tyler stated that he would like to adopt aspects of others' instructional strategies within in the school, he had not had opportunities to observe those teachers. Tyler did note that mathematics teachers talked in the halls between classes regarding specific students who are struggling and general deficiencies in students' prerequisite knowledge. Beyond these informal opportunities, Tyler reported holding regular meetings with the mathematics department. He described those meetings as follows.

We do meet as a math department. I try to meet twice a month if we can, it all depends on if we have to meet for a particular reason, if our principal will need something that we need to talk about - if we had a faculty meeting. But recently, it's been really busy, so, we haven't had that many. It varies on the topics. We're coming up with a formative assessment test this Friday. We'll talk about that, what we need to do.

These meetings take place during a common planning time for the mathematics department.

Outside of these meetings, the mathematics department utilizes this planning time for individual tasks.

Beyond holding these mathematics department meetings, Tyler's role as the mathematics department chair also involved participation on the school leadership team. Tyler reported that these meetings gave him regular access to the school principal and opportunities to discuss the direction of the school.

[I enjoy being on the leadership team because we are] able to talk, bounce things off each other, kind of make decisions. Good ideas, bad ideas - I kind of like that. So, I do like the leadership part. Of course, with it comes a lot of responsibility.

Tyler noted that his role on the leadership team, as the mathematics teacher representative, was to help the leadership team analyze test scores and determine what areas needed improvement. He stated that others looked to him to manage the numerical data because the other teachers “don’t like numbers.” Tyler also felt that participating on the leadership team gave him a good idea of what the principal valued for mathematics instruction. He described the principal’s priorities in the following way.

[The principal would be looking for] what kind of instruction's going on, or the questions that you're asking. As far as looking at the students, how they're responding, how they are behaving, do you manage your classroom. If you know the content, if you're comfortable with content. If you're comfortable with what you're talking about it would be how you perhaps answer student's questions. So, I don't know what else he would be looking for, seeing if things are running smoothly.

Tyler described the principal’s influences as predominantly “procedural” rather than influencing the classroom “instructionally.” He stated that the principal outlined new procedures for certain areas, such as placing students in mathematics classes, but did not dictate the type of instructional strategies he expected mathematics teachers to take. Tyler commented that both he and the school principal enjoyed working at Rose because the school was large enough to have a leadership team to guide the direction of the school.

I know our principal now, he said one of the things he likes [about being principal] here is our leadership team. I'm not sure the smaller schools, just one or two teachers per subject have that.

Tyler also noted that coming to a larger middle school helped his transition from teaching at the high school level.

A bigger school, just compared to a smaller school. I guess that's one of the things that kind of drew me here too is the bigger school, easier for me to kind of adjust from high school to middle school.

District Community

Unexpectedly, Tyler made very few comments regarding the influence the school district had on mathematics instruction. Tyler noted that he did not communicate with other mathematics teachers in the district and cited only the district curriculum map, which he closely followed, with influencing mathematics instruction.

Not really, haven't had many opportunities [to talk about teaching math with other math teachers or administrators in the district]. One influence would be the curriculum map ... when we're gonna be teaching stuff.

Based on observational data and the Scoop Notebook, Tyler almost exclusively used the adopted textbook as the source of content and pedagogical approaches, connecting the textbook content to the district curriculum map. Tyler did not appear to deviate from these resources. For instance, in the Scoop Notebook, Tyler noted that the “closure” of each lesson consisted of book work to be graded the following day. Additionally, the sequence of lessons included in the Scoop Notebook followed the sequence of lessons in the district-adopted textbook. Tyler's view of mathematics as preparation for more mathematics supported his use of resources that promote a somewhat linear view of mathematics instruction – moving sequential through the textbook and the district's curriculum map.

Online Course Community

When asked to describe the teachers that took part in the online courses, Tyler commented on the strong content knowledge of most of the teachers, stating they knew the mathematics that was taught in the online courses.

I think all the teachers knew the content, knew it pretty well, I think, knew the area that they were teaching, and had good ideas and had good questions and were able to answer questions [better] than what I may have ever thought.

However, Tyler did not feel that teachers in the classes had any common goals for the courses or common problems for which they felt responsible. He stated that some teachers were involved for professional development credit hours, others for credit towards an advanced degree, while others took the courses to get ideas they could take back to the classroom. Tyler reported taking the courses at the request of the school principal, since it was his first year at Rose.

Some [teachers] might have needed the course for the extra hours or some probably wanted to just get some ideas they could take back to the classroom. At the beginning, I was new to the school and our principal wanted all of us to take it. So, that was the initial [reason].

For Tyler, the biggest benefit of participating in the courses was garnering resources he could use for classroom instruction. Tyler noted that he could select activities from CMP for use in his mathematics classroom, most often the same activities that were completed during the online courses. Tyler also cited aligning CMP with his current textbook as beneficial.

Just getting the materials that we got through the courses [was a benefit]. I pulled a couple lessons with probability [from CMP for] this past unit. I like the resources that I got, acquired from [the courses]. One of the [other] things that we did that I thought was kind of useful is we linked Connected Math with our textbook, seeing where we might could use something from Connected Math with our Glencoe [textbook]. I thought that was beneficial, seeing how it aligns with our curriculum.

Given Tyler's somewhat linear view of mathematics teaching and learning, the curriculum alignment assignment in the professional development course would support his use of CMP.

When asked if others in the online courses shared his view of valuable aspects of the courses, he stated that he was unaware of what others found valuable.

As Tyler reflected on his experiences in the online courses, he noted that despite the lack of continued communication with mathematics teachers across the district, he valued talking to other teachers across the district during the courses. The following quote provides an illustration.

I enjoyed working with the other schools, hearing what they do. I enjoyed communicating back and forth with the other teachers. I think just being able to share with colleagues really helps. The teachers brought some ideas. They shared with everybody something they were doing – just hearing some of the other teachers’ ideas on certain problems or what they have done in class before.

Tyler’s Instructional Practices

Tyler’s instructional practices were analyzed using the same set of a priori codes from Borko et. al (2005). This yielded a characterization of his instructional practices as consisting of predominantly traditional approaches to mathematics instruction. The following paragraphs provide further elaboration.

All data sources indicated that instruction in Tyler’s classroom was exclusively teacher-led. The following instructional sequence in one of Tyler’s lesson plans was indicative of the structure of instruction in Tyler’s classroom.

1. Explain to the students that we will be looking at data and how we can display it.
2. PowerPoint presentation which includes practice and example problems.
3. Students will work on creating line graphs, bar graphs, and histograms in notes.
4. I will monitor the students’ progress, provide assistance and answer questions.

Tyler regularly modeled practice problems for students, as is apparent in the aforementioned instructional sequence. The unit Tyler included in the Scoop Notebook centered on displaying data. Tyler modeled how to construct a histogram, box plot, and other graphical displays by providing a series of steps for their constructions. Students then solve similar problems, in this instance, creating a certain type of graphical display of data. Since the unit of study centered on

displaying data, students had opportunities to represent data using a variety of graphs. However, assignments included in the Scoop Notebook indicated that Tyler did not encourage students to represent data in multiple ways or provide opportunities for students to select their own representation. Thus, students were not required to provide extensive justification of their graphical display. In this case, that justification might have been why a particular graphical display illuminated important aspects of a set of data. These graphically displays were the only apparent representation used other than symbols by Tyler or the students; students did not use any concrete materials on the lessons in the Scoop Notebook during classroom observations.

During observations, students sat in rows and worked individually on assigned problems, speaking only when called upon individually by Tyler. As students solved problems in class, Tyler remained at the front of the room, calling on students who raised their hand to provide a solution. Students provided their solution to him, which he verified with other students in the class. Tyler discouraged any communication between students when solving the problem or explaining their solution. The following observer comments highlight the nature of conversations between Tyler and the students.

Tyler assigns a problem to students, telling them to “do this one on your own.” This appears typical. Tyler did not give instructions to students about how to work on problems, yet they consistently seem to work on problems alone. Once students finish the problem, Tyler quickly asks students for the solution. Students begin to talk as more solutions are provided. Tyler responds loudly with “cool it.”

Data collected in the Scoop Notebook indicated that students worked individually throughout the included lessons. One lesson plan included group work, but Tyler noted in the lesson reflection that he did not have time to complete the activity.

I intended to do a small project with M&M's and they were going to make circle graphs and bar graphs, but I did not get to it. I will probably add this project for next time teaching statistics and circle graphs.

Each lesson closed with a homework assignment that mirrored the problems solved in class. Tyler used unannounced quizzes to assess students between tests. Based on data collected in the Scoop Notebook, feedback on these quizzes consisted of a score based upon the percentage of correct answers. Problems on these assessments, as well as those on homework and tests, provided limited opportunities to make connections to previously learned material, other subject areas, or the outside world.

Discussion of Tyler's Identity in Relation to His Instructional Practices: Research Question Two

I again draw on Wenger's (1998) characteristics of identity to construct a within case analysis of Tyler's identity in relation to his instructional practices. As stated earlier, centrally important to this analysis is understanding the ways in which this identity unfolded in the mathematics classroom, thus affording and/or constraining certain ways for students to participate in mathematics.

Negotiated experience. As one of two teachers in the online courses that were certified in grades 7 – 12 mathematics and the only mathematics teacher at Rose certified in 7 – 12 mathematics, Tyler's identity in the online course community and school community centered on his deep level of content knowledge. Others in the online courses commented on his strong content knowledge, while Morgan referred to Tyler as the "technical guy." These labels were perhaps initially based on his secondary level of certification; however, they take on greater

meaning in Tyler's participation in the online courses. Tyler was as the "go to" person when questions arose about mathematics content, which focused his engagement in the courses on content and not the underlying pedagogical approaches suggested in the problems solved in the courses. Therefore, Tyler's experiences in the online courses were interpreted by others as being strictly focused on mathematics content.

Similarly, Tyler saw his role at Rose as the expert in mathematics, noting that other middle school mathematics teachers often do not like the subject. Tyler viewed his status as mathematics department chair as stemming from his 7 – 12 mathematics licensure. In both contexts, Tyler took on an identity that highlighted his knowledge of mathematics and chose not to engage in aspects of participation that would bring to light his knowledge of pedagogical approaches appropriate for adolescent learners. This type of participation was consistent with his core identity regarding mathematics teaching and learning, that is, math trains the mind to think and prepares students for future mathematics and to be good at math, students must follow his examples and engage in a number of similar problems as practice. Therefore, the product of Tyler's participation in each community and its corresponding reification was projected in the mathematics classroom as a continued focus on mathematics content over effective pedagogical approaches.

Community membership. As I have stated, Tyler's engagement in each community was almost exclusively focused on mathematics content. Since the extent to which engagement in a community signifies competence within the community (Wenger, 1998), Tyler's engagement and thus his competencies centered on discussions of mathematics content (which he noted were of value to him) rather than activities that had an almost exclusive focus on pedagogical

approaches (e.g. case of mathematics instruction). Within the school community, Tyler's status as the mathematics department head and "go to" guy regarding mathematics content helped to define what the school valued as effective mathematics teaching.

The extent to which Tyler engaged each of the communities was a reflection of and reflected in his use of the tools and artifacts of that community. For instance, Tyler's precise use of mathematical language during the online courses provided an image of his engagement within the community. However, as Tyler contrasted his instructional practices when teaching high school and middle school mathematics, he failed to articulate a vision of mathematics instruction for middle grades students that could be described as coherently as he described mathematical ideas. Tyler's use of CMP serves as another example. While Tyler could select tasks from CMP that aligned with the content in his curriculum and that he felt would enhance students' understanding, he failed to recognize the broader vision suggested by CMP materials – providing opportunities for students to connect various mathematics concepts, using multiple representations to communicate and justify their thinking. Consequently, Tyler's use of the tools (e.g. curriculum resources) provided by these communities signifies a value of mathematics over pedagogical approaches that might support students' understanding. The importance Tyler placed on these tools is in some ways apparent in his accountability to each of the communities he participates.

Within each community, Tyler felt limited accountability to the broader goals and values of the communities. In the online course community, Tyler did not see a set of common goals for the participating teachers; therefore, he failed to see how he might support a broader vision for improving mathematics instruction among the participating teachers and within the school

district. Additionally, Tyler was responsible to the principal for mathematics instruction at the school. However, much like Tyler viewed the principal's role for mathematics instruction as largely procedural, Tyler viewed his accountability to the mathematics department as recommending certain procedures (e.g. placing students in mathematics classes) to the school principal. Despite having a common planning time, Tyler did not use his role as department chair to discuss mathematics instructional practices or mathematics content during these meetings. For mathematics teachers at Rose, including Tyler, the limited use of common planning time indicated few opportunities for teachers to improve their instructional practices. Since having access to other teachers as sources of support is integral in teachers' ability to change their instructional practices (Grossman et al., 2001; Senger, 1999; Wilson & Berne, 1999), unless teachers at Rose sought outside resources (e.g. people, materials, professional development programs, graduate school), making improvements in mathematics instruction may be difficult.

Given the limited discussion of the school district during interviews, Tyler's participation in the broader district community was limited. Tyler provided an image of the district community as handing down mandates, such as the district curriculum map. Since the textbook corresponds to the district curriculum map, Tyler felt the district expected him to follow the textbook closely. Tyler reported he was unfamiliar with the instructional practice of other teachers in the district and did not see a direct influence on mathematics teaching from anyone outside the school. Since Tyler sees mathematics teaching as involving almost exclusively knowledge of content, Tyler may not find value in engaging others that to not have an explicit focus on mathematics.

Learning trajectory. Tyler's strong identification with mathematics, even before he decided to become a teacher, influenced his views of mathematics teaching and learning. Tyler was a highly successful student in mathematics, majoring in Engineering. He did not comment on any need for changes in the instructional practices he experienced as a student, perhaps since he was so successful. Thus, Tyler began teaching with a knowledge base of what was acceptable and desirable for mathematics teaching based on his experiences as a student.

Teaching high school mathematics was most likely a very natural fit for Tyler given his positive experiences in math and his strong identification with the subject. In fact, Tyler noted reluctance when taking a job teaching middle school mathematics. However, regardless of the grade band, Tyler saw that being a mathematics teacher involved a strong level of content knowledge and the ability to break down difficult ideas – he did not differentiate between middle and high school mathematics students. His inability to differentiate between the two settings may be from a lack of knowledge of adolescents or it may be that he sees himself returning to the high school classroom, thereby limiting Tyler's identification with being a middle grades mathematics teacher and making it unnecessary to spend time making changes to his instructional practices. Tyler's identity in terms of his learning trajectory "incorporates the past and the future in the process of negotiating the present" (Wenger, 1998, p. 155). Tyler's past and future center more on mathematics content than on what might constitute best practices, and as such, Tyler's negotiation of the present centers on mathematics content as well.

Nexus of multimembership. As Tyler participated in the professional development, school, and classroom communities, he did so with somewhat of a consistent view of mathematics teaching and learning. Tyler's focus in each of these contexts was mathematics

content over pedagogical approaches – Tyler was the “math guy” in each community. Therefore, he had little need to reconcile his various forms of membership since he participated in similar ways across each context. Tyler’s reflections on his own instructional practices highlighted what he saw as weaknesses in his use of collaborative grouping and encouragement for students to communicate mathematically with one another. He knew these were of value to the online course community and even commented on the benefits of discussing mathematics content with other teachers, yet cited logistical issues, such as class size and room arrangements, as reasons why he failed to provide analogous opportunities for students. In this sense, Tyler reconciled the valued instructional practices of the online course community with the realities of his school and classroom communities by forming an identity around mathematics content as opposed to a middle school teacher of mathematics.

Relations between the local and the global. Although Tyler stated that he was a member of NCTM, he stated in an interview that he did not have an image of what the organization’s vision for mathematics instruction might be, or an idea of the types of teachers that belong to NCTM. Tyler did attend one local mathematics teachers’ conference two years prior to our interview, but had not attended any of other meetings since. Therefore, the extent to which Tyler placed his local instructional practices into a broader view was perhaps limited to his experiences as a student of mathematics and teacher in the online courses. Tyler’s image of effective mathematics teaching and learning was possibly based on what he saw as effective teaching as a student and his efforts in learning mathematics as effective ways of students’ participation in the mathematics classroom. Given his highly positive views of mathematics, his reliance on these experiences is not surprising. However, by limiting his own exposure to broader views of

mathematics teaching and learning, Tyler bound himself to the instructional practices with which he was most familiar.

Summary of the Case of Tyler Hill

Tyler's 7 – 12 licensure and experience teaching high school mathematics yielded an identity focused on mathematics content. Tyler's status as department chair was based in part on his licensure and reaffirmed the value the school placed on his knowledge of mathematics. Therefore, as Tyler made pedagogical decisions in the school, he did so by focusing on content rather than knowledge of how adolescents best learn mathematics. Tyler had a similar experience in the online course community where he functioned as a "go to" person for questions regarding mathematics content. Tyler saw little benefit to fully participate in the online course community— he already knew the mathematics in the courses and he did not buy into the goals for instructional practices.

This identity influenced his participation in the online courses and school communities. Although Tyler noted the benefits of collaboration in the online courses, he did not note similar benefits of collaboration among teachers at Rose or between his students in the mathematics classroom. Tyler described a somewhat hierarchical leadership style at Rose and in the district. This leadership style was evident in his classroom instructional practices through his reliance on the district curriculum map and district adopted conventional textbook as the nearly exclusive resources for making instructional decisions. These characteristics of Tyler's identity were projected in his instructional practices through teacher-led, procedurally oriented problems, followed by similar problems which he expected students to solve with speed and fluency.

CHAPTER V

Comparative Analysis: Looking Across the Communities

While Chapter IV addresses each research question from a within-case analysis perspective, Chapter V addresses question one through a comparative analysis of each school and classroom context and question two through a discussion of each teacher's instructional practices in light of the findings from question one. The schools and classroom communities are the focus of the comparative analysis for two reasons. First, each of the four teachers was part of the same district and online course communities, making comparisons of these communities illogical. Second, the school and classroom contexts seemed to elicit differing views of the district and online course communities, which provides a way of understanding teachers' participation in relation to their core identities in the district and online course communities. Following the comparison of the school and classroom communities, is a discussion of teachers' instructional practices in relation to the themes generated through the comparative analysis.

Comparison of School Communities

As previously mentioned, Katie and Leigh taught at Carter Middle School, while Morgan and Tyler taught at Rose Middle School. Demographic differences in these two schools played a role in the development of teachers' identities. Thus, the comparison begins with demographic differences at Rose and Carter. In conjunction with these demographic differences, three themes were developed in the comparison of the two schools: (1) teachers placing the online courses in the larger context of professional development, (2) the existence of a professional teaching

community, and (3) teachers as curriculum decision-makers. The following sections provide further details on both the demographic differences and the developed themes.

Demographic Differences at Carter and Rose

While Rose is the largest middle school in the district, Carter is one of the smallest. For the teachers in this study, this was an important difference. For example, during the online courses, Tyler had the opportunity to watch a video of Katie Williams teaching a lesson to her sixth grade mathematics class. Tyler commented on this video during an interview, noting that Katie had greater ability to incorporate the reform-oriented practices in her classroom since she had smaller class sizes than he did.

Carter [has] smaller classes than we've got, we're running 27 to 30, which I think is a big number. You can probably do more with a smaller class. I mean, I know that Katie Williams does the Connected Math a lot. She has that working pretty good probably because she has smaller, not a smaller number of students to work with, but that type of curriculum, that's how it's set up. Where here, it's a little bit more difficult, you've got a larger number of students, and perhaps how the classroom layouts are and with the kind of desk and tables you've got.

Morgan made a similar comment.

We have pretty crowded rooms, not real conducive to group work, especially that kind of group work where they had to get it. I felt like [Katie] had a smaller class, and that [allowed for] more interaction.

Additionally, both Tyler and Morgan felt that teaching at a larger school meant that a greater percentage of their time was spent managing discipline issues, evident when Morgan said the following.

You're going to have more behavior problems just because there's [a larger] number of kids. That influences your ability to teach a lot of times, if you're managing other things.

In addition to enrolling a smaller number of students, Carter also served a more rural and economically disadvantaged community than did Rose. Katie and Leigh, both teachers at Carter, noted the impact poverty had on the lack of value for mathematical knowledge, evident when Katie said the following.

We have a much lower socioeconomic group than Rose. We have a lot more people here on welfare and disability and that kind of thing. The value on education is more there than it is here, basically is what I'm trying to say.

Leigh took the lack of value on education a step further by articulating how the cultural differences in the community impacted how she taught mathematics.

I don't think they hear it spoken, math spoken at all in the home, the language of math at all. They need to really be aware that the math are around them. I think a lot of them just don't – that was one of the big awakenings when I went into teaching was understanding that things I think you just commonly talk to your kids [about]. In different socio-economic or different cultures, a lot of times it's not always the case and a lot of parents don't take time and talk to their kids, just common talking, you know, give me a tablespoon, give me a teaspoon. Kids have no awareness of the common things we take for granted [that] they should know. You know, getting ten gallons of gas. I found a lot of that here, a lot of the common things that are missing that we take for granted. And you have to go back and say, "Okay, now I have to think of a different way to approach that" because they have no idea. So you have to ... back up to teach that pre-concept of something that you expect they would know so you can take them further.

Placing the Online Courses in the Larger Context of Professional Development

Mathematics and science teachers at Carter chose to participate in multiple grants that have allowed them access to multiple district-level leaders and university personnel. By continuing to participate in and seizing opportunities for leading professional development workshops with district leaders and university personnel, teachers at Carter developed a general vision for mathematics instruction and a level of professional trust that yielded them the confidence to adopt pedagogical strategies and organize mathematics content in ways that may

not align with the district curriculum map or adopted textbook. This was evident when Katie stated that the multitude of AMSP-related grants in which they had been involved demonstrated to her that the district was “open to allowing their teachers to develop a curriculum” as long as it “makes sense.” She went on to say the following.

I just kind of feel like they trust us as professionals and as long as they feel like when they come in the room ... lessons are being taught, things are ... being accomplished, kids are learning, that we're doing what we're supposed to be doing, we're doing our job.

Although the Rose teachers participated in the online courses over the two-year period, they did not take part in the additional professional development experiences that might have continued to support the vision for mathematics instruction suggested in the courses.

Existence of a Professional Teaching Community

Despite not having analogous professional development experiences, the teachers at Rose Middle School did have common planning time that could foster the development of a professional teaching community. This common planning time was not available to teachers at Carter. Stein and Brown (1997) noted the availability and use of a common planning time as being integral to changing instructional practices. Contradicting Stein and Brown, although teachers at Rose Middle had this common planning time, they lacked a consistent vision for mathematics instruction, in other words, they lacked shared set of goals for which they felt accountable to attain. This lack of shared vision was evident as Tyler, the department chair, discussed the nature of their meetings together.

We do meet as a math department. I try to meet twice a month if we can, it all depends on if we have to meet for a particular reason, if our principal [has] something that we need to talk about - if we had a faculty meeting. But recently,

it's been really busy, so, we haven't had that many. The topics of our meetings vary. Like we're coming up with a formative assessment test this Friday, we'll kind of talk about that, what they, what we need to do.

Tyler went on to say that this test was something the principal had asked them to do as a way to place students in mathematics classes according to ability. Tyler did not comment on any common problems or issues related to mathematics teaching and learning that might have focused their meetings and provided an opportunity to establish a set of shared goals for mathematics instruction at Rose. Therefore, the development of a shared set of goals and joint accountability towards meeting those goals, characteristics of a professional teaching community, were not evident among the mathematics teachers at Rose.

Even though the teachers at Carter lacked shared planning time, they sought out opportunities to informally discuss mathematics content and pedagogy, which was in addition to the integrated mathematics and science course and their participation in professional development. During an interview, Katie provided an example of these informal conversations when she talked about Leigh's pedagogical choices for division of fractions. Katie noted that while Leigh found it sufficient to teach students to multiply by the reciprocal, Katie chose to focus on what constituted the whole, which she felt would support students' conceptual understanding. Through these sorts of conversations and their participation in a multitude of professional development experiences, the Carter teachers developed a shared sense of purpose for improving mathematics instruction and thus a professional teaching community at Carter.

The existence of a professional teaching community was reflected in their identities as well. Although Leigh and Katie viewed mathematics teaching differently, they both valued discussing mathematics content and pedagogy with other mathematics teachers. Both took pride

in students' achievement at the school, which served as a common goal for each. On the other hand, Tyler and Morgan projected vastly different ideas regarding mathematics teaching from one another and when taken with their limited use of the common planning time, highlights the isolated nature of their instructional practices. Furthermore, while Morgan wished to more centrally participate in the mathematics department a Rose, she remained an outsider. This was evident when she said the following.

I am finding that math is a real struggle for students. They're afraid of it. They don't like it. I think because of those reasons I'm more geared to [teaching mathematics] because I think I can help more – I can have a bigger impact, I think, in the math department.

Yet, when asked if she had opportunities to meet with the mathematics department, she stated that she did not.

Teachers as Curriculum Decision-Makers

Katie and Leigh, teachers at Carter Middle School, saw the district as supportive of their efforts to improve mathematics instruction by allowing them to experiment with various curriculum materials and instructional strategies. Katie noted the following.

That's one thing I liked about [our county school system] when I student taught here [was that] I felt like [the district was] open to allowing their teachers to develop a curriculum. As long as you were sticking to the State standards, the way that you went about teaching them, anything goes as long as it makes sense and you're [students are] achieving.

Leigh made similar statements regarding the district's openness to a variety of approaches and materials, evident in the following statement.

I don't think [the district expects] something specific. I think it's a feel of a math class, you know, you walk in and you see the math on the walls, you see the student working. [The district wants teachers to] create an environment where kids feel comfortable trying math.

On the other hand, both Tyler and Morgan noted the district's expectation that teachers follow the district curriculum map and the adopted textbook, leaving little flexibility for incorporating other resources. For example, Morgan noted the following regarding the district adopted textbook.

[The district] purchases curriculum books that are fairly new to this county, and you have to use them. The district expects you to follow the textbook, definitely. They put [in the] money and time.

Tyler also noted his reliance on the district adopted textbook as he discussed an activity he found beneficial in the online courses.

One of the things that we did that I thought was useful is we had to link Connected Math with our textbook – see where we might could use, how we could possibly use something from Connected Math with Glencoe [the district adopted textbook]. I thought that was beneficial, seeing how it aligns with our curriculum.

Tyler's statement indicates his view that the district adopted textbook is synonymous with the curriculum. For Tyler, it was important to rely on the adopted textbook as the nearly exclusive source for content and pedagogy, selecting ancillary activities on occasion. The Scoop Notebook and classroom observations confirmed this finding. Each lesson included in the Scoop Notebook followed the sequence of lessons in the textbook. Classroom observations indicated that students worked problems from worksheets provided by the textbook manufacture that provided students opportunities to practice problems similar to those in the textbook.

Comparison of Classroom Communities

While comparing the school communities provided important characterizations of the differences between the two schools and the impact those differences had on teachers' identities, it fails to capture the differences in the classroom communities within those schools. The

selection of the four cases was based, in part, on differences in the classroom community established by teachers within each school. Consequently, a separate comparison of classroom communities is necessary. The comparative analysis of the four classroom communities yielded three important themes: (1) the use of discourse and curriculum materials as pedagogical tools; (2) the role of the mathematics student; and (3) preparations for teaching mathematics. The following sections focus on these three themes.

The Use of Discourse and Curriculum Materials as Pedagogical Tools

The ways in which teachers negotiate the use of tools (discourse, curriculum materials, and mathematics content) within the classroom provides a view of teacher learning (cf. Cohen & Hill, 2001; Nasir & Hand, 2006) and consequently evidence of the types of identities teachers hold. Katie's almost exclusive use CMP and self-generated materials in her mathematics classroom, despite the district's adoption of a conventional textbook, demonstrates an *enacted curriculum* (Ball & Cohen, 1996) that focused on important aspects of Katie's identity – communication of mathematics and students' ownership of mathematical ideas. Katie's comment that she entered the online courses unaware of how to best support students' understanding, taken with her later extensive use of CMP provides a clear instance of the development of a mathematics teaching identity consistent with reform-oriented approaches to mathematics instruction.

Leigh, on the other hand, used CMP materials quite differently. She selected activities for occasional use, yet maintained her focus on teacher led, procedural-oriented tasks. In fact, during one observation, she modified a task that was student-centered to make it more teacher-directed. This was evident as Leigh required students to follow her use of a manipulative rather

than allowing students to develop their own ideas, evident during the following exchange during a classroom observation.

Leigh: We are going to look at things where outcomes change each time. Get out your bucket [of Snap Cubes] and take a few of each color.

Leigh: Remember the big rule with manipulatives is that we have to stay together or we can't use them.

Observer comment: Leigh calls attention to students having them follow an example of removing black cubes continually without replacement.

Leigh: Three out of eight, two out of seven, one out of six. What if I want to find the probability that all these things happened, what would I need to do?

Student: Multiply

Leigh: Good

Observer comment: Several students raise hands to ask questions. Leigh calls on students to gather the same number and type of cubes. She does three more examples, requiring students to model her selection. Leigh assigns problems from book. Students work quietly even though they are organized for collaborative grouping.

However, when she did use CMP and other reform materials, she noted the benefits for students and the information she gained regarding student thinking, evident in a reflection included in the Scoop Notebook.

I expected the conversation regarding examples of permutations and combinations to go a little quicker than it did, but it was a really good discussion with rich ideas and I chose to let the conversation continue. [The task and the ensuing discussion] created a rich background for students to grasp the formula without hesitation.

Tyler also noted selecting tasks from CMP and other reform-oriented curriculum resources for use as an opening or culminating activity to a unit of study.

I have [used materials from the online courses] before. Just some of the material with Connected Math, I've done with Factor Game and some of the other things that we've done.

Given the lack of student-centered activities present during observations and the lessons included in the Scoop Notebook, those activities were “special days” rather than a normative part of his repertoire of classroom resources, which is similar to Leigh’s use of CMP.

Another important goal of the online courses was fostering effective discourse among the teachers. Katie, Leigh, and Tyler all commented on the benefits of communicating with other teachers from across the district regarding mathematics content and pedagogy.

Katie: Just the way that we would discuss the problems that we had worked through, how all the different teachers had different conceptions about maybe what it was asking or different ways to work the problem or different approaches. It was really helpful to see - All those things, how other people thought, and even if we arrive at the same goal, the same answer, just the different roads everybody took to get there.

Leigh: That was the neatest thing about the courses is you had math teachers from everywhere, all in our district, all getting to sit and sharing ideas and realize that there’s one problem, but we’re seeing it in eight different ways and that really helps. Because then you’re able to say, “Well, some of my students are probably seeing it this way or this way or this way.” And you had different ideas on how to approach the same thing.

Tyler: The teachers [in the online courses] brought some ideas. They shared with everybody what they were doing, just hearing some of the other teacher's ideas on certain problems or what they have done in class before. I thought that the collaboration was important. I thought it was good. I liked the collaboration with the other teachers.

For both Katie and Leigh, teachers at Carter who had opportunities to regularly communicate with one another, the use of discourse as a pedagogical tool was evident in their classrooms.

Katie used collaborative grouping and whole class discussion to elicit conversations between students and between herself and the class (Field notes, March 24, 2008). Discourse became a central element of Katie’s identity as a mathematics teacher, evident in all her work. Leigh, on the other hand, saw the benefits of communication in the mathematics classroom, but only

occasionally used it as pedagogical tool, evident in the aforementioned reflection in her Scoop Notebook. Tyler, however, did not use discourse as a pedagogical tool even though he noted the value of communication among mathematics teachers in the online courses. This was evident in his description of how students learning mathematics in his classroom.

[Students learn math] by doing, by doing the work, by doing the problems. I can be up there, and I can show them an example, and they look and then do it.

Based on observations, “doing the problems” consisted of students working individually at their desk and providing answers when called upon by Tyler.

The Role of the Mathematics Student

Tyler and Leigh also had similar views of the role of the student. Since both selected tasks that were primarily teacher-direct and did not regularly use discourse as a pedagogical tool, students in each of their rooms were expected to listen quietly throughout class, speak only when called upon, and practice problems similar to those modeled by the teacher. In addition to the ways students participated in mathematics classes, Tyler and Leigh also noted how students constrained what took place in the classroom. For Leigh, this was evident as she discussed the lack of personal responsibility for practicing mathematics.

They’ve gotten the practice in the classroom, they go home and have the practice, they come back, they have more practice so it’s continuing so they don’t lose it the minute they walk out of my classroom. And we’ve gotten so far in the direction of handholding that we can’t expect them to do any homework. I don’t see the same results because I have to spend so much time going back to what they’re not getting because they won’t do anything if you’re not standing over them. We’re so far into just giving into spoon-feeding that they aren’t willing to stop and think. And if you push them to do that, it’s not going over well and that’s part of that responsibility thing, you know, and it’s really affecting the classroom. It just bothers me to see the effect it’s having in the classroom and to feel I can’t change it.

Tyler made similar comments during interviews regarding students' willingness to learn mathematics, evident when I asked about the nature of the students who struggle in mathematics.

[They are] unmotivated, maybe not in just the math class, but in general. Don't have any kind of work ethic. I'm saddened to see some students now who aren't doing any of it. Come to class and lay their heads down and not putting forth any effort.

Participation in Katie's mathematics classroom meant something quite different than participation in Leigh's or Tyler's classroom. She expected students to work collaboratively in small groups, take part in whole class discussions, and justify their solutions. Additionally, students in Katie's classroom were expected to regularly use concrete materials and calculators to understand mathematical ideas. For instance, during one classroom observation, students used coins and dice to collect data and model probability situations. While Katie did note that some students were more willing to engage in problem-solving tasks than others, she primarily focused on gaps in prerequisite knowledge when asked about challenges with students learning mathematics. She provided the following statement.

They're in sixth grade and they are still using their fingers to add and subtract and they don't know their multiplication tables and so, you're finding - I've got these standards I've got to cover and you can't start where you're supposed to start because you have to go back and make sure they get basics. So, that's really challenging.

Like Katie, Morgan also saw gaps in students' knowledge of basic computation, yet went a step further in explaining why she feels those gaps occur.

I think there's a big fear with kids. They just hate math. They said that more than once in math class. And it's getting them to love it and to like it and to feel like they can do it. I love that challenge. I don't find that so much in any other subject. I think [students' dislike comes from] rote math. I think that there's a place for that. I think memorization of multiplication tables and knowing how to do formulas and plugging things in the right places - it's essential to get to an answer, but I think my focus is more going to be on how do you apply it to

everyday use and word problem situations, life skills. I just think it's not emphasized as much in practical use in the younger grades.

The dichotomy between the instructional decisions the regular mathematics teacher makes and Morgan's core identity focused on students' opportunities to explore mathematics made apparent the conflict between what Morgan wanted to accomplish in the mathematics classroom versus what she felt she had to do. This was evident in her opening quote in Chapter IV, "Just these three years of teaching, I'm seeing – to teach math, we have to do it differently. We just have to do it differently."

Preparation for Teaching Mathematics

Using Wenger's (1998) view of identity necessitates understanding not only current forms of participation, but also past and anticipated participation. Therefore, each of the participating teachers were asked to discuss their preparation for mathematics teaching and their future in mathematics teaching. Though neither majored in mathematics, both Leigh and Tyler took college-level mathematic coursework at least equivalent to a minor in mathematics. Additionally, both intended on teacher mathematics during their teacher education programs. They also had similarities in their future plans for mathematics teaching. Though both noted enjoying teaching middle grades mathematics, they each anticipated teaching high school or college coursework in the future. Therefore, their learning trajectories focused on mathematics content over adolescent learners. This focus on mathematics content was an important aspect of both Leigh's and Tyler's core identity and was reflected in their participation in each community, which is detailed in Chapter IV.

On the other hand, neither Katie nor Morgan intended on teaching mathematics during their teacher education programs. Katie's content focus was reading, while Morgan was

prepared as a modified special education teacher. As such, each had limited coursework in mathematics at the college level. During a conversation with me, Morgan commented on her weak background in mathematics and how the online courses increased her knowledge of mathematics.

After I finished the interview today, we talked about getting resources for [Morgan's] classroom. I encouraged her to look at the Investigations curriculum to supplement CMP in her resource classes next year. She said that getting resources was one of the best things about the classes, with another being the amount of mathematics she learned. (Field notes, February 29, 2008)

In addition to participating in teacher education programs that did not specifically focus on mathematics content, both Katie and Morgan saw their future in mathematics education as teaching middle school mathematics. In fact, Morgan wished to have an increased responsibility for mathematics instruction given the new content and pedagogical content knowledge she gained from the online courses.

Discussion of Instructional Practices in Relation to Comparisons across Contexts

Using Wenger's (1998) framework for analysis, Chapter IV address question two through a discussion of teachers' identities in relation to their instructional practices from a within-case analysis perspective. Rather than focusing on results of the individual cases, this section refers to findings from the comparative analysis to understand the formation of teachers' identities and the related instructional practices. Both Katie and Morgan seemed to have identities that, for the most part, aligned with the vision of reform documents in mathematics education (NCTM, 1989, 1991, 1995, 2000; NRC, 2001). Conversely, Tyler and Leigh held identities that, for the most part, aligned with conventional ideas regarding mathematics teaching and learning. Therefore,

the following paragraphs are organized by the two different approaches to mathematics teaching and learning.

How Reform-minded Identities “Played Out” in the Mathematics Classroom

Both Katie and Morgan felt a need for changes in the way mathematics was taught. Each noted weakness in conventional approaches to mathematics instruction and were in search of new ways to reach students. For Katie, this centered on communication and students’ ownership mathematical ideas. Similarly, Morgan saw a need for students to experience mathematics and found it essential for her to ask questions that supported students’ understanding of mathematics. Each viewed CMP as an integral part of incorporating what they valued in mathematics teaching. Therefore, both Katie and Morgan began using CMP as a regular part of classroom instruction early in the online courses. As Wenger (1998) notes, the extent to which an individual can make use of the tools and artifacts of a particular community provides a measure of community membership. Both Katie and Morgan sought to use the tools and artifacts, in this case curriculum materials and pedagogical approaches, of those with a reform-minded vision of mathematics instruction. However, Morgan and Katie participated in different school communities with differing views of teachers’ role in making curriculum decisions. Katie felt the school and district communities supported her use of CMP and alternative pedagogical approaches that she felt would best support students’ understanding.

Conversely, as Morgan used CMP at Rose, she encountered what she felt were expectations from the school and district to use the district-adopted textbook. Morgan’s responsibility for mathematics instruction soon diminished, and as such, her identity consisted of a vision for mathematics instruction rather than integrated into her instructional practices.

Wenger accounts for these contrasting community views through a *nexus of multimembership*. Since individuals belong to multiple communities of practice, acceptable forms of participation across communities may vary. Thus for Morgan, the contrasting views of each community forced her to reconcile who she was as a mathematics teacher by participating in classroom in ways that were acceptable within the school, yet holding a reform-minded view of what was possible in mathematics classrooms.

Despite Morgan's lack of responsibility for daily planning and instruction in the mathematics classroom, she remained highly reflective regarding the instructional practices used in her inclusion classroom. Both she and Katie reflected on the information gained regarding student thinking, noted students' knowledge as superficial and limited to procedures, and commented on the misconceptions held by students. This sort of student-centered, critical reflection of instructional practices provides a foundation for long-term changes in teachers' beliefs and instructional practices (Senger, 1999).

In contrast to Morgan, Katie did have the responsibility for daily planning and instruction. As is articulated in Chapter IV, Katie regularly selected activities and established classroom norms where communication was a central part of participation in the mathematics classroom. Students worked cooperatively to solve tasks, then shared their solutions with the entire class and the teacher. Her value of students' ownership of mathematical ideas was evident in her organization of topics and curriculum materials. Katie organized her course around the "big ideas," hoping students would gain greater conceptual understanding than if she focused on isolated skills and concepts. Unfortunately, Katie was the only teacher in the study that had both

reform-minded ideas and the responsibility for daily planning and instruction to see those ideas become realized in the classroom.

Another important similarity between Katie and Morgan is their participation in a teacher education program that was not focused on mathematics content. Those past experiences can be viewed as a part of each teacher's learning trajectory. Wenger notes that trajectories for learning focus attention on the ideas that the formation of an identity is an ongoing process of becoming. As such, it is important to consider histories of experiences, as well as their present and future goals. Each commented on seeing a need for changing the way mathematics is taught and saw the courses as a window into what was possible in the mathematics classroom. Thus, their openness to new ideas may be a product of their focus on adolescent learners over mathematics content. Additionally, each intended on remaining in the middle school classroom over the next five to ten years. Therefore, they may have a greater sense of responsibility for improving their own instructional practices than teachers who intend on teaching areas other than middle grades mathematics.

How Conventional-minded Identities “Played Out” in the Mathematics Classroom

Tyler and Leigh each had strong mathematics backgrounds; consequently, central to both of their identities was knowledge of mathematics content. This was an important consideration in understanding their trajectories for learning and thus their identities as mathematics teachers. Other teachers in the study identified each as being the “go to” person in the school with regards to mathematics content. Additionally, central to both teachers' identities was the need for students to practice mathematics to be successful. Both noted the need for students to work hard and have personal responsibility for practicing skills. These aspects of their identity were

apparent in several areas of their instructional practices. Both typically selected teacher led tasks that involved modeling a problem then requiring students to solve a similar problem. Since learning mathematics centered on “personal responsibility,” there were few opportunities for students to work cooperatively. Each expected students to work individually, solve problems quickly, and provide a solution when called upon. When selecting materials for classroom instruction, each relied heavily on the district adopted, conventional textbook. Both, on occasion, used outside resources (such as CMP) for atypical instructional periods.

Both Leigh and Tyler noted the benefits of discussing mathematics with other teachers in the professional development courses, yet they did not afford those same opportunities to their students. This discrepancy represents a case of differing forms of participation across different communities, which is a result of different expectations for competencies and expertise in each community (Wenger, 1998). Appropriate ways of participating in the online courses included discussing mathematics content and pedagogy with other members of the community. Each found value in these discussions as a way of improving instructional practices. The classroom communities they established with students did not take on these same characteristics, since their identities as mathematics teachers were centered on students practicing skills rather than on opportunities for students to communicate mathematically. In relation to Wenger (1998), each teacher reconciled these differences and justified their focus on procedural-oriented tasks by citing underperforming students’ poor work ethic in the mathematics classroom. In other words, they were not critical of the role instructional practices may have in students’ mathematical deficiencies, whereas both Katie and Morgan saw weakness in traditional approaches to mathematics instruction in supporting students’ understanding.

Despite the number of similarities in Leigh's and Tyler's instructional practices, there were some differences. Leigh noted that her participation in the online courses gave her an "awareness" of other approaches to mathematics instruction. Leigh did attempt to use an increasing number of materials that represented an alternative vision for mathematics instruction. In fact, her reflections indicated she valued these tasks for the information she gained from students and the depth of conversations apparent when solving alternative tasks. Tyler, on the other hand, rarely used resources other than the textbook. When he did, he used it to supplement conventional approaches. He did not mention any additional benefits to students or to his knowledge of students when using these tasks. Thus, although both held conventional-minded identities and shared a number of instructional strategies, Leigh appeared to be more open to alternative views of mathematics instruction and reflective of the opportunities she gave for student to learn mathematics. Therefore, it appeared more likely that Leigh may be on a trajectory to further refine her instructional practices, whereas Tyler's instructional practices seem firmly established in conventional approaches to mathematics instruction.

Leigh's openness to alternative views may be a product of her access to a professional teaching community at Carter that valued communication about and reflection on instructional practices. Also, since the teachers at Carter felt as though they could regularly use curriculum materials other than the district-adopted textbook, Leigh may have felt less confined by administrative decisions than Tyler did at Rose. Also important to refining her instructional practices is the access Leigh has to a consistent vision for mathematics instruction. Since the teachers at Carter have regularly taken part in professional development opportunities with one another, Leigh may have greater access to a consistent message regarding the benefits of reform-

oriented approaches. In contrast, Tyler has not participated in further professional development opportunities that might align the views regarding mathematics teaching and learning evident in the online courses with the goals expressed by district leaders.

Summary of Findings

Chapters IV and V presented the results and discussion from this research project. Chapter IV included the within-case analyses of the four teachers selected for in-depth study, addressing both research questions from a within-case analysis perspective. Results of the within-case analyses indicated that two teachers held reform-minded identities related to mathematics teaching and learning and two teachers held traditional-minded identities as mathematics teachers. Those identities resulted in differing forms of participation across the district, school, classroom, and online course communities, which is summarized in the following paragraphs.

Katie, a teacher at Carter, valued communication and students' ownership of mathematical ideas. This was evident in each of the communities in which she participated. Katie noted the value of communication in the online courses and the open dialogue among mathematics teachers at the school. Additionally, her involvement in a multitude of professional development experiences in the district provided her the impression that her value of communication and students' ownership of ideas was shared among district leaders. Consequently, Katie felt a strong sense of alignment within each of the communities she participated. This resulted in instructional practices that represented the vision for mathematics instruction suggested in the online courses.

Leigh, another teacher at Carter Middle School, focused her participation on mathematics content and felt that extensive practice was needed for students to be successful. Leigh predominantly used teacher-led instructional practices and activities in her classroom. However, she noted the value of communicating with other teachers in the professional development courses and the open dialogue regarding mathematics teaching and learning in the professional teaching community at Carter. As such, Leigh's participation in the classroom community was in contrast to her participation in other communities. She reconciled these differences by noting students' unwillingness to practice mathematics and the perceived lack of support from parents and the school principal for encouraging this practice. Leigh did note the benefits of using reform-oriented tasks with regards to the information she gained about students' thinking, yet the perceived lack of support inhibited further integration into her classroom.

Like Leigh, Tyler's identity focused on mathematics content. Tyler served as the "go to" person at Rose when issues arose regarding mathematics content. He felt that his status as department chair was based, in part, on his licensure as a 7 – 12 mathematics teacher, further reinforcing his focus on mathematics content. Tyler also noted the benefits of discussing mathematics with other teachers in the professional development courses, but did not afford those same opportunities to other teachers in his department even though they had a common planning time to communicate with one another. Additionally, Tyler held a linear view of mathematics teaching in which learning mathematics served to prepare students for future mathematics class. He did not see his role as a mathematics teacher as improving students' attitudes and dispositions towards mathematics, which was evident in his opening quote. Consequently, Tyler relied on traditional approaches to mathematics instruction even though he

recognized that those instructional practices did not represent the view of mathematics teaching and learning valued in the online courses.

In contrast to Tyler, Morgan did develop an identity related to mathematics teaching and learning that was consistent with views suggested in the online courses. Morgan's identity involved providing opportunities to explore mathematics and developing questions that would promote students' conceptual understanding. Morgan, sensing a need to change traditional instructional practices based on her experiences working with struggling students, saw limited benefit of focusing exclusively on procedures and skills. However, she perceived the existence of a competing view of mathematics teaching and learning in her school community.

Additionally, as Morgan's role shifted to working in inclusion classrooms rather than as a resource teacher, she was no longer responsible for daily planning and instruction in the mathematics classroom. As a result, the value she placed on students' opportunities to explore mathematics concepts was relegated to a vision for mathematics instruction.

Important differences were also evident between each of the schools. For instance, at Carter, teachers developed a professional teaching community focused on improving mathematics instruction. The teachers found value in talking to one another about mathematics and even observed and critiqued one another's instructional practices. This professional teaching community developed over the course of several professional development initiatives, one of which being the online courses. Consequently, teachers at Carter understood the goals of the district regarding mathematics instruction and felt free to experiment with various curriculum materials and instructional strategies. Katie did so by using regularly using CMP and focusing on student-centered approaches to instruction. Leigh, however, focused more on challenging

students mathematically through practicing skills and procedures that she felt would result in improved achievement scores and best prepare students for future mathematics.

In contrast to the teachers at Carter, Tyler and Morgan, teachers at Rose, perceived an expectation to follow the district adopted textbook and the corresponding curriculum map. These teachers did not participate in the same professional development experiences as the teachers at Carter and did not articulate an understanding of the district's priorities for mathematics instruction. Although mathematics teachers at Rose shared a common planning time which could have been used to discuss mathematics teaching and learning, they typically used this time for individual planning. Additionally, both teachers commented on the need to focus on basic skills at Rose, citing deficiencies in students' computational abilities. Given the stark differences between the goals, values, and beliefs promoted in the online course and those evident in the school community at Rose, both participating teachers were forced to reconcile these competing values in forming their identities as mathematics teachers. Tyler did so by focusing on mathematics content over reform-oriented approaches to mathematics instruction, while Morgan continued to focus on reform-oriented approaches, citing weakness in traditional approaches in developing students' understanding of and attitudes towards mathematics.

CHAPTER VI

Summary, Implications and Relation to Theory, and Conclusions

Chapters IV and V included the results and discussion of the data analysis. This chapter includes a brief summary of the dissertation project, implications and relationship to theory, recommendations for future research, and conclusions.

Summary of the Research Project

This qualitative case study documents the identities of four middle grades mathematics teachers and the influences of those identities on their instructional practices. Three sources of data were collected: interviews, observations, and the Scoop Notebook (Borko et al., 2005). An initial interview protocol was used to understand the district, school, classroom, and online course communities, as well as how each of the four teachers participated in those communities. Each participating teacher was observed twice. A modified version of the Oregon Teacher Observation Protocol (Wainwright et al., 2004) was used in conjunction with field notes to highlight aspects of teachers' instructional practices, to understand the mathematical norms in the classroom, and to triangulate interview and Scoop Notebook data. Documents collected in this study were incorporated in the Scoop Notebook, which included lesson plans, lesson reflections, samples of student work, sample feedback on student work, and student assessments. Teachers collected the document data over five to seven consecutive days of instruction during the Spring of 2008. Teachers received monetary compensation for their participation in the study.

Using a case study approach to inquiry, four of the seven teachers were selected for in-depth investigation. The criteria for selecting the four cases were as follows: (a) contrasting views of mathematics teaching and learning, (b) differing school cultures, (c) area of licensure, (d) mathematics background, and (e) the various instructional strategies used in the mathematics classroom. Wenger's (1998) characteristics of identity provided the framework for data analysis. This view of identity aligns with situative views of learning and provided an analytic lens that allowed a focus on the development of a mathematics teaching identity.

Two levels of analysis were conducted. First, Chapter IV addresses question one from a within-case analysis perspective by looking at the relationship between teachers' core identities and their participation in district, school, classroom, and online course communities. Following this analysis, Chapter IV also includes a discussion of teachers' instructional practices in light of these identities framed around Wenger's characteristics of identity, thus addressing question two of this research project from a within-case analysis perspective. Chapter V contains a comparative analysis of the school and classroom communities, since each appeared to elicit differing views of mathematics teaching and learning, thus different identities for the participating teachers. The following sections summarize these findings.

Summary of Findings for Question One: Relationships between Identities and Participation

The within-case analyses indicated that the perceived alignment of goals, values, and beliefs for mathematics instruction between each of the communities is an important element of developing a reform-minded identity. Of the four teachers included in these analyses, Katie was the only teacher who felt that effective participation in each community focused on the same elements: communication of mathematical ideas (between students, between teachers, and

between teacher and students) and opportunities to develop ownership of mathematical ideas. Therefore, Katie held an identity that was consistent across the communities in which she participated. For each of the other teachers, effective participation in each of the communities was different, which forced them to reconcile these differences. For example, both Tyler and Leigh valued discussions about mathematics in the online courses, yet did not provide analogous experiences to students in their classroom. Given the contrasting forms of effective participation in each community, teachers were forced to reconcile these differences, which often took the form of conventional-minded views of mathematics teaching and learning.

In the comparative analysis, it became apparent that teachers' views of the district's expectation for mathematics instruction were categorized and shaped by the schools in which they teach, despite the fact that teachers within the same school had quite different identities. These contrasting views emanated from four distinct differences in the two schools: demographic differences (i.e. school size and socioeconomic status), the existence of a school-based professional teaching community, placing the online courses in a larger context for professional development, and the role of the teacher in making curriculum decisions. Despite the alignment between the schools and their views of the district's expectation for mathematics instruction, individual differences in their identities within the classroom communities were apparent. These differences centered on their preparations for mathematics instruction, the role of the student, and the use of curriculum materials and discourse as pedagogical tools. Differences in their identities within the classroom community illustrated the types of learning opportunities students had and the nature of the instructional practices each teacher utilized. These differences resulted

in characterizations of two teachers as holding predominantly reform-minded identities and two teachers as holding conventional-minded identities.

Summary of Findings for Question Two: Relationships between Identities and Instructional Practices

Two teachers held reform-minded identities and thus attempted to use pedagogical approaches consistent with reform-oriented instructional practices. Each saw weakness, not in students, but in instructional practices that resulted in a lack of mathematical understanding. Additionally, these two teachers participated in teacher education programs that were not focused on mathematics content. Consequently, each entered the teaching profession focused more on supporting learners than mathematics content. Lastly, each teacher remained highly reflective and critical of their own and others' instructional practices. This reflection provided each with opportunities for changes in their identities as mathematics teachers. However, since these two teachers taught in schools where teachers perceived the existence of differing priorities for mathematics instruction, their use of reform-oriented instructional practices differed. Katie's perceived alignment between each community allowed her to more fully integrate reform-oriented practices than Morgan, who felt constrained by the school and district in her attempts to utilize reform-oriented approaches.

Two other teachers held conventional-minded identities and thus predominantly used traditional instructional practices. Both intended to teach mathematics following their teacher preparation programs and held identities that were strongly centered on mathematics content over pedagogical approaches appropriate for adolescent learners. Rather than seeing weaknesses in instructional practices as a cause of students' deficiencies in mathematics, both conventional-

minded teachers cited weaknesses in students' work ethic as a primary cause of these deficiencies. However, since Leigh had access to a school-based professional teaching community and ongoing professional development centered on reform-oriented approaches, she appeared more likely than Tyler to adopt an alternative view of mathematics teaching and learning. Tyler's instructional practices were isolated from others in the school, not open to the level of critique and discussion apparent at Carter. Additionally, he chose to not take part in additional professional development opportunities available to teachers in the district, whereas the teachers at Carter did.

Implications and Relation to Theory

Each of the teachers in this study participated in the online courses, yet their use of the pedagogical approaches suggested in the courses varied greatly. The question then becomes one of *why* some teachers are able to do so while others are not. Wenger's (1998) notion of identity becomes a reasonable and fruitful way of approaching this "why" question. While this view of identity narrows the focus to individuals, it does so by accounting for the ways in which individuals participate in social practices (such as teaching). This is particularly important for teachers because of their engagement in multiple communities: district, schools, classrooms, and professional development. As Cobb et al. (2003) noted, if we shift our focus from individual teachers' actions and competencies and onto "functions of teaching," which includes such things as selecting activities and curriculum resources, interpreting test scores, and developing assessment instruments, then it becomes clear that multiple people hold responsibilities for mathematics teaching. Therefore, to account for both individual teacher actions and the broader enterprises (e.g., school and district leaders) concerned with mathematics teaching and learning, I

drew on Wenger's notion of identity to conduct this research. A survey of the literature indicates that while educational researchers have consistently drawn on Wenger's notion of communities of practice as a framework for empirical analysis, very few studies (e.g., Hodge, 2006; Van Zoest & Bohl, 2005) utilized Wenger's notion of identity.

What this lens provided was an observation of consistencies and inconsistencies in the ways teachers participated in their local communities, which, for this study, I narrowed to the district, school, classroom, and online course communities. By highlighting identities in these four communities, I was also able to make comparisons across contexts, identifying important relationships to teachers' identities. Additionally, connecting teachers' identities to particular instructional practices was equally significant since developing instructional practices that best support students' learning is the lynchpin of professional development (Ball & Cohen, 1999).

Despite the benefits of Wenger's (1998) notion of identity, there are shortcomings. First, this view of identity fails to yield insight into the knowledge of subject matter, teaching, and learning that was captured in Collopy's (2003) view of identity, which incorporates cognitive aspects such as beliefs and knowledge. By using Wenger's participatory view, I was only able to address knowledge through prior experiences and opportunities, such as a content focused teacher education program, and the ways in which teachers participated in local contexts (for example, Tyler's desire to be recognized as being knowledgeable about mathematics). Second, Sfard and Prusak (2005) argued that Wenger's concept of identity was not "operationalized," that is, that Wenger fails to provide a formal definition of what he means by the term identity, but rather only provides descriptions of it. I attempted to remedy this noted weakness by additionally drawing on Gee's (2000) concept of a core identity, where he defined identity to be

a “certain kind of person” and the core being those elements that remain relatively consistent across contexts.

In addition to these theoretical implications, several empirical implications exist as well. They are the focus of the following sections and include professional development as changing culture, the professional teaching community as a catalyst for sustained change, and deficient views of students and their learning of mathematics.

Professional Development as Changing Culture

A central focus of professional development must be on creating opportunities for sustainable change rather focusing exclusively on developing teachers’ knowledge of specific mathematics. That is not to say that developing teachers’ content knowledge is not an important part of professional development opportunities. However, unless developing teachers’ content and pedagogical content knowledge is done in conjunction with creating a local culture that can support lasting change over time (Senger, 1999), teachers are likely to dismiss the pedagogical approaches suggested in professional development due to perceived constraints within their district, school, and classroom. Research on effective professional development indicates the importance of creating a school culture that supports teacher learning. Hawley and Valli (1999) noted that successful professional development initiatives are primarily school-based and function as an integral part of school operations. Therefore, professional development providers shoulder the responsibility to inform not only mathematics teachers of instructional practices that might support students’ conceptual and procedural understanding of mathematics, but also must ensure that those instructional practices are valued and consistent with the vision for mathematics instruction in the local school. Part of that support might be informing school and

district leaders of the priorities of the professional development opportunity so that they might develop a shared set of goals, values, and beliefs regarding mathematics teaching and learning (Cobb et al., 2003). Principals and other administrators also need opportunities so that they might

develop an eye for what reformed mathematics classrooms might look like, think ... about the pedagogical relationship between teacher and supervisor, and explore the characteristics of school culture that seem to hinder or support the supervisory process (Nelson, 1999, p. 10)

In this study, the teachers at Carter had dramatically different perceptions of the district's vision for mathematics instruction than did the teachers at Rose. These contrasting visions seem to arise out of the teachers having different opportunities to interact with school and district leaders, thus impacting teachers' perceptions of integrating reform-oriented approaches in their classroom. Based on conversations with a member of the district's leadership team, the district did have a reform-oriented vision for mathematics instruction in the school, yet the four teachers included here did not articulate that same vision. Consequently, some teachers felt compelled to closely follow the district adopted conventional textbook, while others felt the freedom to utilize reform-oriented approaches to instruction. Therefore, it is necessary that mathematics teachers be privy to the goals for mathematics instruction in their local school and district, either through direct contact in professional development opportunities, or other avenues that make the district's vision for mathematics instruction transparent.

Professional Teaching Community as a Catalyst for Sustained Change

Changes in identity, changes in being a certain kind of mathematics teacher, imply deep-seated shifts in how an individual participates in the practices of teaching. These changes take time. The ongoing nature of professional development at Carter supported the development of a

professional teaching community and provided opportunities for teacher's to regularly reflect on their instructional practices with one another. Conversely, despite having a shared planning time, teachers at Rose did not develop a similar professional teaching community among mathematics teachers.

The concept of identity as a learning trajectory (Wenger, 1998) highlights the notion that the development of an identity is ongoing and never complete. Thus, sustained opportunities over time are needed to maintain and further refine reform-minded identities. This implication is consistent with an abundance of literature (e.g. pp. 40 – 41 of Chapter II) on the value of developing professional teaching communities. As Grossman, et al. (2001) notes, the benefit of cultivating these communities is that they provide an ongoing forum for teacher learning. Cast in terms of identity, they provide a forum for participation focused on improving mathematics instructional practices. Thus, more central participation within this community denotes changes in one's identity. Based upon findings in this study, that identity carries a corresponding view of the teacher's and students' role in the classroom and reflects the teacher's selection of instructional practices.

A Teacher-Centered Problem

An important distinction between the teachers that constructed a reform-minded identity and those that held conventional-minded identities was their views regarding students' deficiencies in mathematics. Whereas the reform-minded teachers saw weakness in students' mathematics ability resulting from inadequate pedagogical strategies, the conventional-minded teachers noted students' poor work ethic as a primary cause of mathematical deficiencies. These are important distinctions since teachers' views of students are linked to the tasks teachers select

and the instructional strategies they employ (Beswick, 2004). Teachers that see deficiencies as student-centered problems are less likely to relinquish power in the mathematics classroom, provide opportunities for students to communicate mathematically and interact with one another, and generally less likely adopt instructional strategies that align with the National Council of Teachers of Mathematics (NCTM) standards documents (1989, 1991, 1995, 2000).

On the other hand, the reform-minded teachers saw deficiencies as a teacher-centered problem. A multitude of studies have shown that teachers' willingness to critically reflect on their own and others' instructional practices is a critical aspect of teacher change (Hiebert, Morris, & Glass, 2004; Senger, 1999). In relation to Wenger's use of a learning trajectory as a characteristic of identity, those with reform-minded identities may well be on trajectories that lead them further toward instructional practices consistent with NCTM standards documents, whereas those with conventional-minded identities may become further entrenched in their traditional practices and perceptions of students' deficiencies.

Recommendations for Future Research

The themes developed in this research project illuminated several important relationships between identity and instructional practices. Despite the benefits of using Wenger's (1998) framework, further examination is needed to address specific nuances in the development of mathematics teachers' identities. The following sections address this need by highlighting the recommendations for future research.

Preparation of Mathematics Teachers

The two teachers who developed reform-minded identities did not intend on teaching mathematics, but found themselves doing so based on teaching positions available when they

entered the profession. On the other hand, the two teachers that carried conventional-minded identities both intended on teaching mathematics and had strong mathematics backgrounds. These strong backgrounds were perhaps a result of positive experiences as students of mathematics in K -12 classrooms that caused them to seek additional study at the university level. The adage “teachers teach as they were taught” might be true for these two teachers, since each may not have seen need for pedagogical approaches different from their own experiences as students.

The two reform-minded teachers were more focused on supporting students than on mathematics content. Consequently, they perhaps did not feel tied to traditional approaches to mathematics instruction. Rather, they were open to a variety of ways of supporting middle grades students’ learning of mathematics. The differences in the pedagogical approaches used by the teachers’ in this study relative to their preparation as mathematics teachers is an important finding and worthy of more investigation. How are the identities of middle grades mathematics teachers prepared as K – 8 generalists different from 7 – 12 mathematics content specialists? What experiences as K – 12 students are particularly instrumental in the development of a mathematics teaching identity? What role might a teacher education program focused on general pedagogical principles over knowledge of mathematics content play in the development of middle grades mathematics teachers’ identities and consequently their selection of instructional practices?

Supporting Mathematics Teachers of Special Populations

Morgan Roberts, the special education teacher included in this study, valued her experiences in the professional development courses and became increasingly confident in her

ability to teach mathematics. In fact, she commented several times on her desire to be a part of the mathematics department since she felt she could have a significant impact on students' understanding of mathematics. This is of particular importance since her work centers on students who typically struggle with and have negative dispositions towards mathematics. However, Morgan was consistently viewed as a special education teacher within the school rather than a teacher who was knowledgeable in and about mathematics. Consequently, Morgan had little concrete experiences within the school in which she could utilize the pedagogical approaches suggested in professional development. Even as she attempted to integrate reform-oriented approaches, she was told by a former school principal she could not.

It appears as though an integral aspect of her ability to utilize reform-oriented instructional practices is the extent to which she is perceived by others as being a teacher of mathematics, as well as special education generalist. Therefore, special attention to teachers who work with learning disabled students may be needed in professional development experiences to ensure these teachers have opportunities to enact their broadening views of mathematics teaching and learning. Therefore, research is needed to understand the nature of this special attention. If being viewed as a mathematics teacher is an important aspect of a special education teacher's ability to improve mathematics instructional practices, how might they best be supported when investigating mathematics content focused professional development? What types of professional development designs might best support shifting the special education teacher's role within the school regarding mathematics teaching and learning?

Katie as Representative Case of Effective Reform

Katie was the only teacher in this study that held a reform-minded identity and had responsibility for daily planning and instruction. Given the goals of the online courses, she represents the most aligned with reform practices suggested in the online courses. Katie's core identity was the most consistent across the contexts and rarely needed to reconcile competing views across contexts. While using Wenger's (1998) characteristics of identity highlighted the richness of her individual experiences across the four contexts, this framework's shortcoming is in its ability to make generalizations regarding the development of an identity across multiple teachers with a variety of personal experiences. This leaves unanswered the questions of whether teachers with similar experiences as Katie would develop a similar mathematics teaching identity and whether or not other teachers who are successful with integrating reform-oriented approaches have had similar experiences to Katie. Hence, more research is needed to determine if Katie's experiences and the corresponding instructional practices are representative of other teachers. In other words, are the relationships between the contexts of teachers work and the identities teachers develop found in this study similar among other populations of teachers?

The Nature of the Online Courses

One purpose of the online courses was to determine the feasibility of offering mathematics content focused professional development online. The design included a blended format where teachers "met" online, but did so by coming together with other teachers from their local school. The marked differences in each school may have been further entrenched by the fact that teachers' from differing schools rarely had the opportunity to come together. Perhaps if

the professional development were provided in one location where teachers regularly met face to face, then teachers from across schools may have adopted a shared set of goals for mathematics instruction, a shared accountability for meeting those goals, and thus a professional teaching community across the district.

Using Wenger's (1998) characteristics of identity to analyze the adoption of pedagogical approaches suggested in other professional development designs may help to determine if online professional development can foster successful changes in instructional practices in ways similar to site-based professional development. What role did the online format of the professional development courses play in the development of teachers' identities? Would site-based professional development using similar materials and assignments yield results similar to those found in this study? If teachers had met exclusively online, would the development of local professional teaching communities be hindered?

Conclusions

Interest in this study arose out of my participation as a graduate research assistant in the online courses. During this time, I had little interaction with the teachers in this study. I attended a few online classes and two or three face-to-face class meetings. My primary window into the courses was the weekly meetings between the two course instructors. Here, the course instructors discussed their pedagogical practices and their lines of research associated with the online courses. Additionally, I assisted with data analysis and dissemination of findings related to the online courses. In conjunction with my participation as a graduate research assistant was an increasing interest in the cultural influences on mathematics teaching and learning, outlined so clearly in the book *The Teaching Gap* (Stigler & Hiebert, 1999). Thus understanding the

priorities of the professional development courses and the local expectations for mathematics teaching and learning was a keen interest during my doctoral studies. Observing the amalgamation of these various contexts was a natural place to conduct my dissertation work.

As Stigler and Hiebert state, the problems of mathematics education in the United States are not the result of incompetent teachers, but of a cultural “system” that binds teachers to pedagogical approaches that are “severely limited.” They go on to say,

Teaching systems, like other complex systems, are composed of elements that interact and reinforce one another; the whole is greater than the sum of the parts. An immediate implication of this fact is that it will be difficult, if not impossible, to improve teaching by changing individual elements or features. In a system, all the features reinforce each other. It has now been well documented in several studies that teachers asked to change features of their teaching often modify the features to fit within their preexisting system instead of changing the system itself. The system assimilates individual changes and swallows them up. Thus, although surface features appear to change, the fundamental nature of instruction does not. (Stigler & Hiebert, 1999, pp. 97 – 98)

Therefore, improving teaching means more than improving teachers’ knowledge and skills, it means fostering changes in the system, which includes a multitude of individuals and communities which shoulder responsibility for mathematics teaching and learning (e.g., district leaders, school principals, curriculum specialists, and classroom teachers) (Cobb et al., 2003).

Wenger’s (1998) conception of identity provides a useful way of understanding how teachers negotiate their views of mathematics teaching and learning into the broader system of mathematics education. This negotiation of a mathematics teaching identity not only takes place within classrooms, but also between teachers, schools, and districts – elements of the system. It is the system that deserves attention because of the difficulties inherent in changing it. If we want to see broad changes in mathematics instruction rather than changes in individual classrooms, we must carry a dual focus on developing individual knowledge and skills of reform

practices and on developing teachers as catalysts for system-wide change. Stigler and Hiebert (1999) provide a similar vision for the future.

The star teachers of the twentieth century have been those who broke away from the crowd and created different and unusual methods of teaching. They distinguished themselves by being different, by leaving the standard practice behind. They gained fame by rising above the routine and showing the effectiveness of alternative form of teaching. Although these efforts won the applause of educational critics, they did not have much effect on standard practice.

The star teachers of the twenty-first century will be those who work together to infuse the best ideas into standard practice. They will be teachers who collaborate to build a system that has the goal of improving students' learning in the "average" classroom, who work to gradually improve standard classroom practices. In a true profession, the wisdom of the profession's members finds its way into the most common methods. The best that we know becomes the standard way of doing something. The star teachers of the twenty-first century will be teachers who work every day to improve teaching – not only their own but that of the whole profession. (pp. 178 – 179)

This study sheds light on what might entail developing the star teachers of the twenty-first teachers. Teachers need to carry a sense of autonomy for making instructional decisions and feel support from each of their professional communities for taking risks on unconventional approaches to teaching. It is only when teachers feel considerable agency for making instructional decisions that they might be willing to adopt those practices which might best support students learning of mathematics.

REFERENCES

REFERENCES

- Adler, J. (2000). Social practice theory and mathematics teacher education: A conversation between theory and practice. *Nordic Mathematics Education Journal*, 8(3), 31 - 53.
- Appalachian Mathematics and Science Partnership (2007). AMSP goals Retrieved August 8, 2007, from <http://www.appalmsp.org/>
- Apple, M. W., & Jungck, S. (1992). You don't have to be a teacher to understand this unit: Teaching, technology and control in the classroom. In A. Hargreaves & M. Fullan (Eds.), *Understanding teacher development* (pp. 20 - 42). New York: Teachers College Press.
- Ball, D. L. (1994, November). *Developing mathematics reform: What don't we know about teacher learning -- but would make good working hypotheses?* Paper presented at the Conference on Teacher Enhancement in Mathematics K-6, Arlington, VA.
- Ball, D. L. (1996). Teacher learning and the mathematics reforms: What we think we know and what we need to learn. *Phi Delta Kappan*, 77(7), 500 - 508.
- Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is -- or might be -- the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25(9), 6 - 8, 14.
- Ball, D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the Learning Profession: Handbook of Policy and Practice* (pp. 3 - 32). San Francisco: Jossey-Bass.
- Ball, D. L., & Forzani, F. M. (2007). What makes educational research "educational"? *Educational Researcher*, 36(9), 529 - 540.
- Barnett, C., & Friedman, S. (1997). Mathematics case discussions: Nothing is sacred. In E. Fennema & B. S. Nelson (Eds.), *Mathematics teachers in transition* (pp. 381 - 399). Mahwah, NJ: Lawrence Erlbaum Associates.
- Battista, M. T. (1994). Teacher beliefs and the reform movement in mathematics education. *Phi Delta Kappan*, 75(6), 462-463, 466 - 468, 470.
- Beckmann, C., Wells, P., Gabrosek, J., Billings, E., Aboufadel, E., Curtiss, P., et al. (2004). Enhancing the mathematical understanding of prospective teachers: Using Standards-based, grades K-12 activities. In R. Rubenstein & G. Bright (Eds.), *Perspectives on the teaching of mathematics* (pp. 151 - 163). Reston, VA: National Council of Teachers of Mathematics.

- Beswick, K. (2004, July). *The impact of teachers' perceptions of student characteristics on the enactment of their beliefs*. Paper presented at the International Group for the Psychology of Mathematics Education, Bergen, Norway.
- Birman, B. F., Desimone, L., Garet, M. S., Porter, A. C., & Yoon, K. S. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis*, 24(2), 81 - 112.
- Boaler, J., & Humphreys, C. (2005). *Connecting mathematical ideas: Middle school video cases to support teaching and learning*. Portsmouth, NH: Heinemann.
- Borasi, R., & Fonzi, J. (2002). *Professional development that supports school mathematics reform* (Vol. 3). Arlington, VA: National Science Foundation.
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3 - 15.
- Borko, H., Mayfield, V., Marion, S., Flexer, R., & Cumbo, K. (1997). Teachers' developing ideas and practices about mathematics performance assessment: Successes, stumbling blocks, and implications for professional development. *Teaching and Teacher Education*, 13(3), 259 - 278.
- Borko, H., & Putnam, R. T. (1995). Expanding a teachers' knowledge base: A cognitive psychological perspective on professional development. In T. R. Guskey & M. Huberman (Eds.), *Professional development in education: New paradigms and practices* (pp. 35 - 65). New York: Teachers College Press.
- Borko, H., Stecher, B. M., Alonzo, A. C., Moncure, S., & McClam, S. (2005). Artifact packages for characterizing classroom practice: A pilot study. *Educational Assessment*, 10(2), 73 - 104.
- Braswell, J. S., Lutkus, A. D., Grigg, W. S., Santapau, S. L., Tay-Lim, B. S. H., & Johnson, M. S. (2001). *The nation's report card: Mathematics 2000 (NCES 2001-517)*. U.S. Department of Education. Washington, DC: National Center for Education Statistics.
- Brown, C. A., Stein, M. K., & Forman, E. A. (1996). Assisting teachers and students to reform the mathematics classroom. *Educational Studies in Mathematics*, 31(1/2), 63 - 69.
- Cady, J. (2007). *Appalachian mathematics and science partnership online courses*. Unpublished manuscript, Knoxville, TN.
- Carpenter, T. P., Fennema, C., Peterson, P. L., Chiang, C., & Loef, M. (1989). Using knowledge of students' mathematical thinking in classroom teaching: An experimental study. *American Educational Research Journal*, 26(4), 499 - 532.

- Carpenter, T. P., Fennema, E., & Franke, M. L. (1996). Cognitively guided instruction. *Elementary School Journal*, 97(1), 3 - 20.
- Carpenter, T. P., Fennema, E., Franke, M. L., & Levi, L. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal*, 38(3), 653 - 689.
- Carter, K. (1990). Teachers' knowledge and learning to teach. In M. Haberman & J. Silkula (Eds.), *Handbook of research on teacher education* (pp. 291 - 310). New York: Macmillan.
- Cobb, P. (2007). Putting philosophy to work: Coping with multiple theoretical perspectives. In F. J. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 3 - 38). Charlotte, NC: Information Age Publishing.
- Cobb, P., McClain, K., Lamberg, T., & Dean, C. (2003). Situated teachers' instructional practices in the institutional setting of the school and district. *Educational Researcher*, 32(6), 13 - 24.
- Cohen, D. K., & Hill, H. C. (2001). *Learning policy: When state education reform works*. New Haven, CT: Yale University Press.
- Collopy, R. (2003). Curriculum materials as a professional development tool: How a mathematics textbook affected two teachers' learning. *Elementary School Journal*, 103(3), 287 - 311.
- Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers*. Washington, DC: Mathematical Association of America.
- Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.
- Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice*, 39(3), 124 - 130.
- Davis, R. B., Maher, C. A., & Noddings, N. (Eds.). (1990). *Constructivists views on the teaching and learning of mathematics*. Reston, VA: National Council of Teachers of Mathematics.
- Diversity in Mathematics Education Center for Teaching and Learning. (2007). Culture, race, power, and mathematics education. In F. J. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 405 - 433). Charlotte, NC: Information Age Publishing.
- Drake, C., Spillane, J. P., & Hufferd-Ackels, K. (2001). Storied identities: Teacher learning and subject-matter context. *Journal of Curriculum Studies*, 33(1), 1 - 23.

- Engestrom, Y. (1998). Reorganizing the motivational sphere of classroom culture: An activity theoretical analysis of planning in a teacher team. In F. Seeger, J. Voight & U. Waschescio (Eds.), *The culture of the mathematics classroom* (pp. 76 - 103). New York: Cambridge University Press.
- Field Notes. (2008, February 29). Notes taken by Thomas Hodges at Rose Middle School. East Tennessee.
- Field Notes. (2008, March 5). Notes taken by Thomas Hodges at Carter Middle School. East Tennessee.
- Field Notes. (2008, March 12). Notes taken by Thomas Hodges at Carter Middle School. East Tennessee.
- Field Notes. (2008, March 27). Notes taken by Thomas Hodges at Rose Middle School. East Tennessee.
- Franke, M. L., Carpenter, T., Levi, L., & Fennema, C. (2001). Capturing teachers' generative change: A follow-up study of teachers' professional development in mathematics. *American Educational Research Journal*, 38(3), 653 - 689.
- Franke, M. L., Fennema, E., & Carpenter, T. P. (1997). Teachers creating change: examining evolving beliefs and classroom practice. In C. Fennema & B. S. Nelson (Eds.), *Mathematics Teachers in Transition* (pp. 255-281). Mahwah, NJ: Lawrence Erlbaum Associates.
- Franke, M. L., & Kazemi, E. (2001a). Learning to teach mathematics: Focus on student thinking. *Theory into Practice*, 40(2), 102 - 109.
- Franke, M. L., & Kazemi, E. (2001b). Teaching as learning within a community of practice: Characterizing generative growth. In T. Wood, B. S. Nelson & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary school mathematics* (pp. 47 - 74). Mahwah, NJ: Lawrence Erlbaum Associates.
- Gee, J. P. (2000). Identity as an analytic lens for research in education. *Review of Research in Education*, 25, 99 - 125.
- Gee, J. P. (2001). *An introduction to discourse analysis*. New York: Routledge.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory*. Chicago: Aldine.
- Greeno, J. G., & the Middle School Mathematics through Applications Group. (1998). The situativity of knowing, learning, and research. *American Psychologist* 53(1), 5 - 26.
- Grossman, P. L., Wineberg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record*, 103, 942 - 1013.

- Hawley, W. D., & Valli, L. (1999). The essentials of effective professional development: A new consensus. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 127 - 150). San Francisco: Jossey-Bass.
- Hiebert, J., Morris, A. K., & Glass, G. (2003). Learning to learn to teach: An "experiment" model for teaching and teacher preparation in mathematics. *Journal of Mathematics Teacher Education*, 6(3), 201 - 222.
- Hill, H. C., & Ball, D. L. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal for Research in Mathematics Education*, 35(5), 330 - 349.
- Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42(2), 371 - 406.
- Hodge, L. L. (2006). An orientation on the mathematics classroom that emphasizes power and identity: Reflecting on equity research. *The Urban Review*, 38(5), 373 - 385.
- Hoyles, C. (1992). Mathematics teaching and mathematics teachers: A meta-case study. *For the Learning of Mathematics*, 12(3), 32 - 44.
- Kazemi, E., & Franke, M. L. (2004). Teacher learning in mathematics: Using student work to promote collective inquiry. *Journal of Mathematics Teacher Education*, 7(3), 203 - 235.
- Lampert, M., & Ball, D. L. (1998). *Teaching, multimedia, and mathematics: Investigations of real practice*. New York: Teachers College Press.
- Lave, J. (1996). Teaching, as learning, in practice. *Mind, Culture, and Activity*, 3(3), 149 - 164.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Little, J. W. (2002). Locating learning in teachers' communities of practice: Opening up problems of analysis in records of everyday work. *Teaching and Teacher Education*, 18(8), 917 - 946.
- Little, J. W. (2004). 'Looking at student work' in the United States: A case of competing impulses in professional development. In C. Day & J. Sachs (Eds.), *International handbook on the continuing professional development of teachers* (pp. 94 - 118). Berkshire, England: Open University Press.
- Maxcy, S. J. (2003). Pragmatic threads in mixed methods research in the social sciences: The search for multiple modes of inquiry and the end of the philosophy of formalism. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 51 - 89). Thousand Oaks, CA: Sage.

- Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.
- Merseth, K. K. (1996). Cases and case methods in education. In J. Sikula (Ed.), *Handbook of research on teacher education* (2nd ed., pp. 722 - 744). New York: Macmillan.
- Nasir, N. S. (2002). Identity, goals, and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning*, 4(2&3), 213 - 247.
- Nasir, N. S., & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research*, 76(4), 449 - 475.
- National Commission on Mathematics and Science Teaching for the 21st Century. (2000). *Before it's too late*. Washington, DC: Author.
- National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (1995). *Assessment standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Middle School Association. (2003). *This we believe: Successful schools for young adolescents*. Columbus, OH: Author.
- National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.
- Nelson, B. C. (1999). *Building new knowledge by thinking: How administrators can learn what they need to know about mathematics education reform*. Cambridge, MA: Educational Development Center.
- Nickerson, S. D., & Moriarty, G. (2005). Professional communities in the context of teachers' professional lives: A case of mathematics specialists. *Journal of Mathematics Teacher Education*, 8(2), 113 - 140.
- Patton, M. Q. (1990). *Qualitative evaluation methods*. Thousand Oaks, CA: Sage.
- Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (Vol. 1, pp. 257 - 315). Charlotte, NC: Information Age Publishing.

- Price, J. N., & Ball, D. L. (1997). 'There's always another agenda': Marshalling resources for mathematics reform. *Journal of Curriculum Studies*, 29(6), 637 - 666.
- Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning. *Educational Researcher*, 29(1), 4 - 15.
- Raymond, A. M. (1997). Inconsistencies between a beginning elementary school teacher's mathematics beliefs and teaching practice. *Journal for Research in Mathematics Education*, 28(5), 550 - 576.
- Remillard, J. T. (2000). Can curriculum materials support teachers' learning? Two fourth-grade teachers' use of a new mathematics text. *The Elementary School Journal*, 100(4), 331 - 350.
- Remillard, J. T., & Bryans, M. B. (2004). Teachers' orientations toward mathematics curriculum materials: Implications for teacher learning. *Journal for Research in Mathematics Education*, 35(5), 352 - 388.
- Reys, B. J., Reys, R. E., Beem, J., & Papick, I. (1998). The Missouri middle grades mathematics (M3) project. *Journal of Mathematics Teacher Education*, 2(2), 215 - 222.
- Saunders, W., Goldenburg, C., & Hamann, J. (1992). Instructional conversations beget instructional conversations. *Teaching and Teacher Education*, 8(2), 199 - 218.
- Schifter, D., Russell, S. J., & Bastable, V. (1999). Teaching to the big ideas. In M. S. Solomon (Ed.), *The diagnostic teacher: Constructing new approaches to professional development* (pp. 22 - 47). New York: Teachers College Press.
- Schifter, D., & Simon, M. A. (1992). Assessing a teachers' development of a constructivist view of mathematics learning. *Teaching and Teacher Education*, 8(2), 187 - 197.
- Senger, E. (1999). Reflective reform in mathematics: The recursive nature of teacher change. *Educational Studies in Mathematics*, 37(3), 199 - 201.
- Sfard, A., & Prusak, A. (2005). Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity. *Educational Researcher*, 34(4), 14 - 22.
- Silver, E. A., & Stein, M. K. (1996). The QUASAR Project: The "revolution of the possible" on mathematics instruction reform in urban middle schools. *Urban Education*, 30(4), 476-521.
- Simon, M. A., & Schifter, D. (1991). Towards a constructivist perspective: An intervention study of mathematics teacher development. *Educational Studies in Mathematics*, 22, 309 - 331.

- Smith, M. S., Silver, E. A., & Stein, M. K. (2005). *Improving instruction in geometry and measurement: Using cases to transform mathematics teaching and learning*. New York: Teachers College Press.
- Sowder, J. T. (2007). The mathematical education and development of teachers. In F. J. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (Vol. I, pp. 157 - 223). Charlotte, NC: Information Age Publishing.
- Stein, M. K., & Brown, C. A. (1997). Teacher learning in a social context: Integrating collaborative and institutional processes with the study of teacher change. In E. Fennema & B. S. Nelson (Eds.), *Mathematics teachers in transition* (pp. 155 - 191). Mahwah, NJ: Lawrence Erlbaum Associates.
- Stein, M. K., Silver, E. A., & Smith, M. S. (1998). Mathematics reform and teacher development. In J. G. Greeno & S. V. Goldman (Eds.), *Thinking practices in mathematics and science learning* (pp. 17 - 52). Mahwah, NJ: Lawrence Erlbaum Associates.
- Stein, M. K., Smith, M. S., Henningsen, M. A., & Silver, E. A. (2000). *Implementing standards-based mathematics instruction: A casebook for professional development*. New York: Teachers College Press.
- Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York: Summit Books.
- Sykes, G. (1999). Teacher and student learning: Strengthening the connection. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 151 - 179). San Francisco: Jossey-Bass.
- Thomas, G., Wineberg, S., Grossman, P. L., Myhre, O., & Woolworth, S. (1998). In the company of colleagues: An interim report on the development of a community of teachers. *Teaching and Teacher Education*, 14(1), 21 - 32.
- Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grows (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127 - 146). New York: Macmillan.
- Van Zoest, L. R., & Bohl, J. V. (2005). Mathematics teacher identity: A framework for understanding secondary school mathematics teachers' learning through practice. *Teacher Development: An International Journal of Teachers' Professional Development*, 9(3), 315 - 345.
- Wainwright, C., Flick, L., Morrell, P. D., & Schepige, A. (2004). Observation of reform teaching in undergraduate level mathematics and science courses. *School Science and Mathematics*, 104(7), 322 - 335.

- Warfield, J. (2001). Where mathematics content matters: Learning about and building on children's mathematical thinking. In T. Wood, B. S. Nelson & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary school mathematics* (pp. 135 - 155). Mahwah, NJ: Lawrence Erlbaum Associates.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York: Cambridge University Press.
- Wenger, E. (2008). Communities of practice: A brief introduction Retrieved January 17, 2008, from <http://www.ewenger.com/theory>
- Wilcox, S., & Jones, E. (2004). A tool for the teaching principle: Professional development through assessment. In R. Rubenstein & G. Bright (Eds.), *Perspectives on the teaching of mathematics* (pp. 239 - 258). Reston, VA: National Council of Teachers of Mathematics.
- Wilson, S. M., & Berne, J. (1999). Teacher learning and the acquisition of professional knowledge: An examination of research on contemporary professional development. *Review of Research in Education*, 24, 173 - 209.
- Wood, T., Cobb, P., & Yackel, E. (1991). Change in teaching mathematics: A case study. *American Educational Research Journal*, 28(3), 587 - 616.
- Yackel, E. T., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, 27(4), 458 - 477.
- Yin, R. K. (2003). *Case study research: Design and method* (3rd ed.). Thousand Oaks, CA: Sage.

APPENDIXES

APPENDIX A

Initial Interview Protocol

Name _____ Date _____ Time: _____

Initial questions include numbered items. Sub-items are possible follow-up questions.

1. Why did you choose to be a math teacher?
2. What is it that you like best about being a math teacher?
3. Tell me about what it is like to be a mathematics teacher at this school.
 - a. If you have taught at other schools, is it similar to or different from those? In what ways?
 - b. There were four different schools involved in the AMSP online courses. In what ways do you feel like your school is similar to and different from the other schools?
 - c. Are you a typical math teacher at this school?
 - d. Who are the good math teachers here? What makes them good?
 - e. (from b.) Is that your opinion, or do you think others in the school would agree?
 - f. If a new math teacher was hired in the school, what would be some tips you would give them?
4. What are your professional goals for the next 5 – 10 years?
5. What role does math play in your students' lives?
6. Tell me about your students.
 - a. How do they best learn math?
 - b. What do you think they expect from you as their math teacher?
 - c. What is it about students who are good at math that allows them to succeed?
 - d. What common characteristics do you see in students who struggle with math?
7. Tell me about your experiences in the online courses. (thinking about math, thinking about teaching math, collaboration with their colleagues)
 - a. If you were talking to a teacher that wasn't involved, how would you describe the courses?
 - b. How would you describe the teachers in the courses?
 - c. Do you feel like you have changed in any way as a teacher?
 - d. If so, what has changed?
 - e. If so, what experiences in the courses would you contribute to the change?
 - f. If not, why?
 - g. What do you think others in the courses saw as valuable?
 - h. While in the courses, did you have opportunities to talk about things that go on in your classroom? What about since?
 - i. How have the online courses and other grants you've worked on influenced who you work with?
 - j. In what ways do you work with those people?
8. What influences the math you teach and how you go about teaching it?

- a. Who influences the math you teach and how you go about teaching it?
 - b. What influence does [name] have?
 - c. If your principal came to watch a math lesson, what do you think he/she would be looking for in effective teaching? How do those expectations influence what you do?
 - d. What role do district level administrators play in how you teach math?
 - i. What do you think are their goals for math instruction?
9. Do you belong to any professional organizations, like TMTA, SMMEA, or NCTM? If so, how do you participate in those organizations?
- a. Who are the teachers that belong to those organizations?
 - b. To someone who has never been to [organization] how would you describe the meetings?
 - c. How do you participate in those organizations?
 - d. Do you have opportunities to talk about things that go on in your classroom?
10. If you walked into a math classroom and saw the “best” teacher teaching, what would you see?
- a. What makes this person an effective teacher
 - b. How do you compare yourself to this teacher?
 - c. What keeps you from being this teacher?

APPENDIX B

Post-Observation Interview Protocol

Name _____ Date _____ Time: _____

Initial questions include numbered items. Sub-items are possible follow-up questions.

1. Tell me about the class I observed today.
 - a. What were the mathematical ideas did you want students to understand?
 - b. What made you think they were ready for these ideas?
 - c. How did you go about selecting the task(s)?
 - d. Why did you choose these instructional strategies (using language specific to those instructional strategies) for the lesson?
 - e. Was this a lesson you had taught before? If so, did you teach it the same way or differently? If different, how so?
 - f. What aspects of this lesson did you like and dislike?
2. How do you think your students responded to the lesson?
 - a. How did you get this information?
 - b. What mathematics did students learn today? How do you know?
3. If you had to teach the lesson again, what would you do the same way and what would you change?
4. Where do you plan to go from here?
 - a. On what information are you basing this decision?

APPENDIX C

Classroom Observation Protocol

Teacher _____	Grade Level (K-8)/Course (HS) _____
Lesson Topic _____	
Observer _____	Date _____ Duration of observation (min.) _____
Portion of the class period observed: ☐ All or most ☐ Over half ☐ Less than half	

1. Role of manipulatives in the lesson (mark all that apply)

- ☐ Demonstrate or confirm known concepts/procedures
- ☐ Explore ideas, test conjectures, look for patterns
- ☐ Not used in this lesson during the time observed

2. Role of calculators in the lesson (mark all that apply)

- ☐ Demonstrate or confirm known concepts/procedures
- ☐ Explore ideas, test conjectures, look for patterns
- ☐ Not used in this lesson during the time observed

During the lesson, take notes describing noteworthy aspects of the lesson and then complete this

portion of the instrument. Each of the items 5-14 should be rated 'globally'; the descriptors are possible indicators, not a required 'check-off' list.

	Not Observed	1	2	3	4	Characterizes the Lesson
--	-----------------	---	---	---	---	-----------------------------

3. This lesson encouraged students to seek and value various modes of investigation or problem solving. (Focus: Habits of Mind)	N/O 1 2 3 4
--	---------------------

Teacher:

Presented open-ended questions

Encouraged discussion of alternative explanations

Presented inquiry opportunities for students

Provided alternative learning strategies

Students:

Discussed problem-solving strategies

Posed questions and relevant means for investigating

Shared ideas about investigations

4. Teacher encouraged students to be reflective about their learning. (Focus: Metacognition – students' thinking about their own thinking)	N/O 1 2 3 4
--	---------------------

Teacher:

Encouraged students to explain their understanding of concepts

Encouraged students to explain in own words both what and how they learned

Routinely asked for student input and questions

Students:

Discussed what they understood from the class and how they learned it

Identified anything unclear to them

Reflected on and evaluated their own progress toward understanding

5. Interactions reflected collaborative working relationships and productive discourse among students and between teacher/instructor and students. (Focus: Student discourse and collaboration)	N/O	1	2	3	4
---	-----	---	---	---	---

Teacher:

Organized students for group work

Interacted with small groups

Provided clear outcomes for group

Students:

Worked collaboratively or cooperatively to accomplish work relevant

to task

Exchanged ideas related to lesson with peers and teacher

6. Intellectual rigor, constructive criticism, and the challenging of ideas were valued. (Focus: Rigorously challenged ideas)	N/O	1	2	3	4
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Teacher:

Encouraged input and challenged students' ideas

Was non-judgmental of student opinions

Solicited alternative explanations

Students:

Provided evidence-based arguments

Listened critically to others' explanations

Discussed/Challenged others' explanations

Not
Observed **Characterizes**
the Lesson

7. The instructional strategies and activities probed students' existing knowledge and preconceptions. (Focus: Student preconceptions and misconceptions)	N/O	1	2	3	4
--	-----	---	---	---	---

Teacher:

Pre-assessed students for their thinking and knowledge

Helped students confront and/or build on their ideas

Refocused lesson based on student ideas to meet needs

Students:

Expressed ideas even when incorrect or different from the ideas of

other students

Responded to the ideas of other students

8. The lesson promoted strongly coherent conceptual understanding in the context of clear learning goals. (Focus: Conceptual thinking)	N/O	1	2	3	4
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Teacher:

Asked higher level questions

Encouraged students to extend concepts and skills

Related integral ideas to broader concepts

Students:

Asked and answered higher level questions

Related subordinate ideas to broader concept

9. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence. (Focus: Divergent thinking)	N/O 1 2 3 4
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Teacher:

Accepted multiple responses to problem-solving situations

Provided example evidence for student interpretation

Encouraged students to challenge the text as well as each other

Students:

Generated conjectures and alternate interpretations

Critiqued alternate solution strategies of teacher and peers

10. Appropriate connections were made between content and other curricular areas. (Focus: Interdisciplinary connections)	N/O 1 2 3 4
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Teacher:

Integrated content with other curricular areas

Applied content to real-world situations

Students:

Made connections with other content areas

Made connections between content and personal life

11. The teacher/instructor had a solid grasp of the subject matter content and how to teach it. (Focus: Pedagogical content knowledge)	N/O 1 2 3 4
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Teacher:

Presented information that was accurate and appropriate to student cognitive level

Selected strategies that made content understandable to students

Was able to field student questions in a way that encouraged more questions

Recognized students' ideas even when vaguely articulated

Students:

Responded to instruction with ideas

relevant to target content

Appeared to be engaged with lesson

content

12. The teacher/instructor used a variety of means to represent concepts. (Focus: Multiple representations of concepts)	N/O 1 2 3 4
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Teacher:

Used multiple methods, strategies and teaching styles to explain a concept

Used various materials to foster student understanding (models, drawings, graphs, concrete materials, manipulatives, etc.)

CAPSULE DESCRIPTION

13. For each pair of statements below, mark the one that best describes what you observed in the lesson

☐ Teacher-as-facilitator

☐ Active student role in lesson

☐ Emphasis on developing conceptual understanding

☐ Teacher-as-expert

☐ Passive student role in lesson

☐ Emphasis on learning factual knowledge,

skills/procedures

14. Overall, how well did this lesson exemplify effective use of an inquiry approach to mathematics instruction?

☐ Not at all

☐ Beginning

☐ Progressing

☐ Proficient

☐ Accomplished

(adapted from Oregon Teacher Observation Protocol, C. Wainwright, L. Flick, P. Morrell– 2004 and the AMSP PEP Observation Protocol)

APPENDIX D

Field Notes (page 1)

Date:
Observation #:
Observer name:
Teacher Name:
Start time:
End time:
Location:
Purpose:

SETTING	DIAGRAM OF SETTING:	
	SETTING/CONTEXT/PARTICIPANTS NOTES:	
Time:	Descriptive notes	Reflective notes (OC)

VITA

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