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A Cultural Historical Activity Theory Perspective of Teacher Learning in the Edmodo Math Subject Community

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by

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ABSTRACT

A Cultural Historical Activity Theory Perspective of
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by

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Teachers are participating in online communities in ever increasing numbers to find and share knowledge with educators around the world. However, the majority of the studies on online communities of practice often fail to examine the process of knowledge sharing as a complex, dynamically evolving practice that is shaped by local classroom and school contexts as well as other sociocultural factors.

This study was designed to address the need for a more comprehensive and multifaceted exploration of teacher learning in an online community of practice. A Cultural Historical Activity Theory (Leontiev, 1978; Engeström, 1987; Cole and Engeström, 1993; Vygotsky, 1978) framework was used as a guide for examining how teachers acquired and made use of the shared knowledge from the Edmodo Math Subject Community, an online community of practice with more than 250,000 members. Multiple data types were collected in order to examine the teachers' object-oriented actions in two overlapping activity systems.

Data analysis revealed that the participants were driven by the contradictions and limitations of their local school activity systems to take control of their learning and find knowledge in the Math Subject Community. The participants' ability to find knowledge was defined by the roles they performed in the community, the tools they used, the collective knowledge of the community, and the implicit community rules of reciprocity and professionalism. The participants' ability to select and implement the knowledge they found in the Math Subject Community in their classrooms was shaped by their local school activity system tools, the support of their colleagues and administration, their students' range in math abilities, and the community rules.

A Model of Teacher Knowledge Acquisition was developed to display the participants' fluid, ongoing process of navigating between two overlapping activity systems to find new knowledge. The Model of Teacher Knowledge Acquisition presents teacher learning as a complex, socially constructed process that is influenced by multiple activity systems that interact with and shape one another.

Overall, the participants felt that engaging in this process of acquiring knowledge allowed them to make changes, both small and large, in their teaching and learning strategies.

TABLE OF CONTENTS

CHAPTER I: INTRODUCTION 1

BACKGROUND TO THE PROBLEM 1

STATEMENT OF THE PROBLEM 3

STATEMENT OF PURPOSE 4

RESEARCH SITE 5

CONCEPTUAL FRAMEWORK 6

RESEARCH QUESTIONS 7

METHODS 7

LIMITATIONS 9

DELIMITATIONS 10

CHAPTER II: LITERATURE REVIEW 12

TEACHER LEARNING 12

TEACHER KNOWLEDGE 13

TEACHER LEARNING MODELS AND THEORIES 17

OPPORTUNITIES FOR KNOWLEDGE ACQUISITION 19

EFFECTIVE TEACHER LEARNING OPPORTUNITIES 20

ONLINE COMMUNITIES OF PRACTICE 21

COMMUNITY OF PRACTICE 22

KNOWLEDGE SHARING IN ONLINE COMMUNITIES OF PRACTICE 24

BARRIERS 28

PARTICIPATION IN KNOWLEDGE SHARING ACTIVITIES 29

LIMITATIONS 33

CULTURAL HISTORICAL ACTIVITY THEORY **35**

THE CHAT FRAMEWORK 36

CHAT AND TEACHER LEARNING 44

CONCLUSION **44**

CHAPTER III: METHODOLOGY **47**

RESEARCH SITE **47**

METHODS **50**

RESEARCH QUESTIONS 50

THEORETICAL FRAMEWORK 51

DATA COLLECTION PROCEDURES 52

PARTICIPANTS 60

DATA ANALYSIS PROCEDURES 65

ETHICAL CONSIDERATIONS **70**

POSITIONALITY OF THE RESEARCHER **71**

LIMITATIONS **72**

TEACHER SELF-REPORTS 72

SAMPLING 73

CHAPTER IV: THE GLOBAL ACTIVITY SYSTEM **75**

RQ1: WHAT TYPES OF KNOWLEDGE DO TEACHERS SHARE IN THE MATH SUBJECT COMMUNITY? **76**

TYPES OF INITIAL POSTS 76

TYPES OF REPLIES 78
TEACHER KNOWLEDGE 81
MATH TOPICS 83
RQ2: HOW IS THE PROCESS OF ACQUIRING KNOWLEDGE SHAPED BY THE MATH SUBJECT COMMUNITY GLOBAL ACTIVITY SYSTEM? 87
OBJECT & OUTCOME 88
SUBJECT 90
TOOL 91
COMMUNITY 97
DIVISION OF LABOR 98
RULES 104
COMMUNITY VS. PRACTICE 108
CONCLUSION 113
CHAPTER V: THE LOCAL ACTIVITY SYSTEM 115
RQ3: HOW IS THE PROCESS OF ACQUIRING KNOWLEDGE SHAPED BY THE TEACHER'S LOCAL SCHOOL ACTIVITY SYSTEM? 115
OBJECT AND OUTCOME 116
SUBJECT 116
TOOLS 118
COMMUNITY 124
DIVISION OF LABOR 125
RULES 132
CONTRADICTIONS 135

CULTURE AND HISTORY 142

CONCLUSION 143

CHAPTER VI: NAVIGATING MULTIPLE ACTIVITY SYSTEMS 145

RQ4: HOW DO TEACHERS NAVIGATE BETWEEN THEIR LOCAL SCHOOL ACTIVITY SYSTEM AND THE GLOBAL MATH SUBJECT COMMUNITY ACTIVITY SYSTEM IN ORDER TO ACQUIRE NEW KNOWLEDGE? 145

MODEL OF TEACHER KNOWLEDGE ACQUISITION 147

ONLINE PEDAGOGICAL LITERACY 172

RQ4: CONCLUSION 174

FURTHER RESEARCH 175

RQ5: WHAT ARE THE ENSUING EFFECTS OF PARTICIPATING IN THIS PROCESS OF KNOWLEDGE ACQUISITION? 176

TRANSFORMATION OF LEARNING 177

TRANSFORMATION OF TEACHING 181

RQ5: CONCLUSION 185

FURTHER RESEARCH 187

CHAPTER VII: CONCLUSION 188

DISCUSSION 194

IMPLICATIONS FOR RESEARCH 196

IMPLICATIONS FOR PRACTICE 199

REFERENCES 204

APPENDIX A: INFORMED CONSENT 215

APPENDIX B: SURVEY 217

APPENDIX C: INTERVIEW GUIDE 224

APPENDIX D: CODEBOOKS 227

LIST OF FIGURES

Figure 3.1. Edmodo Math Subject Community screenshot……..…49

Figure 3.2. Edmodo Math Subject Community wall discussion thread……....53

Figure 3.3. Survey participants reported use of technologies for classroom instruction…….....61

Figure 4.1. Edmodo Math Subject Community click counter……...…77

Figure 4.2. Edmodo Math Subject Community screenshot……...91

Figure 4.3. Actions performed in the Edmodo Math Subject Community……91

Figure 5.1. The three communities that shape teachers' actions within their local school activity systems…….121

Figure 6.1. Model of Teacher Knowledge Acquisition in a global Practice-Based Crowdsourcing Platform……..143

Figure 6.2. The Iterative Process of Finding Knowledge in the Model of Teacher Knowledge Acquisition..……..152

LIST OF TABLES

Table 2.1. Rodd Lucier's 7 Degrees of Connectedness……31

Table 3.1. Demographics of Interview Participants……..63

Table 4.1. Frequency and Types of Initial Posts in the Math Subject Communit....73

Table 4.2. Frequency and Types of Replies in the Math Subject Community…….79

Table 4.3. Types of Teacher Knowledge Posts in the Math Subject Community…81

Table 4.4. Types of K-8 Math Topic Posts in the Math Subject Community…....84

Table 4.5. Types of High School Math Topic Posts in the Math Subject Community……...85

Table 4.6. Four C's of Participation……98

Table 6.1. Local and Global Activity System Sociocultural Factors That Influence the Knowledge Acquisition Process……...142

Table 6.2. Model of Teacher Knowledge Acquisition Checklist……...167

CHAPTER I:

INTRODUCTION

Background to the Problem

As the pressure mounts to hold students to higher standards and provide all students with an equitable educational experience, reformers, researchers, and administrators have turned their focus to developing higher quality teacher learning opportunities (Wilson & Berne, 1999). Many individuals believe that higher quality learning opportunities for K-12 teachers will lead to increased student achievement, more effective teachers, successful reform initiatives, and higher quality U.S. schools (Birman, Desimone, Porter, & Garet, 2000; Borko, 2004; Boyle, Lamprianou, & Boyle, 2005; Desimone, 2009; Kleickmann et al., 2012). According to Cochran-Smith and Lytle (1999), "Over the last 20 years, teacher learning has become one of the most important concerns of the educational establishment" (p. 249). This spotlight on teacher learning has resulted in a significant increase in the research and development of effective formal and informal teacher learning opportunities (Wilson & Berne, 1999; Kleickmann, et al., 2012).

According to Peressini, Borko, Romagnano, Knuth, and Willis (2004), teacher learning refers to the acquisition of knowledge related to the profession of teaching. Since teaching is a complex and challenging job, teachers need ongoing learning opportunities to construct knowledge that will help them stay current with the evolving knowledge domains in their practice (Commission on Teacher

Credentialing, 2009). Teachers also need to be knowledgeable about the changes in learning theories, curriculum, standards, education policies, instructional tools, and other advances in the field of education in order to design effective learning environments for their students (Horizon Research, 2013; Tech & Learning, 2011).

In the past decade, increasingly more teachers have joined online communities of practice in order to find and share professional knowledge that will help them stay current with the changes in their field (Chen, Chen, & Tsai, 2009; Borg, 2012). According to the Speak Up 2012 National Survey (Project Tomorrow, 2013), 39% of the 53,947 K-12 teachers who responded were using professional social networking sites for ongoing learning and professional growth. The number of educators using professional social networking sites has almost doubled since the Speak Up 2007 National Survey. Additionally, in a survey of more than 200,000 randomly selected educators, MMS Education (2012) found that K-12 teachers' participation in social networking sites has increased from 61% to 82% since 2009, with the greatest potential for growth in professional and educational sites.

The U.S. Department of Education Office of Educational Technology [OET] (2010), the International Society for Technology in Education (2012), and the Center for Teaching Quality (2013) recommend that teachers from all stages of the learning-to-teach continuum utilize online communities of practice for ongoing learning and professional growth opportunities.

Statement of the Problem

Even though administrators, educational reformers, and researchers are increasingly urging teachers to use online communities of practice to gain new knowledge, the research in this field is limited. As I shall show in the literature review for this study, the majority of the studies of online communities of practice address how discrete elements, such as motivation, social presence, and trust, affect teacher participation in researcher—or administrator—designed online communities. Very few studies have focused specifically on teacher-driven online communities of practice for the purpose of understanding how teachers contribute and make use of the shared knowledge in the community. *Shared knowledge* refers to the information, resources, advice, ideas, and feedback that members exchange in an online community.

Jones and Preece (2000) argued that teachers face a tension between global access and local problems. Teachers must be able to transform the global knowledge from their online communities into actions they can carry out in the local context of their classroom. While access to educators around the world may help teachers find experts who can address their specific needs, many times the problems teachers face are situated in the context and communities within their schools and classroom, which limits the transferability of solutions and knowledge between the global and local community. Researchers have yet to examine how teachers navigate between multiple activity systems in order to learn new knowledge that they can implement in their classrooms.

Finally, much of the research on how teachers learn is focused on the effectiveness of the learning opportunity rather than the intricate web of sociocultural factors that influence how teachers acquire and make use of new knowledge. Teachers work in a complex activity system that is shaped by multiple, often competing, variables, such as students' needs, standardized testing, funding issues, administrator and parental demands, and educational policies. When teachers participate in a learning opportunity, such as a conference or an online community of practice, their ability to acquire new knowledge is shaped by multiple factors in their local school activity systems. Researchers need more extensive frameworks for understanding the sociocultural factors and activity systems that shape how teachers learn.

Statement of Purpose

This study was designed to address the need for a more comprehensive and multifaceted exploration of teacher learning in an online community of practice. For this study, I explored how teachers acquired new knowledge by navigating between two overlapping activity systems: their local school activity system and the online community of practice global activity system. I also examined how participation in the process of navigating between two overlapping activity systems shaped the way the participants learned and taught. The goal of this study was to provide insight about the complex network of sociocultural factors that shaped how teachers learned through acquiring and implementing shared knowledge from the online community of practice.

Research Site

For this study, I examined the Edmodo Math Subject Community. Edmodo (http://www.edmodo.com) is a free social networking tool for teachers and students. On the Edmodo site, teachers can create class groups, join subject communities, and add colleagues to their networks. Edmodo has 12 subject communities (e.g., Math, Science, Language Arts, Health and PE, Computer Technology) that provide a virtual space for teachers to connect with other educators and exchange subject-specific ideas, resources, and knowledge.

I selected the Edmodo Math Subject Community (MSC) for this study based on the strong national focus on improving teacher education and professional development in the STEM (Science, Technology, Engineering, and Math) fields. The MSC is open to anyone who is interested in sharing math resources, adding to the collective knowledge of the field of math, and connecting with other math educators and experts. The MSC provides a space for all members to ask questions, solicit feedback, and connect and collaborate with one another. The community *wall* (the news feed that all members see when they login to the community) is frequently populated with new posts and replies from members.

It is important to note that although the MSC is a global community with members located in many different countries around the world, the significant majority of the members are located in the United States. Thus, even though I refer to this community as a "global activity system," the object-oriented actions of the members are heavily influenced by U.S. cultural norms, rules, and roles.

Conceptual Framework

I used Cultural Historical Activity Theory (CHAT) (Leontiev, 1978; Engeström, 1987; Cole & Engeström, 1993; Vygotsky, 1978) as a framework for exploring the local contexts and global factors that shaped how teachers found and made use of the shared knowledge in online communities of practice.

CHAT expands the unit of analysis to an activity system. The activity system is a historically evolving, dynamic network of elements with a complex mediational structure (Cole, Engeström, & Vasquez, 1997; Engeström, 2000). Each activity system evolves from the joint actions of individuals who are motivated to achieve or transform an object. The common elements within an activity system are: *subject, tool, object, outcome, rules, division of labor,* and *community* (Engeström, 1987; Cole & Engeström, 1993).

CHAT provides a framework of basic principles and "theoretical lenses" (Roth & Lee, 2007, p. 201) that can be used to understand the critical components within an activity system, such as object-orientedness, tool mediation, the relational and dualistic nature between the elements, and the continual development of the system and elements over time (Kaptelinin, Kuutti, & Bannon, 1995). This perspective can provide an analytical lens for examining the cultural artifacts, social norms, community roles, objects, and outcomes that influence how teachers find, select, adapt, and use shared knowledge from online communities of practice. Ultimately, the CHAT framework can be used as a guide for systematically exploring the complex issues and network of actions that shape the process of learning.

Research Questions

Using the CHAT framework, I explored teachers' actions as they navigated between their local classroom activity system and an online community global activity system in order to pursue an object (e.g., acquire knowledge) and achieve an outcome (e.g., improve student engagement*).* The following research questions guided my study:

1. What types of knowledge do teachers share in the Math Subject Community?
2. How is the process of acquiring knowledge shaped by the Math Subject Community global activity system?
3. How is the process of acquiring knowledge shaped by the teacher's local school activity system?
4. How do teachers navigate between their local school activity system and the Math Subject Community global activity system in order to acquire new knowledge?
5. What are the ensuing effects of participating in this process of knowledge acquisition?

Methods

Data collection. The data collection process occurred in three phases, with each phase informing the next. During the first phase, I collected discussion threads from the community wall to examine what type of knowledge was being shared in the MSC. The second phase involved the development and distribution of an online survey to examine how and why teachers participated in the MSC. In the third phase,

I interviewed select survey respondents to gain a more in-depth understanding of the sociocultural factors that influenced how they navigated between their local school activity systems and the MSC global activity system. The three data collection phases were designed to gather multiple data types that would provide increasingly more detail about teachers' goal-driven actions in two overlapping activity systems.

Phase I: Community wall discussion threads. In first phase of the data collection process, I collected 600 discussion threads from the Math Subject community wall over a period of 9 months. A *discussion thread* includes both the initial post and all of the replies to the post. The posts were selected randomly in order to be a representative sample of the community posts.

Phase II: Survey. For the second phase of the data collection process, I designed an online survey to learn more about the participants in the Edmodo MSC. I chose to do an online survey in order to gather data from a large number of participants. I posted the survey to the MSC wall for 8 weeks and received 150 responses.

Phase III: Interview. In the third phase of the data collection process, I conducted semi-structured interviews with 10 survey respondents to explore the various sociocultural factors that shaped how the participants acquired new knowledge from the MSC and used that knowledge in their classroom. By conducting in-depth interviews, I was able to explore the unit of analysis (the activity system) from the subject's perspective.

Data analysis procedures. I used two data analysis procedures to examine the multiple data sources that I collected. I started by conducting a content analysis

of the discussion threads in order to examine the process of knowledge sharing in the MSC. Then, I conducted a theoretical thematic analysis of the entire data set in order to explore the complexity of two overlapping activity systems.

Content analysis of MSC discussion threads. I began exploring the MSC global activity system by conducting a directed content analysis (Hsieh & Shannon, 2005) of the 600 discussion threads that I had collected from the MSC community wall. I used the literature on teacher learning and online communities of practice to inform the selection of categories for coding the data. The results from the content analysis provided insight about the MSC members' knowledge sharing actions and types of knowledge that are shared in the MSC global activity system.

Theoretical thematic analysis. After examining the discussion threads, I conducted a theoretical thematic analysis (Braun & Clarke, 2006) of all three data sets: 600 discussion threads, 150 surveys, and 10 interviews. Using the CHAT framework as a guide, I explored the meaningful patterns and latent themes across the data sets. Using the results from the theoretical thematic analysis, I synthesized a narrative of how teachers navigated between multiple activity systems to acquire and use new knowledge in their classrooms.

Limitations

Teacher self-reports. One main limitation of my data collection methods was the teacher self-reports of their actions in the MSC and their classrooms. A CHAT analysis requires the researcher to be fully situated in the teacher's teaching and learning activity systems in order to understand the complexity of these systems.

However, since the teachers that I surveyed and interviewed were located all around the world, I was unable to observe teachers in their local classroom settings.

Sampling. This study was also limited by voluntary response and nonresponse bias since the survey data was not collected randomly. Without access to the Edmodo MSC members' email accounts, I was unable to randomly select members to participate in the survey. The only way to receive survey responses from MSC members was to post the survey to the community wall. The research participants volunteered to be in the study and were given incentives for completing the survey and participating in an interview. This means that the sample consisted of participants who were motivated by incentives and wanted to share their MSC experiences.

Due to the fact that the sampling procedures were not random, the results may not accurately represent the population. However, the goal of this study was not to generalize the results to the entire population or to other online teacher communities. The purpose of this study was to explore teachers' actions as they navigated two overlapping activity systems. Thus, even though the sampling procedures were limited by response bias, the survey and interview results still provided useful data for understanding how the process of acquiring knowledge can be shaped by various sociocultural factors within multiple activity systems.

Delimitations

The study was delimited to K-12 math teachers who participated in the MSC. The study was also delimited to the examination of shared knowledge in the MSC

and teachers' beliefs about how this shared knowledge was tied to their instructional practices. This study does not include an in-depth examination of teachers' teaching and learning activity systems, nor does it include an examination of how participation in the MSC affects student learning. Conducting classroom observations to examine whether teachers changed their practice as a result of participating in this process was beyond the scope of this study. Additionally, the study did not focus on the conceptual understanding of math topics that were discussed in the MSC, since the purpose of the study was to examine teachers' knowledge acquisition processes rather than how they implemented content pedagogy in instructional activities.

CHAPTER II:

LITERATURE REVIEW

In chapter one, I highlighted a need for using a comprehensive framework to examine how teachers acquired knowledge in an online community of practice. This chapter begins with a summary of the key findings from the literature on teacher learning and online communities of practice. The summary is followed by a review of the limitations in the literature in these two fields. The chapter concludes with an explanation of how the Cultural Historical Activity Theory (Cole & Engeström, 1993; Engeström, 1987; Leontiev, 1978; Vygotsky, 1978) framework can be used to address the gaps in the literature and provide a more comprehensive examination of teacher learning in an online community of practice.

Teacher Learning

The term *teacher learning* encompasses all of the formal programs (e.g., professional development schools, workshops, lectures) and informal experiences (e.g., teaching experience, peer collaboration, knowledge communities, action learning) that provide opportunities for teachers to gain new knowledge (Cochran-Smith & Lytle, 1999; Desimone, 2009; Kleickmann et al., 2012; Lieberman, 1995; Wilson & Berne, 1999). Ongoing learning and development activities play a critical role in helping teachers navigate the complex activity systems in which they work (Boyle, Lamprianou, & Boyle, 2005). According to Peressini et al. (2004), learning is often described as "an individual's acquisition of knowledge, change in

knowledge structures, or growth in conceptual understanding" (p. 69). Since teaching is a complex and challenging job, teachers need an extensive understanding of multiple knowledge domains in order to successfully navigate their practice (Commission on Teacher Credentialing, 2009).

Teacher Knowledge

The debate about what type of knowledge teachers need has weaved its way through the research on teacher learning ever since Shulman's (1986) research was distilled in the article: "Those Who Understand: Knowledge Growth in Teaching." In this article, Shulman listed three main categories of teacher knowledge: Content Knowledge, Pedagogical Content Knowledge, and Curricular Knowledge. Shulman (1987) expanded his initial list to include four additional categories: Knowledge of Learners, Pedagogical Knowledge, Knowledge of Educational Contexts, and Knowledge of Educational Aims. Each of these categories describes a distinct knowledge domain that teachers need to learn in order to navigate the complexity of the profession:

Content knowledge. Content knowledge refers to the teacher's expertise in the subject matter (Shulman, 1986; Tharp & Gallimore, 1988). This type of knowledge requires an in-depth understanding of the facts, concepts, procedures, processes, and principles in a field. Teachers need to be experts in their subject in order to help students gain a comprehensive understanding of how the subject matter knowledge is organized and how to think critically and analyze the key ideas in the field. Content knowledge is the most commonly studied type of knowledge in the

field of teacher learning (Grossman & Richert, 1988; Garet, Porter, Desimone, Birman, & Yoon, 2001; Borko, 2004; Kleickmann et al., 2012).

Pedagogical knowledge. Pedagogical knowledge pertains to the teacher's ability to design an effective learning environment (Villegas-Reimers, 2003). This requires the ability to select and utilize optimal teaching strategies to help all students reach their potentials as learners. Teachers also need to know how to scaffold student learning, evaluate student learning, and adapt lessons to meet students' needs (Grossman & Richert, 1988; Tharp & Gallimore, 1988; Ball, 1995).

Pedagogical content knowledge. Shulman (1986) introduced the term "Pedagogical Content Knowledge (PCK)" (p. 9) to combine subject matter knowledge with the understanding of how students learn. This type of knowledge is different from the first two knowledge types because it requires a comprehensive understanding of how students learn in relation to a specific topic. Kleickmann et al. (2012) noted that even though content knowledge is a prerequisite to PCK, highly developed content knowledge does not necessarily correlate with strong PCK. Teachers with strong PCK are able to design effective learning activities based on their knowledge of how students learn the content. PCK also involves an understanding of common student misconceptions and how and why students have trouble learning the content.

Curricular knowledge. Curricular knowledge involves a comprehensive understanding of the assigned curriculum and how to evaluate and select the most useful curriculum materials and tools to enhance student learning (Shulman, 1986). Teachers are generally given a collection of curriculum materials (e.g., textbooks,

worksheets, photos, labs) and they often have a range of tools (e.g., computers, videos, mobile devices, whiteboards, manipulatives) to choose from when designing learning activities. Teachers need to be able to assess the effectiveness of these materials and tools based on their knowledge of the students in their classroom and then select the materials and tools that will optimize the learning experience. Additionally, curricular knowledge also requires "lateral" insight about how the curriculum relates to the other subjects that students are learning and "vertical" insight about the content that students learned previously and what they are expected to learn next (Shulman, 1986, p. 10).

Knowledge of learners. Knowledge of learners requires an in-depth understanding of each student. For example, teachers need to know what prior experiences and cultural influences shape their students' understanding of the content, what teaching and learning strategies work best for each student, and what types of obstacles might hinder a student's ability to learn, such as traumatic experiences, hunger, or lack of sleep (Grossman & Richert, 1988). Knowledge of learners requires an appreciation of the diversity of students and the ability to adapt the subject matter and curriculum materials based on the context of the classroom (Ball, 1995; Darling-Hammond, 1996, Villegas-Reimers, 2003; Frank, Zhao, Penuel, Ellefson, & Porter, 2011).

Knowledge of educational contexts. Knowledge of educational contexts refers to the idea that teachers understand the characteristics and culture of their classroom, school, and the local community. This type of knowledge requires an in-depth understanding of the various sociocultural factors (e.g., norms, traditions,

behaviors) that shape each of the communities that a teacher participates in. A teacher with a strong knowledge of educational contexts also recognizes the roles of the network of individuals who shape each of the communities.

Knowledge of educational aims. Teachers need to have insight about the policies, educational aims, standards, and institutions that influence what and how to teach. Knowledge of educational aims requires the ability to act and make decisions about teaching based on the understanding of the policies and rules that govern the educational community.

Although Shulman's (1986, 1987) teacher knowledge domains were developed more than three decades ago, they are still relevant today as the nature of teaching and learning in many school settings has not changed much in 30 years. However, the complexity of each of these domains has increased substantially. For example, widespread access to the Internet and new technologies has transformed curricular knowledge, since teachers now have access to thousands of tools, such as online websites, apps, mobile devices, interactive whiteboards, and laptops, that they can use to improve and assess student learning. The content knowledge that teachers are expected to know is also changing with the implementation of the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). Additionally, knowledge is not a fixed "truth," but rather something that teachers negotiate throughout their practice and learning opportunities. Thus, teachers need ongoing learning opportunities to construct knowledge that will help them stay current with the evolution of the knowledge domains.

Teacher Learning Models and Theories

Researchers have explored various learning theories and models in order to understand how teachers acquire new knowledge. These theories and models fall into two distinct categories based on the notion of where learning occurs: In one's own mind (intrapersonal) or minds in interaction (interpersonal).

Intrapersonal learning. Intrapersonal learning refers to the psychological actions of an individual. The unit of analysis is the individual teacher's cognition. When researchers assess the intrapersonal learning processes of teachers they are interested in understanding how teachers think, make decisions, and adapt new knowledge to varying situations. In Kolb's (1984) Experiential Learning Cycle, individuals learned through an iterative process that involved experience, reflection, formulation of new ideas, and the testing of the new ideas. In Shulman's (1987) Model of Pedagogical Reasoning and Action, teachers learned new knowledge through a cyclical process of comprehension, adaptation, practical experience, evaluation, and reflection. In Susman's (1983) Detailed Action Research Model, teachers acquired knowledge by identifying a problem, researching and developing a plan of action, implementing the plan, and evaluating the process. These models demonstrate the necessity of designing learning opportunities that allow teachers to reflect, adapt, and actively synthesize new knowledge into their practice. However, missing from these models are the contextual and social influences that affect the learning process.

Interpersonal learning. Interpersonal learning refers to the notion that knowledge is co-constructed with others through situated, social, and distributed

learning opportunities (Putnam & Borko, 2000). Situated learning refers to experiences in which teachers work together to solve authentic challenges they face in the classroom (Brown, Collins, & Duguid, 1989). Social learning occurs as teachers negotiate meaning and understanding with more knowledgeable individuals (e.g., experts). According to Vygotsky's (1978) Zone of Proximal Development (ZPD), learning takes place when a more knowledgeable other is available to assist the learner in solving a problem. Tharp and Gallimore (1988) explained, "Teachers, like their students, have ZPDs; they, too require assisted performance" (p. 190). Knowledge acquisition is also inherently distributed. Distributed cognition theory posits that knowledge is distributed across people and objects within a complex system (Hutchins 1995; Salomon, 1993). Therefore, interpersonal learning is a process of negotiating meaning through interactions with tools and more knowledgeable others.

Intrapersonal and interpersonal learning. Intrapersonal and interpersonal learning models and theories provide different ways of examining how teachers acquire knowledge. Intrapersonal studies allow researchers to analyze the metacognitive strategies and decision-making processes of teachers, while interpersonal studies provide insights about how knowledge is created and shared among teachers through mediational tools.

Both intrapersonal and interpersonal learning models and theories have limitations. Critics of the intrapersonal approach to understanding learning have argued that the mind and body cannot be separated (Kaptelinin, Kuutti, & Bannon, 1995; Jonassen & Rohrer-Murphy, 1999). Jonassen and Rohrer-Murphy claimed that

"knowing can only be interpreted in the context of doing" (p. 64). Therefore, teacher learning could not be understood solely as a psychological process devoid of any contextual and sociocultural influences (Webster-Wright, 2009). On the other hand, interpersonal studies have not addressed how the collectively produced external knowledge became internalized. These types of studies also tended to focus on learning as a one-way flow of information from the experts to the teacher. Since teacher learning is a multifaceted process, researchers may benefit from combining intrapersonal and interpersonal models and taking a more comprehensive approach to understanding how teachers learn.

Opportunities for Knowledge Acquisition

Another way to examine how teachers learn is by exploring how they acquire new knowledge. According to Cochran-Smith and Lytle (1999), teachers acquired new knowledge in three different ways: from outside experts, from practice, and from inquiry. The idea of teacher learning from outside experts, or "knowledge-for-practice" (Cochran-Smith & Lytle, 1999, p. 250), assumes that teachers learn and grow by mastering discrete domains of knowledge that are developed and transmitted from researchers and experts. "Knowledge-for-practice" refers to the formal learning opportunities, such as workshops and conferences, which teachers attend in order to learn from more knowledgeable others.

Teachers also learn through practice. Since every classroom and group of students provides a different challenge, teachers are often learning throughout their workday as they test, adapt, and improvise lesson plans in real time. Shulman (1987)

cited teacher experience, or the "wisdom of practice," (p. 8) as one of the main sources of knowledge for teachers. Cochran-Smith and Lytle (1999) defined this type of learning as "knowledge-in-practice, " (p. 250) which referred to the accumulation of knowledge that a teacher gained from practical experience in a classroom.

The third teacher learning opportunity, "knowledge-of-practice," (Cochran-Smith & Lytle, 1999, p. 250) refers to the idea that teachers acquire knowledge through inquiry. In "knowledge-of-practice," (p. 250) teachers collaborate with a wide network of peers and educators, co-construct knowledge, redesign local curriculum, and critically reflect on their practice (Cochran-Smith & Lytle, 1999). This type of learning often occurs in communities.

Effective Teacher Learning Opportunities

Many researchers have assessed the characteristics of various learning opportunities in order to identify what traits lead to a change in knowledge acquisition and, ultimately, a change in teaching practice (Boyle, Lamprianou, & Boyle, 2005; Desimone, Porter, Garet, Yoon, & Birman, 2002; Frank, Zhao, Penuel, Ellefson, & Porter, 2011; Garet, Porter, Desimone, Birman, & Yoon, 2001). However, the ongoing debate about how teachers learn best has resulted in a wide range of independent, isolated, and disjointed efforts to design effective learning opportunities (Desimone, Porter, Garet, Yoon, & Birman, 2002; Opfer & Pedder, 2011). Even with the discontinuous nature of the research on teacher learning, two

key factors have surfaced multiple times: long-term, ongoing learning, and community-based learning (Webster-Wright, 2009).

Many researchers have agreed that teachers need ongoing learning opportunities that take place over an extended length of time (Abdal-Haqq, 1995; Birman, Desimone, Porter, & Garet, 2000; Boyle, Lamprianou, & Boyle, 2005; Lieberman, 1995; Little, 1988; Webster-Wright, 2009; Wilson & Berne, 1999). Garet, Porter, Desimone, Birman, and Yoon's (2001) study on teacher learning, one of the most commonly cited articles in the literature, showed that a longer duration of learning activities was significantly related to increased knowledge and skills. Boyle, Lamprianou, and Boyle (2005) also found that learning activities with longer durations were more likely to lead to changes in teaching practices.

Another key characteristic of effective teacher learning opportunities is community-based learning (Ball, 1995; Lieberman, 1995; Wilson & Berne, 1999; Putnam & Borko, 2000; Borko, 2004; Webster-Wright, 2009; Frank, Zhao, Penuel, Ellefson, & Porter, 2011). Wilson and Berne (1999) conducted a meta-analysis of highly regarded research on teacher learning to understand what and how teachers learn. Many of the studies they examined showed that teachers gained new knowledge as a result of participating in communities. Ultimately, they found that teacher learning occurred through professional dialogue within various communities.

Online Communities of Practice

Online communities of practice are one example of an ongoing, community-based learning opportunity for teachers. The U.S. Department of Education Office of

Educational Technology [OET] (2010), Tech & Learning (2011), the International Society for Technology in Education (2012), and the Center for Teaching Quality (2013) have recommended that teachers from all stages of the learning-to-teach continuum should utilize online communities of practice for ongoing learning and professional growth opportunities.

An online community of practice is a virtual space that supports the traditional notions of a community of practice and allows members to connect across spatial and temporal boundaries (U.S. Department of Education OET, 2011). The term "online community of practice" has been broadly applied in the literature to listservs, discussion forums, social networking sites, social bookmarking tools, microblogging, and other interactive online environments. There are a number of online communities of practice for teachers, such as edWeb, Twitter #edchat, Edmodo, Google+ Communities, and Classroom 2.0. These online communities of practice are virtual extensions of the "community of practice" framework (Lave & Wenger, 1991, p. 40).

Community of Practice

The term "community of practice" was coined by Lave and Wenger (1991) to describe the apprenticeship models they observed in different communities. Lave and Wenger noted that learning was not limited to the mentor and apprentice in authentic practice settings, such as occupational settings. In these settings, the entire community worked together to help the apprentice learn. In the communities of midwives, tailors, quartermasters, and butchers, community members helped

newcomers learn how to act and negotiate meaning, "in the manner of full participants" (p. 105). Through mastery of knowledge, skills, and actions, the novice moved from an outsider observing the community to an insider who participated fully and contributed to the community.

Wenger (2000) later revised the term "community of practice" to describe a group of practitioners who negotiate expertise in a "domain" through participation and collective learning (p. 229). These individuals develop a "shared repertoire" of artifacts through mutual engagement in a "joint enterprise" (Wenger, 2000, p. 229). Communities of practice have three main components that separate them from other groups, such as communities of interest (Jones & Preece, 2006) and passionate affinity spaces (Gee & Hayes, 2011): *domain, community,* and *practice* (Wenger, 2006). Communities of practice are organized around a shared interest, or *domain*. This gives a purpose to the community and allows practitioners to communicate through a shared language. The *community* component is essential as it allows members to learn through interaction and dialogue with others. The *practice* component is based on the premise that members are participating in the community to create shared resources and knowledge that can be used to improve their practice.

Since the term "community of practice" was coined, it has been defined, expanded, and utilized often in educational literature (Derksen, 2012). Johnson (2001) described the three common traits that communities of practice have: (1) members with varying levels of expertise, (2) fluid movement from novice to an expert, and (3) authentic problems that allow learners to collaborate and devise solutions to problems arising in settings. Hur and Brush (2009) characterized

communities of practice as "groups of practitioners who share knowledge, concerns, and values within a supportive culture" (p. 280).

With the exponential rise in cheap technologies and increased access to the Internet, communities of practice are no longer limited to face-to-face contact (Preece, 2001; Tech & Learning, 2011; Derksen, 2012). Wenger (2006) described how new technologies "have extended the reach of our interactions beyond the geographical limitations of traditional communities" (p. 6) and expanded the possibilities for communities of practice. These "online communities of practice" (U.S. Department of Education OET, 2011, p. 5) use new technology tools and platforms to support the elements of a traditional community of practice while also bridging the gap between space and time so teachers can connect with other educators around the world (Johnson, 2001; U.S. Department of Education OET, 2011).

Knowledge Sharing in Online Communities of Practice

After conducting a review of the literature on online communities of practice, I found that the main reason teachers participated in these online communities was to find and share knowledge. Online communities of practice allowed teachers to break out of their isolated school environments and seek and share knowledge from peers and experts on a global scale (Rosenholtz, 1989; Tharp & Gallimore, 1988; Hur & Brush, 2009; Duncan-Howell, 2010; U.S. Department of Education OET, 2010; Borg, 2012; Derksen, 2012). According to the U.S. Department of Education Office of Educational Technology [OET] (2011), teachers cited knowledge sharing as the

most useful aspect of participating in online communities. Many researchers have studied why and how teachers share knowledge in online communities of practice and how knowledge sharing affects teacher participation (Hew & Hara, 2007; Gannon-Leary & Fontainha, 2007; Chen, Chen & Tsai, 2009; Duncan-Howell, 2010; Forte, Humphreys & Park, 2012).

In a thriving online community of practice, knowledge is shared more often than it is requested. Hew and Hara (2007) conducted a study of an electronic mailing list (listserv) for literacy teachers to analyze knowledge sharing between participants. They found that the majority of messages on the listserv fell under the "knowledge sharing" (60.8%) and "request for knowledge" (25.7%) categories (Hew & Hara, 2007, p. 583). Forte, Humphreys, and Park (2012) also found similar results. After conducting a content analysis of 2000 Twitter posts containing popular education hashtags (e.g., *#edchat* and *#mathchat*), they found that the most common types of education-related tweets were "resource (knowledge) sharing" (64% of #mathchat and 54% of #edchat posts), "responses to others" (30%), and "requests for information or action" (20% of #edchat posts) (Humphreys & Park, 2012, p. 5). In both of these studies, more people were sharing knowledge than were requesting it, which means that the participants shared knowledge freely without waiting for someone to ask for it.

Knowledge sharing is a beneficial practice in online communities because it allows teachers to find new ideas, resources, and information and maintain awareness about the latest changes in their field. Hew and Hara (2007) found that knowledge sharing helped teachers in two ways: (1) gaining new insights and ideas

and (2) staying up-to-date with the latest information in their field. Duncan-Howell (2010) had similar findings when she surveyed participants in three online communities of practice. In Duncan-Howell's (2010) study, the participants reported that accessing subject-specific resources, new content, and lesson plans were the main reasons they maintained their membership in the communities. Forte, Humphreys, and Park (2012) also found that teachers mainly used Twitter because it was "a source of new ideas and a way of keeping abreast of educational technologies" (p. 5). Hur and Brush (2009) conducted a study of three online communities of practice and found that teachers participated in online communities in order to explore new ideas, broaden their perspectives, and learn from experts around the world. Online communities of practice allowed these members to connect with other individuals whom they may not have known directly, which was what Gee and Hayes (2011) referred to as "weak ties," (p. 34). This allowed teachers to branch out beyond their local networks to find new ideas, solutions, and best practices shared from a diverse group of educators (U.S. Department of Education OET, 2010).

Online communities of practice also provide a platform for teachers to share the latest trends and news related to a subject, grade-level, or topic. Duncan-Howell (2010) found that many teachers participated in online communities of practice to "keep up with current professional trends" (p. 335). Teachers in an online community have access to the most recent news and best practices in their field without having to search for it on the Internet or wait for a professional development workshop.

While the research on knowledge sharing in online communities of practice often focuses more on how and why participants share knowledge, Hew and Hara's (2007) study of a literacy teachers' email listserv provided useful insight into what types of knowledge were shared in a teacher community. Hew and Hara (2007) found that the types of knowledge teachers shared fit in three main categories: personal opinion (44.7%), personal suggestion (41.1%), and book knowledge (10.8%) (p. 583). Personal opinion was defined as an individual sharing thoughts about a teaching strategy or new idea, while personal suggestion referred to a teacher providing a recommended solution based on her or his own practical experience in the classroom. Book knowledge consisted of facts, policies, standards, and other pieces of information that could be found in books or online. The results suggested that knowledge sharing on the listserv was more likely to occur as a negotiated conversation (e.g., responding to a new idea, solving a problem, sharing a personal example) rather than the dissemination of factual information.

Hew and Hara's (2007), Duncan-Howell's (2010), Hur and Brush's (2009), and Forte, Humphreys, and Park's (2012) analyses of seven distinct online communities of practice found knowledge sharing to be a key motivating factor that increased participation in these communities. Overall, teachers were motivated to find new ideas and resources and stay up-to-date with the latest changes in the field of Education.

Barriers

Teacher participation in online communities of practice hinges on the balance between motivating factors and barriers. Knowledge sharing is often cited as the main motivating factor for participating in online communities; however, teachers also face multiple barriers that can inhibit their knowledge sharing experiences.

Time. Researchers have found that lack of time combined with an overwhelming amount of information to explore often resulted in decreased participation in online communities of practice (Carr & Chambers, 2006; Duncan-Howell, 2010; Hew & Hara, 2007). Online communities provide instant access to thousands of conversations, new ideas, and resources. However, teachers have a limited amount of time for knowledge sharing due to their demanding profession. Teachers who feel as though they do not have time to sort through all of the new knowledge in an online community of practice are less likely to participate.

Technology. Technology provides an open platform for sharing and connecting with experts around the world; however, the vulnerability of communicating with strangers through text can also be a barrier. Hew and Hara (2007) reported that technology hindered teachers' participation and knowledge sharing in the email listserv. Teachers in the study feared that they might be criticized or have their ideas misconstrued because the text-based technologies lacked visual and verbal cues. Carr and Chambers (2006) also reported that text-based technologies were problematic for participants in their study of the National Quality Schooling Framework pilot project. They cited a lack of visual and verbal cues as a reason that participants did not engage in meaningful exchanges of

information. Additionally, Lin, Lin, and Huang (2008) discovered that the main problems teachers encountered when participating in the virtual community were role ambiguity, miscommunication, and fear of criticism.

Global reach. Teachers often engage in online communities of practice in order to reach out to a large, diverse audience of experts who have insights and solutions to the specific problems they encounter (U.S. Department of Education OET, 2010; Tech & Learning, 2011; Derksen, 2012). However, Jones and Preece (2006) argued that teachers face a tension between global access and local problems. Teachers must be able to transfer the global knowledge from their online communities into actions they can carry out in the local context of their classroom. While access to educators around the world may help teachers find experts who can address their specific need, many times the problems teachers face are situated in the context and communities within their schools and classroom, which limits the transferability of solutions and knowledge between the global community and local community.

Participation in Knowledge Sharing Activities

Online communities of practice are complex activity systems in which participation in knowledge sharing activities is often shaped by the participants' level of engagement and goals.

Levels of engagement. Rodd Lucier (2012) developed a framework that categorized seven levels of engagement in online communities (see Table 2.1). The lowest level of engagement is the *lurker* who acquires knowledge by observing other

members and reading the community discussion threads. Levels two and three of the framework (*novice* and *insider*) define individuals who make an effort to join a few conversations and try additional social networking tools. Level four (*colleague*) describes participants who connect with others and build their networks. Levels five (*collaborator*) and six (*friend*) refer to members who are willing to ask for help and advice, collaborate on projects, and build strong relationships with other individuals in the community. The seventh level of participation (*confidant*) describes members who make connections between their local community and their online community of practice. Individuals at this level of participation are the ones that colleagues and community members go to for advice and ideas. Forte, Humphreys, and Park (2012) referred to these participants as "bridges," (p. 1) since they freely moved information and resources back and forth between their face-to-face and online communities.

As participants move up through the levels of engagement, they become more actively involved in the knowledge sharing process. Lurkers are passive recipients of knowledge, while novices start to experiment with sharing their own expertise with an online community of practice. Colleagues, collaborators, and friends are actively involved in generating new knowledge with other members. Confidants bridge knowledge sharing activities between their local school and the networks of online communities that they participate in.

Lucier's (2012) "7 Degrees of Connectedness" framework resembles Lave and Wenger's (1991) process of "legitimate peripheral participation" (p. 29). In this process, the newcomer moves from an outsider (*lurker*), who learns about the community through observation, toward a full participant (*confidant*) that contributes

to the community by acting as a bridge, collaborating with others, and sharing knowledge.

Table 2.1

Rodd Lucier's 7 Degrees of Connectedness Framework

Stage 1: Lurker
"Hey other people are sharing some cool ideas on their blogs.
"So many people are saying things I agree with..."
"I follow folks on Twitter, but I'm too shy to say anything."
Stage 2: Novice
"When I join in on the conversation people actually talk back to me."
"I love when other people agree with what I'm saying."
"I like to read a few blogs."
Stage 3: Insider
"The same names keep coming up in my stream."
"I'm beginning to know many of these familiar names and faces."
"I am part of a Personal Learning Network (PLN)."
Stage 4: Colleague
"I love when I meet people face-to-face at a conference or event."
"I sometimes begin conversations by sharing my TwitterID."
"I have degrees of relationships within my PLN."
Stage 5: Collaborator
"Why don't we start a Google Doc to share our ideas?"
"Want to put in a workshop proposal with me?"
"I'll see you at the tweet-up before the conference."
"Can you help me with a project with my students?"
Stage 6: Friend
"It feels like we've known one another for a long time."
"At conferences, I'd rather meet face-to-face with my online colleagues than attend workshops."
"I am comfortable to ask my PLN for help or advice about my work."
Stage 7: Confidant
"I wish the people in my school were as helpful as you are."
"Can you proof-read my latest blog post?"
"Would you like to meet for lunch?"
"When are you coming to town? We have to get together!"

Note. Reprinted from, "Seven Degrees of Connectedness," by Rodd Lucier, 2012. Copyright 2012, Creative Commons Attribution. Reprinted with permission.

However, unlike Lucier's framework, which is a linear progression from novice to expert, Lave and Wenger's process of legitimate peripheral participation is

cyclical. According to Lave and Wenger (1991), “Everyone’s participation is legitimately peripheral in some respect” (p. 117). As newcomers enter a community, they bring their own knowledge and skills, which transform the community. This requires the full participants to continue to learn to evolve with the community. Therefore, newcomers and full participants alike are constantly negotiating their identities, skills, and knowledge in the process of legitimate peripheral participation.

Goals. Another way to analyze participants’ knowledge sharing activities in an online community of practice is by understanding their goals. Online communities of practice bring together a diverse array of individuals who all have goals, or objectives, that stimulate their participation in the community.

The U.S. Department of Educations Office of Educational Technology’s [OET, 2011] report on online communities of practice in education defined a range of roles that participants might take on based on their personal goals or levels of engagement. For example, “cybrarians” and “curators” manage and organize the community’s artifacts, “village elders” and “griots” are the storytellers and keepers of the history of the community, “evangelists” recruit members to the community, “event coordinators” and “hosts” organize synchronous events, and “critics, evaluators, or raters” assess the quality of the artifacts produced by the community members (U.S. Department of Education OET, 2011, p. 24).

Looking at community roles from this perspective, one can see that members’ goals shape the acquisition and distribution of knowledge. Evangelists play a critical role in increasing the number of community members, and ultimately, increasing the collective knowledge of the community. Critics, evaluators, or raters

participate in order to ensure that the shared knowledge reflects the excellence of their field. Cybrarians organize the shared knowledge in a way that makes it easier for members to access specific types of knowledge.

Researchers have yet to examine what drives participants to take on these different roles or pursue these goals. Further research is needed to explore whether participants are motivated to engage in knowledge sharing in an online community of practice because they can enact one of these roles or whether they take on a specific role depending on their goals and objectives within the community.

Limitations

The majority of the studies on teacher learning and online communities of practice often fail to examine knowledge acquisition as a complex, dynamically evolving process that is shaped by local classroom and school contexts as well as other sociocultural factors. Studies on teacher learning typically focus on isolated components of the teacher learning process, such as the acquisition of a specific knowledge type from an informal or formal learning opportunity (Opfer & Pedder, 2011). Additionally, studies on online communities of practice often focus on teachers' goals, barriers, and motivations for participation without examining the complexity of the online community activity system or the multiple competing activity systems that influence how a teacher learns.

Acquiring new knowledge is not a simple, linear process for teachers. Teachers often have to determine what and how to learn based on the integrated network of sociocultural factors that shape their local school activity systems.

Researchers that focus on isolated variables or assume that learning is a simple process of acquiring a specific knowledge domain are not providing an accurate narrative of how teachers learn. Opfer and Pedder (2011) argued that teacher learning needs to be examined using a Complexity Theory framework in order to understand the activity system variables that influence the process of learning. Wilson (2013) shared this same sentiment. According to Wilson (2013),

> A more complex view of teacher learning is clearly needed, one in which professional learning is seen as more dynamic and iterative, connecting teachers' experiences in their classrooms with formal opportunities for collective reflection and for acquiring new knowledge that targets genuine problems of practice (p. 311).

Wilson (2013) also argued that researchers needed to examine the local school activity systems, or "internal coherence of a school," (p. 311) in order to understand how the organizational culture of a school can shape teacher learning and practice.

One way to address these limitations in the literature is to use a theoretical framework that provides the flexibility to examine learning as a complex process that is shaped by multiple variables. Cultural Historical Activity Theory (Cole & Engeström, 1993; Engeström, 1987; Leontiev, 1978; Vygotsky, 1978) is one tool that allows researchers to examine teacher learning from a more comprehensive perspective.

Cultural Historical Activity Theory

Cultural Historical Activity Theory (CHAT) is a framework that can be used for interpreting the local contexts and global factors that shape how teachers learn. CHAT is based on the premise that human cognition should not be analyzed separately from sociocultural and contextual influences. Vygotsky, a key influence in the development of CHAT, believed that mind and body are inextricably linked, in that, "you are what you do" (Vygotsky, 1978, p. 7). Consciousness and knowing can only be understood by analyzing the context of the individual's actions (Jonassen, 1999). By examining consciousness through human interactions in everyday activities, researchers are able to explore the dialectical relationships between traditional dichotomies, such as the individual/collective, internalization/externalization, and mind/society (Kaptelinin & Nardi, 2006). Using the CHAT framework, researchers can also synthesize intrapersonal and interpersonal learning theories in order to construct a more comprehensive understanding of how teachers learn.

CHAT provides a framework of basic principles and "theoretical lenses" (Roth & Lee, 2007, p. 201) that can be used to understand the critical components within an activity system, such as object-orientedness, tool mediation, intentionality, the relational and dualistic nature between the elements, and the continual development of the system and elements over time (Kaptelinin, Kuutti, & Bannon, 1995). This perspective can provide an analytical lens for examining the cultural artifacts, social norms, community roles, objects, and outcomes that influence how teachers learn. Ultimately, the CHAT framework can be used as a guide for

systematically exploring the complex issues and network of actions that shape the process of learning.

The CHAT Framework

CHAT provides researchers with a framework for examining dynamic *activity systems*. The common elements within an activity system are: *subject, tool, object, outcome, rules, division of labor,* and *community* (Engeström, 1987; Cole & Engeström, 1993). In order to use CHAT as a framework for analyzing an activity system, it is important to understand the different components within the activity system and how they interact with and influence one another.

Activity system. The *activity system* is the primary unit of analysis (Engeström, 1987). An *activity* is the intentional interaction of the subject with the world (Kaptelinin & Nardi, 2006). The process of participating in an activity results in the mutual transformation of the subject and object.

According to Leontiev (1978), *activities* are made up of multiple *actions*, which are the intentional efforts of an individual or group of individuals to achieve a *goal*. A goal is a short-term task that is required to pursue an object. Actions are carried out through *operations* (automated processes), which are mediated by *conditions* or tools (Kaptelinin, Kuutti, & Bannon, 1995).

The activity system is a historically evolving, dynamic network of elements with a complex mediational structure (Cole, Engeström, & Vasquez, 1997; Engeström, 2000). Each activity system evolves from the joint actions of individuals who are motivated to achieve or transform an object. Tharp and Gallimore (1988)

argued that activity systems do not occur at random; instead, they occur as a result of societal pressures and resources.

The activity system is made up of an integrated network of elements that provide multiple perspectives for understanding human cognition through action (Barab, Schatz, & Scheckler, 2004). Roth and Lee (2007) used an example of a classroom project about the environment to demonstrate this concept. They described how knowledge could be an object (e.g., learning content), outcome (e.g., demonstrating expertise), or tool (e.g., using the knowledge to engage in discussions about healthy environmental practices). Knowledge could also be used to differentiate the roles within a community (e.g., politician, environmentalist, student, farmer). Knowledge is not just a single element within an activity system; instead, it is a dynamic element that interacts with the other components while also connecting the activity system with other systems. Each element can be examined to understand how the activity system functions as a whole and the overall activity system can be examined to understand how the elements interact with one another.

Contradictions. Within an activity system, there are internal tensions, or *contradictions*, that build up over time and lead to the *transformation* of the system (Engeström & Miettinen, 1999). DeVane and Squire (2012) cited contradictions as one of the strengths of the CHAT framework because researchers can examine contradictions to determine what drives the evolution of an activity system. According to Roth and Lee (2007), there are four main levels of contradictions that subjects might experience: "internal to one element, between two elements, between two objects, and between two activity systems" (pp. 203-204).

When contradictions are brought about consciously, they can lead to a change in one or more of the elements within an activity system, which eventually transforms the whole system (Roth & Lee, 2007). DeVane and Squire exemplified this process of change by describing how new tools for logging (e.g., chainsaws, trucks) led to the transformation of rules (e.g., laws about clear cutting) and new divisions of labor (e.g., loggers, drivers). The introduction of new tools made the old divisions of labor and rules obsolete and transformed the object. The new tools caused a disruption in the activity system and ultimately transformed the entire system.

On the other hand, when elements change, they may not be disruptive enough to transform the activity system (DeVane & Squire, 2012). Blin & Munro (2008) found that the introduction of a new technology at a university created a new activity system that was focused on learning how to use the technology rather than how faculty could use the tool to transform their practice. Therefore, it is important to understand what causes the internal tensions, how they surface, and which contradictions lead to changes within an activity system.

Subject. The subject refers to the people engaged in the activity system. The subject can be an individual or a group of individuals (Jonassen & Rohrer-Murphy, 1999). As subjects pursue the object, their identities and personalities are shaped and transformed through their interactions with the other elements in the activity system (Axel, 1997; Davydov, 1999; Roth & Lee, 2007). However, subjects' actions and decisions are also shaped by their personalities and identities (Stetsenko & Arievitch, 2004). Kozulin (1991) described this phenomena as "life as authoring," (p. 338) in

which subjects constantly reinvent themselves and create their personal narratives based on their negotiation of meaning in relation to sociocultural influences.

Tools. The mediational role of tools is an important concept in CHAT (Nardi, 1996). Vygotsky (1978) argued that tools mediate every human action and experience. Tools, also called artifacts and signs, can be internal, external, psychological, or material (Engeström, 1999; Kozulin, 1998; Vygotsky, 1978). Material tools (e.g., new technologies) are the physical items in the external world, while psychological tools (e.g., mental models and symbols) are cognitive strategies used to master higher mental functions (Kozulin, 1998; Vygotsky, 1978). Some tools fall under more than one of these categories. Language, for example, can be internal and psychological (metacognition), external (communication), and material (text). Engeström (2000) argued that tools should not be limited to specific categories since they moved fluidly from one category to the next as they changed and evolved during an activity.

Tools are deeply embedded within the elements of the activity system. When the subject selects a tool to use, the tool defines the way the subject carries out an action (Kaptelinin, Kuuti, & Bannon, 1995). The subject often shapes and enhances the tool to make it more effective and useful, which then changes the way the subject completes a task (Jonassen & Rohrer-Murphy, 1999). Wertsch (1997) used the example of language to demonstrate how the subject and the tool mutually transform one another: “Speakers shape the situation by choosing a language, but they are in turn shaped in what they can say by this choice” (p. 230). Therefore, tools influence the development and actions of individuals and individuals shape the tools they use.

However, this dialectical relationship is not limited to the subject and the tool. Tools can also shape and be shaped by the sociocultural contexts within a community (Jonassen & Rohrer-Murphy, 1999; Hatano & Wertsch, 2001; Daniels, 2004). According to Kaptelinin, Kuutti, and Bannon (1995), "Tools are never used in a vacuum, but have been shaped by the social and cultural context where the use is taking place" (p. 192). Tools are selected and used in a manner that is consistent with the social norms or cultural influences within a community. Tools can only be appreciated "in the context of human activity" (Jonassen & Rohrer-Murphy, 1999, p. 67).

Tools are constantly changing and evolving as they shape and are shaped by external influences (Barab, Schatz, & Scheckler, 2004). As tools evolve, they can transform social norms, culture, community, subjects, divisions of labor, objects, and entire activity systems (Jonassen & Rohrer-Murphy, 1999). In turn, as each of these elements changes, it affects how a tool is developed and used. Since tools carry with them remnants of the social and cultural influences that lead to their evolution, they provide insight about the historical development of the activity system (Daniels, 2001; Jonassen & Rohrer-Murphy, 1999; Kaptelinin, Kuutti, & Bannon, 1995). Many tools are also used to transmit knowledge from one generation to the next (Kaptelinin, Kuutti, & Bannon, 1995; Stetsenko & Arievitch, 2004). Thus, tools can both provide a glimpse of history and ensure that social and cultural knowledge is preserved across space and time (Nardi, 1996).

Object and outcome. The object, or "objective," (Nardi, 1996, p. 37) is the target or product of the activity system. Objects generally surface to "meet a human

need" (Engeström, 2000). The concept of the object provides insight into *why* people perform different actions (Kaptelinin & Nardi, 2006). The object is the main element that differentiates one activity from another (Leontiev, 1978). There is only one object for each activity system. Activity systems can consist of multiple motives and goals, but the activity system is defined by the single object (Kaptelinin & Nardi, 2006).

CHAT was founded on Vygotsky's (1978) and Leontiev's (1978) idea of object-oriented action. Leontiev (1978) claimed that human action was structured, motivated, and directed by an external object. Engeström (1987) built on this idea by adding that subjects were motivated to transform objects into *outcomes*, or desired results.

Kaptelinin (2005) argued that successful objects have four key characteristics: balance, inspiration, stability, and flexibility (p. 17). Objects need to be balanced, achievable, and enticing. Objects need to be stable because frequent changes can undermine the activity system. However, objects also need to be flexible so they can be transformed and reconstructed during the course of an activity (Engeström, 2000; Jonassen & Rohrer-Murphy, 1999; Nardi, 1996). Since objects change and evolve as an activity unfolds, Engeström (2000) argued that, "the object is never fully reached or conquered" (p. 381). Engeström related the object to the horizon—something that existed in the external world (visible and enticing) but was out of reach. Roth and Lee (2007) argued that the object existed on two planes: the material world and the imagination. Similar to Engeström's metaphor, Roth and Lee

described how the object first existed as an external entity and then became internalized as a motivational target.

Community, division of labor, and rules. The final three elements of CHAT add a collective, social aspect to the subject-tool-object model. The *community* element refers to the group of individuals with a shared interest and culture that interact within an activity system. The community members negotiate the *division of labor* (roles) and the *rules* for participation within the community (Jonassen & Rohrer-Murphy, 1999).

Individuals perform different divisions of labor, or roles, within a community since a single individual cannot have all of the knowledge and skills necessary to carry out all of the actions within the activity system (Tolman, 1999). Individuals participate in different roles based on their skills, knowledge, and interests (Jonassen & Rohrer-Murphy, 1999). In online communities of practice, participants also take on various roles depending on the object they are pursuing.

In addition to the division of labor, each community has a set of collectively negotiated rules, or sociocultural conventions. These conventions are either explicitly stated or implicitly understood guidelines for acting, behaving, and interacting within the community. The rules provide a lens for understanding how to become a full participant in a community. These rules are essential for developing a community of trust and for providing a safe space that facilitates open communication and relationship building.

Culture and history. The tool-mediated actions of subjects are influenced by the culture and history of the activity system. Culture has been defined and redefined

countless times by many different researchers. The Center for Advanced Research on Language Acquisition (2013) described culture as the "shared patterns of behaviors and interactions, cognitive constructs, and affective understanding that are learned through a process of socialization" (para. 1). Culture is often perceived as the characteristics that define a group (e.g., language, actions, behaviors, traditions, artifacts). Agar (1994) believed that culture could only be described by exploring the differences between groups. Each group of individuals, whether it is online or face-to-face, has a shared culture (Stickler & Emke, 2011). Culture is an important tool for exploring the differences between activity system elements as well as between activity systems.

History is another important element that can provide insight about how the culture, tools, and community of an activity system have evolved over time. Engeström (2000) recognized the importance of history as part of the CHAT model and adapted the second generation of the model to include a stronger focus on history and the transformations that change an activity system over time.

Both history and culture play an important role in shaping the subject's tool-mediated, object-oriented actions within an activity system. Understanding the complexity of these two elements and how they shape an activity system allows the researcher to gain a more comprehensive understanding of how the process of learning is influenced by multiple, often competing, sociocultural factors.

CHAT and Teacher Learning

A few researchers have used the CHAT framework to explore teacher learning. Blin and Munro (2008) explored how the introduction of a new technology for university faculty resulted in the development of two overlapping activity systems. Barab, Schatz, and Scheckler (2004) used the CHAT framework to examine an online community for teachers and build a stronger, more effective learning tool for teachers. Roth and Lee (2007) found that introducing teachers to CHAT influenced the way they thought about and designed learning activities. Potari (2013) explored how teachers learned by navigating between and bridging together two activity systems: the "activity system of research" and the "activity system of teaching" (p. 507).

Overall, by using a CHAT framework, these researchers were able to explore the complex, interconnected sociocultural factors, and activity systems that shaped teacher learning.

Conclusion

The acquisition of new knowledge is a complex, dynamically evolving process that is shaped by local classroom and school contexts as well as other sociocultural factors. As teachers build their identities as professionals within multiple contexts, they participate in the process of meaning making and weaving together the different types of knowledge that they use in their practice. To advance the field of knowledge, researchers need to use theoretical frameworks that will

allow them to approach knowledge acquisition as a comprehensive process that is influenced by multiple activity systems.

CHAT is one analytical tool that can be used for understanding how learning occurs (Stetsenko & Arievitch, 2004). According to Roth and Lee (2007), "Learning is equivalent to the mutual change of object and subject in the process of activity" (p. 198). As the subject shapes and influences the other elements in the activity system, the elements reciprocally transform the subject. The dialectical relationships between the subject, object, tool, community, rules, and division of labor provide rich grounds for understanding the process of learning in relation to change and development. Additionally, by designating the activity system as the unit of analysis, researchers can better understand how teachers acquire knowledge in relation to socially and culturally constructed actions mediated by online communities of practice (Jonassen & Rohrer-Murphy, 1999; Roth & Lee, 2007).

Overall, CHAT provides a comprehensive framework for analyzing teacher learning within the context of an online community of practice. Using a CHAT framework, researchers can explore how the acquisition and distribution of knowledge in an online community is influenced by actions, goals, history, context, and community norms and roles. Additionally, when teachers seek out shared knowledge in an online community of practice, they are often performing actions that are influenced by multiple overlapping communities and activity systems, such as their classrooms, schools, local communities, and the global online community. The CHAT framework allows researchers to explore how teachers navigate these

multiple activity systems in order to gain new knowledge and use their knowledge in the classroom.

Chapter III:

Methodology

In the previous chapter, I discussed how Cultural Historical Activity Theory (CHAT) (Cole & Engeström, 1993; Engeström, 1987; Leontiev, 1978; Vygotsky, 1978) provides a rich framework for examining the sociocultural factors that influence how teachers acquire knowledge in an online community of practice. This chapter describes how the literature on teacher learning, online communities of practice, and CHAT informed my data collection and analysis strategies.

Research Site

The number of online communities of practice for K-12 teachers has grown exponentially in the past five years. In order to find an online community of practice to study, I used Hur and Brush's (2009) criteria for identifying an online community of practice: namely that it serve mostly K-12 teachers, have more than 1,000 members, meet the criteria for a community of practice, have been active for more than a year, invite voluntary participation, be organized by community members (not by researcher or administrators), be web-based, and be capable of being researched. This narrowed my search to five popular online communities of practice: Twitter, Edmodo, Classroom 2.0, EdWeb, and The Educator's PLN.

Based on the findings from a study that I conducted about teacher help-seeking behaviors in online communities of practice (Trust, 2013), I selected Edmodo as the site to study for my dissertation. In my prior study, I examined how

participants used six popular online communities of practice (Edmodo, Classroom 2.0, Educator's PLN, Twitter, Diigo, Blogging) to seek help for overcoming challenges they faced in the classroom. I found that participants were significantly more likely to use Edmodo to seek help and acquire knowledge compared to the other online communities of practice. The participants preferred using Edmodo due to its user-friendly interface, similarity to Facebook, and increasing popularity.

Edmodo (http://www.edmodo.com) is a free social networking tool for teachers and students. On the Edmodo site, teachers can create class groups, join subject communities, and add colleagues to their networks. The majority of teachers join Edmodo to use the class group feature as a learning management system.

Edmodo also has 12 subject communities (e.g., Math, Science, Language Arts, Health and PE, Computer Technology) that provide a virtual space for teachers to connect with other educators and exchange subject-specific ideas, resources, and knowledge. I selected the Edmodo Math Subject Community (MSC) for this study based on the strong national focus on improving teacher education and professional development in the STEM (Science, Technology, Engineering, Math) fields.

Additionally, the membership in the MSC has been increasing exponentially in the past two years. I had been participating in the MSC since 2010 and watched the membership increase from 10,000 to more than 250,000 members. This is likely due to the fact that Edmodo is one of the most popular Learning Management Systems (LMS) for education (Capterra, 2012). Teachers who use Edmodo as a LMS, tend to find and join the various Edmodo subject communities to connect with and learn from other educators in their fields.

The MSC is open to anyone who is interested in sharing math resources, adding to the collective knowledge of the field of math, and connecting with other math educators and experts. The MSC provides a space for all members to ask questions, solicit feedback, and connect and collaborate with one another. The community *wall* (the news feed that all members see when they log in to the community) is populated frequently with new posts and replies from members (see Figure 3.1). In the MSC, members can complete the following actions:

- Read wall posts
- Respond to wall posts
- Post on the community wall
- Add resources to their Edmodo library
- Search for posts and members using the Edmodo site search engine
- Browse the Top Content section
- Add a community member as a "connection"

Although the MSC is a global community with members located in many different countries around the world, the significant majority of the members are located in the United States. Thus, even though I refer to this community as a "global activity system," the object-oriented actions of the members are heavily influenced by U.S. cultural norms, rules, and roles.

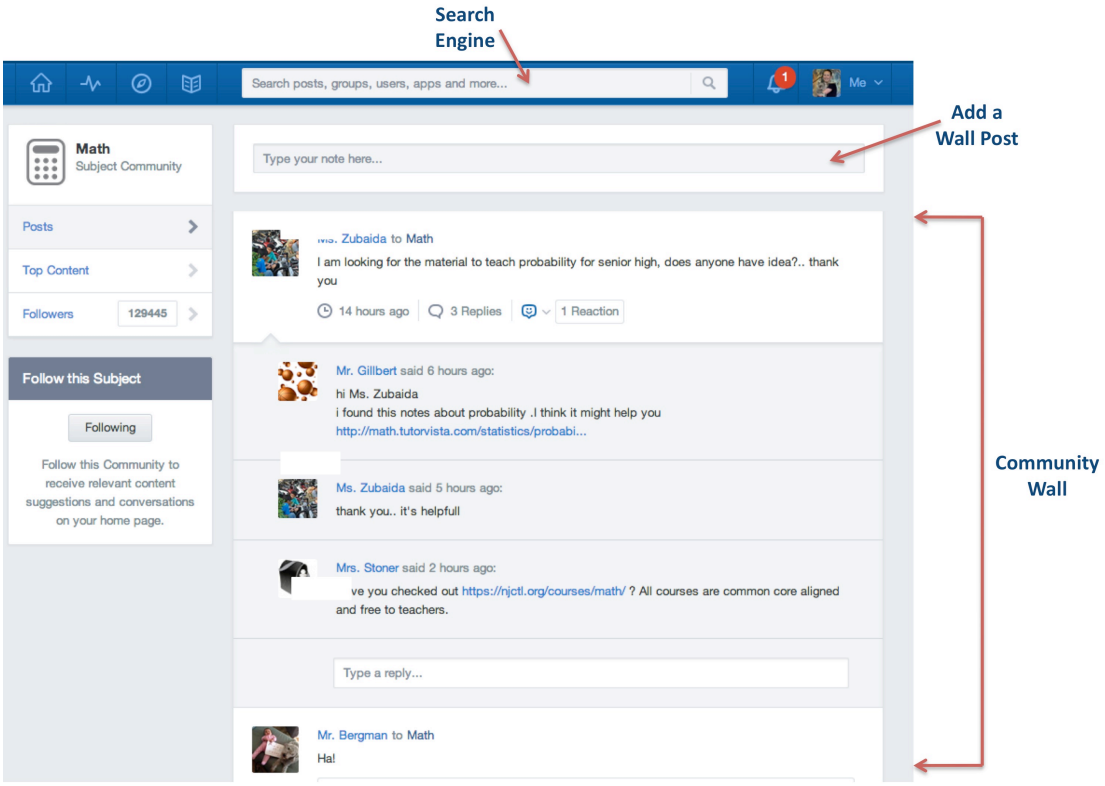

Figure 3.1. Edmodo Math Subject Community screenshot.

Methods

Using CHAT as a theoretical framework, I explored the goals, contexts, contradictions, transformations, and sociocultural factors that shaped how teachers acquired new knowledge from the MSC global activity system.

Research Questions

The following research questions guided my study of the Edmodo Math Subject Community:

1. What types of knowledge do teachers share in the Math Subject Community?

2. How is the process of acquiring knowledge shaped by the Math Subject Community global activity system?
3. How is the process of acquiring knowledge shaped by the teacher's local school activity system?
4. How do teachers navigate between their local school activity system and the Math Subject Community global activity system in order to acquire new knowledge?
5. What are the ensuing effects of participating in this process of knowledge acquisition?

Theoretical Framework

The data collection and analysis strategies were informed by the literature on CHAT. In order to capture the complexity of an activity system, CHAT researchers recommend using a qualitative methodology to collect multiple types of data and ensure that the subject's point of view was included in the study (Nardi, 1996; Jonassen & Rohrer-Murphy, 1999; DeVane & Squire, 2012). DeVane and Squire (2012) recommended that researchers use ethnographic data collection techniques in combination with the examination of important tools and historical artifacts in order to "understand the particulars of an activity system from multiple perspectives" (p. 250). Ethnographic data collection techniques provide insight about human actions within larger real-world contexts. By using ethnographic data collection techniques, such as interviewing and distributing open-ended surveys, I was able to co-construct

knowledge with the participants about the activity systems they navigated and the sociocultural factors that shaped their knowledge acquisition process.

Additionally, using the CHAT framework as a guide, I explored the meaningful patterns and latent themes across the data sets. I conducted a theoretical thematic analysis of the discussion threads, surveys, and interviews in order to explore the complexity of multiple activity systems. By conducting a theoretical thematic analysis of the data, I was able to synthesize a narrative of how teachers navigated between multiple activity systems to acquire and use new knowledge in their classrooms.

Data Collection Procedures

The data collection process occurred in three phases, with each phase informing the next. During the first phase, I collected discussion threads from the community wall to examine what types of knowledge were being shared in the MSC. The second phase involved the development and distribution of an online survey to examine how and why teachers participated in the MSC. In the third phase, I interviewed select survey respondents to gain a more in-depth understanding of the sociocultural factors that influenced how they navigated between their local school activity system and the MSC global activity system. The three data collection phases were designed to gather multiple data types that would provide increasingly more detail about teachers' goal-driven actions in two overlapping activity systems.

Phase I: Community wall discussion threads. In the first phase of the data collection process, I collected 600 discussion threads from the Math Subject

Community wall. A *discussion thread* includes both the initial post and all of the replies to the post (see Figure 3.2). The 600 posts had 1908 replies. In order to examine the changes in the activity system over time, I collected data between October 8, 2012 and May 20, 2013. During the data collection period, the membership in the MSC grew from 20,000 to 115,000 members.

Starting October 8, 2012, I used a random number generator (http://www.random.org/) to select a time of the day and day of the week to collect the 20 most recent discussion threads from the Math Subject community. The threads were selected randomly in order to be a representative sample of the community threads.

Since Edmodo does not have an archive of discussion threads, I was only able to collect data from the latest threads, which were either brand new posts or older posts that received a recent reply. Due to this limitation, it is likely that some of the threads that I collected may have received additional replies after I collected the data; and therefore, those replies were not included in this study.

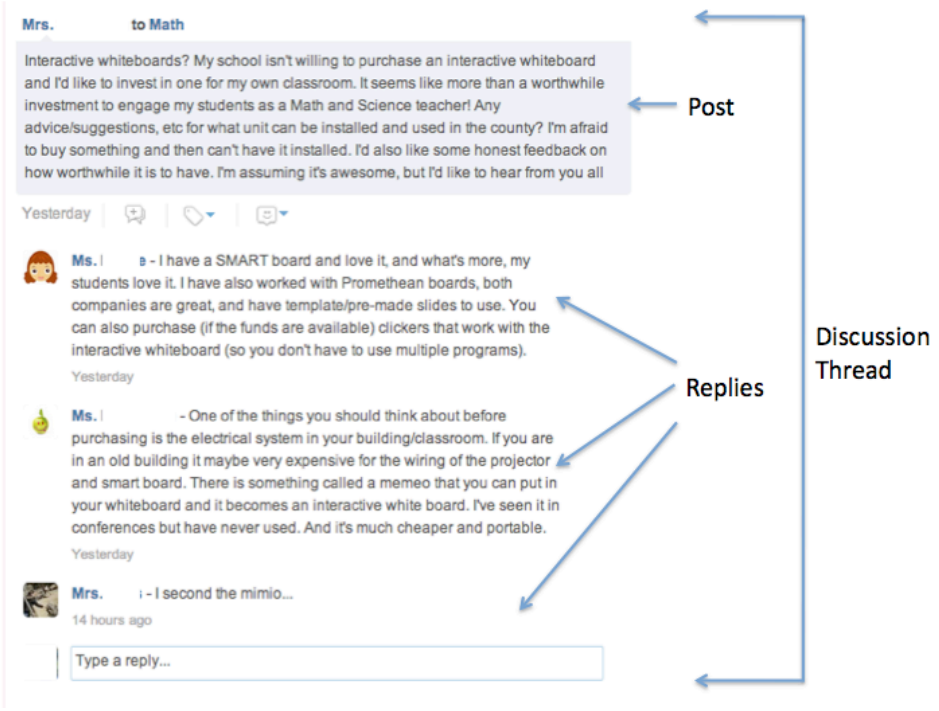

Figure 3.2. Edmodo Math Subject community wall discussion thread.

Phase II: Survey. For the second phase of the data collection process, I designed an online survey to learn more about the participants in the MSC (see Appendix B). I chose to do an online survey in order to gather data from a large number of participants. The survey had four parts: Demographics, Technology Use and Professional Development Opportunities, Edmodo Experience, and Classroom Implementation of Edmodo MSC Ideas and Resources.

In the first part of the survey, participants were asked to respond to questions regarding their teaching experience, age, and location. In the second section, participants were asked to describe the types and frequency of use of various technologies for classroom instruction as well as what type of local and online

professional development opportunities they engaged in. In the third section of the survey, the participants answered questions about their experience as a member of the MSC. The final section of the survey featured questions about how participants implemented shared knowledge from the MSC in their classroom and whether the participants believed that engaging in the process of acquiring knowledge in the MSC changed the way they learned or taught.

Pilot testing. I designed a pilot version of the survey using SurveyMonkey and tested it with the Edmodo Science Subject Community. I selected the Edmodo Science Subject Community because I did not want to reduce the response rate from the Math Subject Community members. I posted the pilot survey on the Edmodo Science Subject Community wall and asked members to fill out the survey and share feedback. I gave all survey respondents a free membership to a database of over 2,000 open educational resources that I designed for K-12 teachers (http://edutechdatabase.wikispaces.com). I received 18 responses on the pilot survey.

After examining the results from the pilot survey, I made a few changes to the survey. One of the questions was an open-ended response about the types of technologies that teachers used in their classroom. The majority of respondents shared that they used the same types of technologies: computers, tablets, interactive whiteboards, and document cameras. So, I changed this question from an open-ended question to a "check all that apply" question. I also included an option for "other," in case respondents used technologies that were not listed.

The pilot survey also featured a question that asked teachers how many times they had implemented an idea or resource from the Science Subject Community in

their classroom. The majority of the responses ranged between 1 and 20 with two respondents reporting numbers of 50 and 99+. I changed this question from an open-ended response to a multiple-choice question that gave teacher a range of options: 0, 1-5, 6-10, 11-20, 21 or more times. This change would allow teachers to respond faster by giving a general range rather than having to count the exact number of times they had implemented a shared idea or resource from the MSC in their classroom.

I also used the results from the content analysis of the data from Phase I to make additional changes to the final survey. I included a question about the types of teacher knowledge that participants shared in the community in order to triangulate the results with my analysis of the wall posts. I also noticed that some teachers posted about creating and joining Edmodo groups (e.g., Algebra Teacher Group, STEM Teacher Group), so I added a question in the Edmodo Experience section of the survey that asked participants to list the Edmodo groups they had joined. And, finally, in order to test a hypothesis that surfaced after conducting the content analysis of the wall posts, I added a question that asked participants to share whether they were more likely to visit the MSC to find new ideas and resources or to connect with other members.

***Survey distribution*.** When the final draft of the survey was complete, I shared a link to the survey, as well as the information about the free membership to the K-12 Tech Tools database, on the Edmodo Math Subject Community wall on June 26, 2013 at 6 p.m. Between June 26, 2013 and August 10, 2013, I shared the survey on the MSC wall 8 times. Each time the survey was posted, it received an

additional 5-15 responses. I used a random number generator to select the day of the week and time of the day to post the survey in the MSC in order to solicit responses from a broader international audience. Overall, 150 MSC members completed the survey.

Phase III: Interview. In the third phase of the data collection process, I conducted semi-structured interviews with 10 survey respondents to explore the various sociocultural factors that shaped how teachers gained new knowledge from the MSC and used that knowledge in their classroom. The interviews also provided an opportunity to explore the unit of analysis (the activity system) from the subject's perspective. I chose to do interviews because of the ability to ask follow-up questions and to get richer, more in-depth responses from participants.

Interview guide. I developed an interview guide in order to conduct the interviews in a systematic, yet flexible, way (Patton, 2002). I wanted to ensure that all participants would be asked the same general questions and I wanted to make sure that the interview time was used efficiently. However, I made sure to set aside extra time during the interviews to ask follow-up and probing questions that were not included on the interview guide. The interview guide included seven key topics with 3-5 main questions per topic (see Appendix C). The topics were:

1. Information & Resources
2. Navigating the Online Community
3. Finding Information & Resources
4. Selecting and Adapting Information & Resources
5. Using and Evaluating Information & Resources

6. Bridging the School and Online Community
7. Participating in the Process of Finding and Using Information & Resources

The topics were ordered in a way that would allow participants to describe their actions from the time they entered the MSC to find knowledge to the time they implemented the new knowledge in their classrooms. I also included two additional topics to examine the participants' beliefs about how engaging in this process of knowledge acquisition in the MSC influenced the way they learned, taught, and shared knowledge with their local school communities.

The interview questions were designed to explore the multiple elements within an activity system: subject, object, tool, community, rules, and division of labor. Participants were asked to describe these elements for their local school activity system as well as the MSC global activity system. They were also asked to share any insight they had about how they navigated between these two activity systems.

I added extra questions to the interview guide based on my findings from the content analysis of the wall posts and the survey data. I noticed that many of the wall posts did not include descriptive content or focus on a specific math topic, so I asked the interview participants to share their thoughts about these findings. Additionally, based on a hypothesis that the MSC was more like a social search engine than a community, I included questions prompting the participants to explore this idea. I also asked follow-up questions related to the participants' survey responses.

Pilot testing. I pilot tested the interview with two individuals who had completed the Science Subject Community pilot survey. These individuals received

a $20 Amazon.com gift card for participating in the interview. After conducting the pilot tests, I found that the interview guide needed to include more specific probing questions about the etiquette and rules of the MSC and the local school activity system factors that influenced the participants' decision-making processes. I also discovered that some of the questions (e.g., "Do your actions in the community depend on your goals?") were too confusing, so I rewrote the questions and made them more specific (e.g., "If you are looking for a specific resource, what actions do you perform in the community?").

Selecting participants. To select interview participants, I used the survey results to identify teachers who fit the criteria for a "purposeful sample" (Lindlof & Taylor, 2011, p. 109). Specifically, I looked for teachers who fit the following criteria:

- Located in the United States,
- Visited the Edmodo MSC at least once a month during the previous school year, and
- Implemented at least one new idea or resource from the Edmodo MSC in their classroom.

I developed these criteria to filter out the respondents who were new to Edmodo or who would not be able to fully answer the interview questions about how they had found, select, and implemented new knowledge from the MSC in their classroom. Additionally, because local school contexts can vary greatly worldwide and my knowledge of international education was limited, I chose to interview only

participants from the United States. Only 67 of the 150 survey respondents fit these criteria.

Interviewing the participants. I followed up with these 67 respondents via email to see if they would be willing to participate in an interview. Ten of the respondents opted to be interviewed. These individuals were given $20 Amazon.com gift cards for participating. I shared the interview guide with the participants ahead of time in order to give them the opportunity to reflect on the questions.

The interviews were conducted between July 1, 2013 and August 05, 2013. Depending on the participant's preference, the interviews were conducted via phone (6 interviews), Skype (1 interview), Facebook Video Chat (1 interview), and Google Hangouts (2 Interviews). The interviews lasted between 60 and 90 minutes. The interviews were audio recorded for transcription purposes. At the end of each interview, I shared a summary of the individual's responses and asked the individual to confirm the validity of the summary. I also provided each participant with an opportunity to make changes to their statements. The majority of the participants did not request to have any changes made. Two of the participants shared additional comments that they thought might be helpful for this study.

Participants

Survey participants. A total of 150 participants filled out the online survey. The majority of the participants (89%) were located in the United States. There were also participants from the following countries: Canada (5), Australia (3), India (2), Philippines (1), Argentina (1), Italy (1), Mexico, (1), United Kingdom (1), and

Singapore (1). The participants ranged in age from 23-years-old to 65-years-old, with an average age of 42. The majority of participants were female (88%). The number of years spent teaching ranged from 0 (brand new teachers) to 38, with an average of 13 years. The grade level of the teachers ranged from Kindergarten to 12th grade. Out of the 150 respondents, 43% of the participants were elementary (K-5) teachers, 37% of the participants were middle school (6-8) teachers, and 20% of the participants were high school (9-12) teachers. All of the participants were math teachers; however, some of the participants also taught other subjects (e.g., Science, Personal Finance, AVID, Computer Science, Technology, Elementary Multiple Subjects).

Technology experience. The survey participants reported that they were avid users of technology for classroom instruction. The majority of the participants (96%) reported using technology in their classroom at least once a week, with 85% of the respondents using technology for classroom instruction on a daily basis. The most common type of technologies used for classroom instruction were computers (92%), interactive whiteboards (70%), and document cameras (57%) (see Figure 3.3).

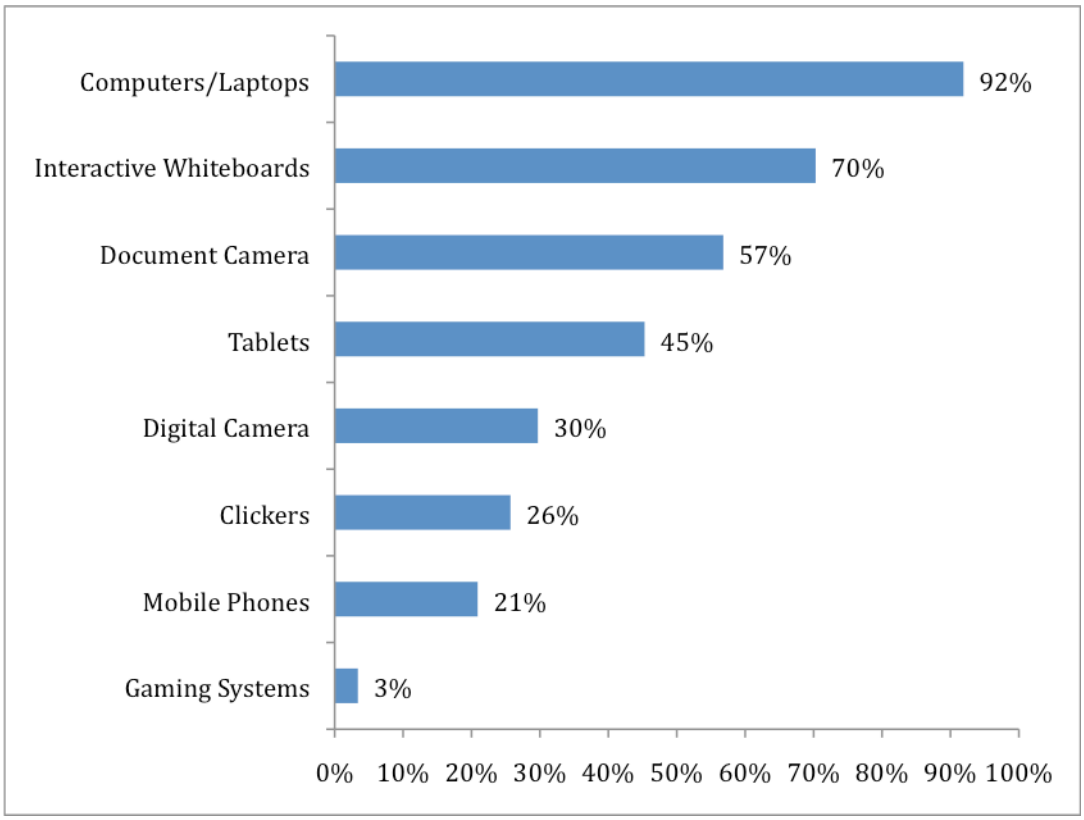

Figure 3.3. Survey participants' reported use of technologies for classroom instruction.

Professional development communities. Participants were asked to list the professional, online, or local communities in which they participated. Most of the survey respondents (85%) reported participating in some form of professional community other than the Edmodo MSC. Approximately one-half of the respondents participated in other online communities, such as Twitter (28%), Facebook (21%), Pinterest (6%), and Diigo (5%). A little more than one-third of the respondents participated in professional organizations, such as the National Council of Teachers of Mathematics (NCTM), and 30% of the respondents participated in school or district professional learning communities. Additionally, 50% of the participants

reported that they were members of one or more Edmodo groups for professional development (e.g., CCSS Resources, Math Teachers, Algebra Teachers).

Edmodo experience. The majority of the survey participants (56%) joined Edmodo in 2013. This was representative of the exponential growth of MSC as increasingly more teachers became aware of this tool for professional growth. Approximately, 25% of the participants were brand new to the community and many of these respondents mentioned that they joined the MSC to acquire knowledge that would help them prepare for the 2013-2014 school year. The remaining 75% of the participants had visited Edmodo at least once during the previous school year. Out of the 112 teachers who had visited the MSC at least once during the previous school year, 79% had implemented an idea or resource from the MSC in their classroom.

In summary, the survey participants were mostly located in the United States, used technology for classroom instruction on a daily or weekly basis, participated in other professional development communities, and were relatively new to the MSC.

Interview participants. Ten survey respondents participated in a 60-to-90 minute interview. All of the interview participants were located in the United States. Seven of the participants were middle school teachers (grades 6-8) and the other three participants taught at elementary schools (grades K-5) (see Table 3.1). Eight of the participants were female and two were male. The number of years spent teaching ranged from 10 to 26, with an average of 16.5 years. The majority of the participants joined the Edmodo MSC before 2013. The average age of the participants was 43-years-old.

Compared to the population of survey respondents, the interview participants used technology for classroom instruction more frequently and they were more likely to participate in other online communities for professional development. All ten of the participants used technology in their classrooms on a daily basis. Additionally, 7 out of the 10 participants were engaged in other online communities for professional development.

Table 3.1

Demographics of Interview Participants

Pseudonym	State	Age	# Years Teaching	Grade Level	Subjects Taught	Year Joined Edmodo
Alex	IL	46	21	6-8	Algebra, Geometry, Advanced Math	2010
Andrea	MI	37	13	6-7	Math, Language Arts	2012
Cecilia	CA	46	12	7	Math Common Core	2012
Christine	GA	35	10	8	Algebra, Social Studies, Avid	2011
Grace	IA	46	11	5-6	Math, Reading, Language Arts	2013
James	TX	42	18	4	Math, Science	2010
Megan	TN	46	26	8	Algebra	2011
Mia	GA	43	13	8	8th Grade Math	2012
Rachel	TX	49	17	7	7th Grade Math	2012
Sarah	AL	46	24	3-5	Advanced Topics Elementary	2012

The interview participants also visited the MSC more frequently and implemented new ideas and resources from the MSC in their classroom more often than the survey participants. All of the participants visited the MSC at least once a month during the previous school year, with 4 participants reporting that they visited the MSC every day. While all of the participants had implemented at least one idea

or resource from the MSC in their classroom, the majority of the participants (70%) reported that they had implemented six or more ideas or resources from the MSC in their classrooms during the previous school year. The differences in Edmodo experience between survey and interview participants can be explained in part by the selection criteria, since I selected interview participants who had visited the MSC at least once a month during the school year and had implemented at least one or more ideas or resources from the MSC in their classroom.

Overall, the interview participants shared many of the same characteristics of the survey population, such as number of years taught, grade level, average age, and gender. However, they were more likely to use technology for classroom instruction on a daily basis and more likely to visit the MSC throughout the school year compared to the survey participants.

Data Analysis Procedures

Looking at the analysis procedures in the literature on online communities of practice, a common strategy that researchers had employed was to conduct a content analysis of the community data and triangulate the results with surveys or interviews of participants (Carr & Chambers, 2006; Forte, Humphreys, & Park, 2012; Hew & Hara, 2007, Hur & Brush, 2009; Lin, Lin, & Huang, 2008). This strategy enabled researchers to examine the richness of an online community through multiple data sources. I adapted this strategy by incorporating a theoretical thematic analysis of the surveys and interviews in order to explore the complexity of multiple activity systems.

Content analysis of the discussion threads. I began exploring the MSC global activity system by conducting a directed content analysis (Hsieh & Shannon, 2005) of the 600 discussion threads that I had collected from the MSC wall. The unit of analysis was the discussion thread, which included both the original post by a member and all of the replies to the post (see Figure 3.3).

I used the literature on teacher learning and online communities of practice to inform the selection of categories for coding the data. I started by categorizing the types of initial posts and replies. After reading all of the discussion threads, I selected codes from the literature on online communities of practice that were the most relevant for classifying the posts and replies. I then used Shulman's (1986, 1987) list of teacher knowledge types and the Common Core State Standards Math Domains (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) to categorize the topics of discussion within each of the posts.

Types of initial posts. Forte, Humphreys, and Park (2012) and Hew and Hara (2007) found that the majority of posts in the online communities of practice they examined were either knowledge sharing or requests for action. Knowledge sharing posts were ones in which members uploaded a document (e.g., lesson plan, behavior tracker, rubric) or posted a link to an online resource (e.g., http://illuminations.nctm.org/) or video. A request for action was when a member asked for help, feedback, ideas, resources, or information (Hew & Hara, 2007). I used these two categories to label the posts from the Edmodo Math Subject Community.

Types of replies. The 600 posts had 1908 replies. I used Forte, Humphreys, and Park's (2012) codebook (p. 4) and Hew and Hara's (2007) list of activities (p. 580) to label the type of replies: idea, resource, advice, feedback, gratitude, compliment, empathy, clarification, comment, and networking. However, not all of the replies fit within Forte, Humphreys, and Park's (2012) or Hew and Hara's (2007) labels, so I created three additional labels: follow-up reply, follow-up question, and solution. Follow-up replies were ones in which members replied to a reply. This type of reply often occurred in wall posts that had back-and-forth conversations among members. Follow-up questions were written by members who wanted additional information regarding the topic of the post. Solutions were replies in which members provided the answer to a post that featured a mathematical problem.

After labeling all 1908 replies, I sorted the 13 labels into 5 broader categories: Knowledge Sharing, Appreciation, Responding to Others, Connecting with Others, and Questioning. The Knowledge Sharing category consisted of replies in which members shared their expertise and resources. This category included 5 sub-categories: ideas, resources, advice, feedback, and solution. The Appreciation category featured replies in which members shared their thanks or complimented another member's idea, resource, or advice. The Responding to Others category referred to more general replies in which members replied to a reply (follow-up reply) or shared a general comment. Connecting with Others replies were ones in which members shared empathy or networked and exchanged contact information. Questioning replies were ones in which members asked a follow-up question to a reply or asked a clarification question about a post.

Types of shared knowledge. I also examined what types of knowledge were shared in the MSC in relation to teacher knowledge and math content domains. I classified the types of initial posts using Shulman's (1986, 1987) list of seven teacher knowledge types: Content, Pedagogical, Pedagogical Content Knowledge (PCK), Curricular, Learners, Educational Context, and Educational Aims. During the first iteration of coding the data, I realized that the majority of the posts fit within the Curricular Knowledge type, so I developed the following four sub-categories to further classify the types of Curricular Knowledge: classroom technology, online resources, general resources, and materials.

I also used the Common Core State Standards Math Domains (2010) for K-8 (e.g., fractions, operations, number sense) and High School Math Subjects (e.g., Algebra 1, Geometry, Calculus) to categorize the types of math topics that were discussed in each of the posts.

Coding. I copied the 600 discussion threads into an Excel spreadsheet in order to code the data. I completed three iterations of data coding. The coding categories were selected and refined during the first two iterations. A codebook (see Appendix D) was developed to organize the codes. The codebook included descriptions of the codes and as well as examples. During these two iterations, I frequently reviewed Shulman's (1986, 1987) description of teacher knowledge types to differentiate between Content Knowledge, PCK, and Curricular Knowledge initial posts. Based on my interpretation of these three knowledge types, I decided that Content Knowledge posts featured specific content-related questions, while PCK posts were ones in which members shared activities, ideas, and lessons for teaching

the content, and Curricular Knowledge were posts in which members shared actual resources (e.g., online websites, uploaded documents) for teaching the content. I also struggled with differentiating between ideas, feedback, advice, and resources when coding the types of replies. I reviewed Forte, Humphreys, and Park's (2012) codebook (p. 4) and Hew and Hara's (2007) list of activities (p. 580) to clarify the differences between these four codes. I then conducted a third and final iteration of coding to ensure that the codes had been categorized correctly.

I used the results from the content analysis to answer the first research question: "What types of knowledge do teachers share in the Math Subject Community?"

Theoretical thematic analysis. Once the data collection for the surveys and interviews was complete, I transcribed the audio recordings of the 10 interviews and copied the transcripts into an Excel spreadsheet. I also copied the open-ended questions from the SurveyMonkey survey into the Excel spreadsheet.

I conducted a theoretical thematic analysis (Braun & Clarke, 2006) of all three data sets: 600 discussion threads, 150 surveys, and 10 interviews. I chose to do a theoretical thematic analysis in order to have the flexibility of exploring meaningful patterns and latent themes across multiple data sets (Braun & Clarke, 2006). I used the CHAT framework to guide my exploration of the patterns within the data. The unit of analysis was the activity system. I started by examining the different CHAT elements within the participants' local school activity systems and the global online MSC activity system: subject, tools, rules, community, division of labor, object, and outcome (Engeström, 1987; Cole & Engeström, 1993). I created

two sets of codes with labels for each of the two activity systems I was examining (e.g., subject-local; subject-global; tools-local; tools-global). I also looked for patterns of underlying constructs that shaped the activity systems. This led me to select two additional codes from the CHAT framework: contradictions and transformations.

I completed two iterations of data coding. During the first iteration of coding, I developed a codebook (see Appendix D) to organize the codes. The codebook included descriptions of the codes and as well as examples. During the second iteration of coding, I reviewed the codes to ensure that they had been categorized correctly. After coding the data, I explored the relationships between the codes and used the results to answer the final four research questions.

Ethical Considerations

For this study, I followed all of the Human Subjects procedures to protect the rights and anonymity of the participants and to ensure that the risks for participating in the study were minimal. I completed the Human Subjects Approval process with the Office of Research at the University of California, Santa Barbara. All of the participants volunteered to participate in the study. The participants gave their informed consent, via the survey, so that I could use their data in this study. The content of the MSC discussion threads, as well as the open-ended survey responses and interview data, were stripped of any identifying information. Interview participants were given pseudonyms. Participants were allowed to opt out of the study at anytime and to request that their data not be used in this study.

Positionality of the Researcher

The researcher in a qualitative study is often inseparable from the research (Lincoln & Guba, 1985). It is important to acknowledge the role of the researcher in a qualitative study in order to understand how the researcher may influence the results of the study. As an individual who has worked in a public school setting and participated in the Edmodo MSC, I found it easier to build trusting relationships with the interview participants. At the beginning of each interview, when I was establishing rapport with the interview participants, many of them asked me about my teaching experience. I shared that I had worked as an Instructional Aide in an elementary school and that I came from an entire family of teachers. This seemed to put many of the interview participants at ease. However, even though I had some background knowledge of working in schools and participating in the MSC, I made sure to ask probe questions when members provided general responses because they assumed that I knew what they were talking about.

When examining my own researcher bias, I found that my experience as an Edmodo MSC participant had influenced my perception of the MSC as a beneficial tool for teachers. When I first came across Edmodo in 2010, I joined four of the subject communities: Math, Science, Language Arts, and Computer Technology. I found the Math Subject Community to be the most interesting in terms of discussions that were taking place on the community wall and for the exponential growth of membership. I had been a participant observer in the MSC for almost three years. As a participant in the community, I posted on the community wall, responded to other member's posts, and searched for posts and members. However, I did not

visit the MSC on a regular basis. I only visited when I needed to find new information or resources, wanted to connect with other members, or wanted to share a resource.

Throughout my dissertation research study, I have been mindful of my bias towards the benefits of the MSC and I have asked the participants to share their perceptions of the flaws of the MSC. I have endeavored to keep my mind open to the problems and limitations of the MSC. In order to balance my researcher bias, I shared my interpretations of the results with the interview participants and asked them to share whether they thought the interpretations were accurate. This member checking process allowed me to make sure that my biases had not significantly influenced my interpretation of the data.

Limitations

Teacher Self-Reports

One main limitation of my data collection methods was the teacher self-reports of their actions in the MSC and their classrooms. A CHAT analysis requires the researcher to be fully situated in the activity system in order to understand its complexity. However, since the teachers that I surveyed and interviews were located all around the world, I was unable to observe teachers in their local classroom settings.

Yet, studies have shown that teacher self-reports can be just as reliable as classroom observations. According to Desimone (2009), when teachers report on their specific actions, surveys and interviews have been highly correlated with

classroom observations. Additionally, observers who don't understand the situational influences of the classroom are likely to collect less accurate data compared to the self-report of a teacher who fully understands all of the competing priorities and challenges that occur in a classroom (Kennedy, 2010). Therefore, I believe that the use of teacher self-reports does not reduce the credibility of the findings of this study.

One important thing to note when using self-report data is that teachers' reports about behavior changes are often not as accurate as their beliefs about behavior changes (Desimone, 2009). Based on these findings, I adapted my survey and interview questions to focus on teachers' beliefs rather than having them describe their actual changes in behavior.

Sampling

This study was limited by voluntary response and nonresponse bias since the survey data was not collected randomly. Without access to the Edmodo MSC members' email accounts, I was unable to randomly select members to participate in the survey. The only way to receive survey responses from MSC members was to post the survey to the community wall. The research participants volunteered to be in the study and were given incentives for completing the survey and participating in an interview. Thus, the sample consisted of participants who were motivated by incentives and wanted to share their MSC experiences. Therefore, the sampling procedures were influenced by voluntary response bias and nonresponse bias.

Due to the fact that the sampling procedures were not random, the results may not accurately represent the population. Additionally, while I was able to receive 150 survey responses, only 10 of the survey respondents who fit the sampling criteria were willing to participate in an interview. It is highly unlikely that this small sample is representative of the population of MSC members.

However, the goal of this study was not to generalize the results to the entire population of K-12 math teachers or to other online teacher communities. The purpose of this study was to explore teachers' actions as they navigated multiple activity systems. Thus, even though the sampling procedures were limited by response bias, the survey and interview results still provided useful data for understanding how human action could be shaped by various sociocultural factors within multiple activity systems.

CHAPTER IV:

THE GLOBAL ACTIVITY SYSTEM

In the previous chapter, I described how the literature on teacher learning, online communities of practice, and CHAT informed my data collection and analysis strategies. In this chapter, I will detail my data collection processes, analyses, and findings for the first two research questions:

RQ1: What types of knowledge do teachers share in the Math Subject Community?

RQ2: How is the process of acquiring knowledge shaped by the Math Subject Community global activity system?

Using a Cultural Historical Activity Theory (CHAT) (Cole & Engeström, 1993; Engeström, 1987; Leontiev, 1978; Vygotsky, 1978) perspective, I examined the MSC as a *global activity system* that provides a virtual space for teachers to connect and exchange knowledge with educators around the world. In order to address the first research question, I conducted a content analysis of 600 discussion threads to analyze what types of teacher knowledge and math topics were being discussed in the MSC. For the second research question, I conducted a theoretical thematic analysis of all three data sets to examine the participants' process of knowledge acquisition and how this process was shaped by the MSC global activity system.

RQ1: What Types of Knowledge do Teachers Share in the Math Subject Community?

In order to examine what types of knowledge teachers shared in the Edmodo MSC, I conducted a directed content analysis (Hsieh & Shannon, 2005) of 600 discussion threads from the community wall. The unit of analysis was the discussion thread, which included the initial post and all of the replies to the post. The 600 posts had 1908 replies.

I completed three iterations of data coding. The coding categories were selected and refined during the first two iterations. A codebook (see Appendix D) was developed to organize the codes. The codebook included descriptions of the codes and as well as examples. I conducted a third iteration of coding to ensure that the codes had been categorized correctly. I used the interview and survey results to assess the reliability of the findings from the content analysis.

Types of Initial Posts

I started by categorizing the types of initial posts and replies. After reading all of the discussion threads, I selected codes from the literature on online communities of practice that were the most relevant for classifying the posts and replies. Forte, Humphreys, and Park (2012) and Hew and Hara (2007) found that the majority of posts in the online communities of practice they examined were either knowledge sharing or requests for action. Knowledge sharing posts were ones in which members uploaded a document (e.g., lesson plan, behavior tracker, rubric) or posted a link to an online resource (e.g., http://illuminations.nctm.org/). A request for

action was when a member asked for help, feedback, ideas, resources, or information. I used these two categories to label the posts from the Edmodo MSC.

Upon examination of the posts, I discovered that the posts were almost evenly split between requests for action (53%) and knowledge sharing (46.5%) (see Table 4.1). The three posts that did not fit the description of these categories were labeled as "comments." Two of the posts categorized as a "comment" were member introductions and the third post was a comment from a member who was expressing frustration that the MSC posts were only in English.

Table 4.1

Frequency and Types of Initial Posts in the Math Subject Community

Posts	Freq.	Percent	Example
Request for Action	318	53.0%	"I have a student that always finishes his work in 15 minutes while the rest of the class takes 40 minutes to complete. I would like to do some enrichment with this student but not sure how to go about it…I feel that I am not challenging him enough. I would appreciate any advice, help, ideas that anyone has to offer as to how I can go about helping this student....Thanks!"
Knowledge Sharing	279	46.5%	"This is a great site for giving your students some cool, challenging puzzles. I use them to keep my higher level students engaged and they are a lot of fun!"
Comment	3	0.5%	"Just joined. Just got here. Hi all 31,454 followers (please don't say hi back). I teach 5th grade math in WA state. Looks like some great resources people have shared. I'll have to pay it forward and figure out something to share."
Total	600		

Knowledge sharing posts. There were three types of knowledge sharing posts: uploading a document, linking to a website, and linking to a video. Out of the 279 knowledge sharing posts, 181 (65%) were links to websites, 65 (23%) were uploaded documents, and 33 (12%) were links to videos. Based on these findings, the most common type of shared knowledge post was a link to an external website.

Knowledge sharing posts with embedded links or resources had click counters (see Figure 4.1) that tracked the number of times the link or resource had been viewed by members. When examining the click counter for the wall posts, I found that the knowledge sharing posts had a range of 0 to 719 views. On average, approximately 90 members clicked on each shared resource. Thus, MSC members were actively clicking on the videos, websites, and uploaded documents that were shared on the community wall.

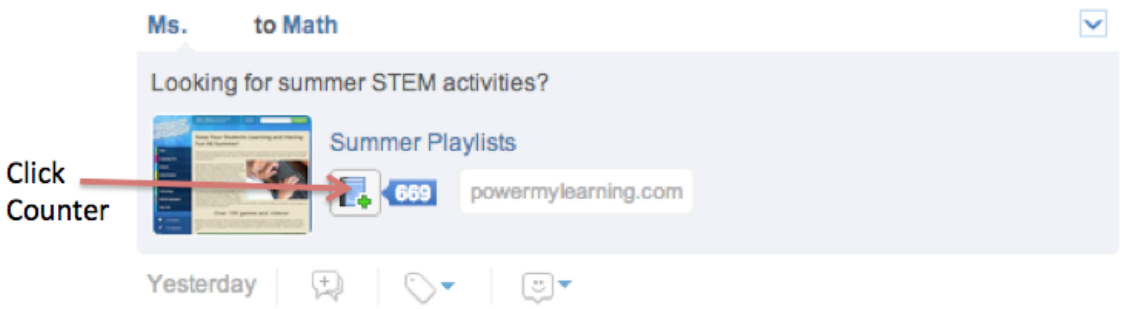

Figure 4.1. Edmodo MSC click counter.

Types of Replies

The 600 posts had 1908 replies. The number of replies per post ranged from 0 to 39. For posts that received replies, the average number of replies was 4.9. I used Forte, Humphreys, and Park's (2012) codebook and Hew and Hara's (2007) list of

activities to label the type of replies in several categories: idea, resource, advice, feedback, gratitude, compliment, empathy, clarification, and networking. However, not all of the replies fit within Forte, Humphreys, and Park's (2012) or Hew and Hara's (2007) labels, so I created three additional labels: follow-up reply, follow-up question, and solution. I sorted the 13 labels into the following categories: Knowledge Sharing, Appreciation, Responding to Others, Connecting with Others, and Questioning.

The Knowledge Sharing category consisted of replies in which members shared their expertise and resources. The Knowledge Sharing *replies* were most often associated with the Request for Action *posts*. A little over half of the replies (52%) fit within this category (see Table 4.2). This category included the following labels: ideas, resources, advice, feedback, and solution. Idea replies were ones in which members shared activities and projects, teaching strategies, and ideas about resources (without linking to or uploading the actual resource). Resource replies featured uploaded documents or links to online resources. Advice replies were suggestions and recommendations based on personal experiences. Feedback replies were responses to posts that asked for members' feedback about resources, activities, and curriculum materials. Solution replies were the answers to content-specific math questions.

Appreciation (20%) and Responding to Others (19%) were the next largest categories. The Appreciation category featured replies in which members shared their thanks or complimented another member's idea, resource, or advice. The Appreciation *replies* were most often associated with the Knowledge Sharing *posts*.

The Responding to Others category referred to more general replies in which members replied to a reply (follow-up reply) or shared a general comment.

Table 4.2

Frequency and Types of Replies in the Math Subject Community

Replies	Freq.	Percent	Example
Knowledge Sharing	984	52%	"What about a painting job for the pyramids of Giza? Or the Leaning Tower? They research and figure out how much paint is needed for a coat for one square foot then have to research the dimensions for famous landmarks…Just an idea."
Appreciation	381	20%	"Thank you, thank you, thank you!! I was trying to figure out what I was going to do with my classes between their semester finals and the days before winter break. NOW I know!!"
Responding to Others	354	19%	"I am also interested in sharing about Singapore Math. We are in our first year of implementation of the 'Math in Focus' series."
Questioning	145	8%	"Can you clarify your question regarding how the state will handle testing of students..."
Connecting with Others	44	2%	"Profe de Mates Española al habla :) Doy 5º y 6º de Primaria...Si alguien da los mismos niveles que yo estaría muy interesada en compartir material y posibles clases "globales"...Hablamos!!!" [Translation: "Hi, this is Spanish Math Teacher speaking. I teach fifth and sixth grades... If anyone teaches the same grades as me, I would be very interested in sharing material and possible 'global' classes. Let's talk!"]
Total	1908		

The final two categories (Questioning and Connecting with Others) made up approximately 10% of the total replies. Connecting with Others replies were ones in which members shared empathy or networked and exchanged contact information. Questioning replies were ones in which members asked a follow-up question to a reply or asked a clarification question about a post.

Overall, members' actions in the MSC seemed to revolve around sharing and requesting new knowledge. The MSC had 318 requests for action posts, 279 knowledge sharing posts, and 984 knowledge sharing replies. According to Hew and Hara (2007), an active online community has twice as many knowledge sharing posts and replies compared to requests for action. The MSC had almost four times as many knowledge sharing posts and replies as requests for actions. Therefore, the MSC can be considered an active knowledge sharing community.

Teacher Knowledge

To explore what types of teacher knowledge were being discussed in the MSC, I used Shulman's (1987) list of seven teacher knowledge types (Content, Pedagogical, Pedagogical Content Knowledge, Curricular, Learners, Educational Context, Educational Aims) to categorize the 600 wall posts. After coding the posts, I found that the majority of the posts fit within two categories: Curricular Knowledge (61%) and Pedagogical Content Knowledge [PCK] (25%) (see Table 4.3). The Curricular Knowledge posts consisted of links to online resources (66%), discussions about general resources or classroom technologies (23%), or links to uploaded

documents (11%). The PCK posts featured ideas, lessons, and activities for teaching math.

Table 4.3

Types of Teacher Knowledge Posts in the Math Subject Community

Posts	Freq.	Percent	Example
Curricular	368	61%	"Any pre-made resources on rotations/reflections/translations in the coordinate plane for middle schoolers?"
PCK	147	25%	"Does anyone have any good lessons on finding the surface area of rectangular prisms? Hands on activities?"
Context	37	6%	"My school is re-doing our schedule for next year…I was surprised that my math periods are only 40 minutes…I am curious...What do you think is an acceptable amount of time for a math class at the middle school level?"
Pedagogy	29	5%	"Does anyone have any quick summary strategies I could use in my class? Think pair share is starting to bore students."
Content	14	2%	"I have a question regarding how to properly read the following: 2.04% Would it be read two and four-hundredths percent OR two point zero four percent? Opinions?"
Aims	4	1%	"High-stakes testing will dominate classrooms throughout NY state this week…Education is suffering because of this! Take a moment to view this video and remember what teaching TRULY is!!!"
Learners	1	1%	"I have a mathematically gifted student this year in my fifth grade class…Since the beginning of the school year in September he has mastered the Common Core curriculum for fifth and sixth grade! So, I'm asking this amazing community to help me decide where to go next…What do you suggest?"

The findings indicated that the Edmodo MSC was an active online community in which teachers exchanged subject-related resources and ideas. Specifically, teachers were looking for and sharing online resources (Curricular Knowledge) and lesson plans, activities, and project ideas (PCK). The MSC did not seem to be a popular place for sharing knowledge related to math content, pedagogical strategies, or educational aims and policies. It is possible that teachers may prefer to look for and share this type of knowledge with their local school community or colleagues, rather than in a global online community.

In order to test the reliability of these findings, I included a question in the survey to ask teachers what type of knowledge they sought out and shared in the MSC. Almost all of the participants (98%) responded that they visit the community to find and share PCK. Additionally, the majority of the survey participants (88%) reported that they search for and share Curricular Knowledge. Less than half of the participants visited the MSC to find pedagogical or content knowledge. These findings support the results from the directed content analysis of the wall posts.

In summary, the MSC seemed to be a virtual platform for the distribution and acquisition of ideas, activities, and resources for teaching math.

Math Topics

I analyzed the 600 wall posts to explore what types of math topics were being discussed in the MSC. Only 251 (42%) of the 600 posts featured specific math topics. I used the Common Core State Standards Math Domains (2010) for K-8 (e.g., fractions, operations, number sense) and High School Math Subjects (e.g., Algebra

1, Geometry, Calculus) to categorize the types of math topics that were discussed in each of these posts (see Tables 4.4 and 4.5). Overall, teachers posted most frequently about Algebra (23%), K-8 operations (19%), and K-8 geometry (14%). More than half of the posts (62%) were geared toward K-8 grade math.

In order to understand why operations, geometry, and Algebra were popular topics, I shared the results from the math topic analysis with the interview participants and asked them to share their thoughts. Five of the participants believed that topics which were complex, hard to teach, and hard for students to learn, were more commonly discussed than less complex, lower-order knowledge.

Three interview participants described how topics such as fractions and algebra are addressed in multiple grades, and therefore, may be relevant to a wider audience. Additionally, three of the participants felt that curriculum, standards, and school requirements played a role in shaping what knowledge teachers shared in the MSC. For example, Sarah, a math teacher and curriculum developer, felt that these topics were popular because the Common Core State Standards encouraged teachers to provide more in-depth coverage of these topics. Andrea shared how she sought out specific math knowledge in the MSC because her administrator required the math teachers to focus on that topic in order to improve student test scores.

Overall, the interview participants did not agree on one main reason that would explain why certain math topics were more frequently discussed than others in the MSC. A more in-depth exploration of the math topics in the MSC, which was beyond the scope of this study, would be helpful for understanding how and why teachers shared specific math knowledge.

Table 4.4

Types of K-8 Math Topic Posts in the Math Subject Community

Content	Freq.	Percent	Example
Operations	47	19%	"I am looking for good resources to help my 3rd graders with multiplication and division facts, patterns, and problem solving/story problems (including multi-step). Any suggestions?"
Geometry	35	14%	"I am teaching third grade. Does anyone have any great ideas/quizzes/ workshops for different types of triangles and angles?"
Fractions	22	9%	"I am looking for help with fractions focusing on addition and subtraction with unlike denominators."
Equations	16	6%	"Need help!!!!! I am teaching systems of equations and inequalities. Does anyone have any resources to share to make teaching elimination and substitution simpler/easier?"
Number Sense	14	6%	"Hi all, I'm looking for comparing numbers, greater than/less than resources?"
Ratios	9	4%	"I am teaching an introduction-to-ratios unit to 6th graders and am looking for a challenge activity for a small group of students tomorrow. Any suggestions?"
Measurement	7	3%	"I am looking for fun measurement activities for an accelerated 5th grade math class."
Functions	5	2%	"Does anyone have any instructions on building a function machine? I have been searching the net and can't seem to find any instructions on building one with my students."

Table 4.5

Types of High School Math Topic Posts in the Math Subject Community

Content	Freq.	Percent	Example
Algebra	57	22%	"I am wanting to start a project on why students should study algebra. I would like for the students to focus on linear equations and inequalities, quadratics, and other major topics we discuss in algebra. Does any one do a similar project that I could borrow ideas from?"
Statistics	22	9%	"Does anyone have good hands-on activities for a high school statistics course?"
Geometry	15	6%	"Anyone willing to share a simple, fun geometry project on triangles (high school)?"
Calculus	2	1%	"I have given this derivative quiz for a few years now in my intro calculus classes (not AP!) and was looking to update it a little. Does anyone have suggestions?"

Interestingly, 349 out of 600 posts (58%) did not address a specific math topic, but rather focused on technology or pedagogical strategies. This suggested that the MSC may be a platform for sharing more general resources, activities, and technology tools related to teaching math rather than a platform for discussing specific math topics. Alex, a middle school math teacher, shared how he only looked for general math resources in the MSC because the posts with specific math topics were typically not relevant to the topics he taught. Alex explained:

> I'm more interested in where can I find a site to get the specifics tailored to me. Because when I visit Edmodo and you've got 'how to solve an equation

with variables on both sides,' what are the odds that that's what I'm looking for now? 1 in 365 days. I could be looking at it anytime.

Alex found the posts with general, adaptable knowledge to be more useful than the posts about specific math topics.

In summary, the findings from the analysis of the wall posts and interview responses revealed that MSC members were looking for and sharing broader, adaptable Curricular and Pedagogical Content Knowledge, instead of focusing on specific math topics. Since the shared knowledge in the MSC was broad and diverse, members were able to find knowledge that could be adapted to their local classroom contexts. This allowed teachers who worked in a variety of contexts to find shared knowledge that met their needs.

RQ2: How is the Process of Acquiring Knowledge Shaped by the Math Subject Community Global Activity System?

The MSC global activity system consists of an integrated network of elements that interact with and mutually constitute one another. In order to explore how the process of acquiring knowledge was shaped by the MSC global activity system, I conducted a theoretical thematic analysis of all three data sets: 600 discussion threads, 150 surveys, and 10 interviews. I used the CHAT framework to guide my exploration of the patterns within the data. The unit of analysis was the activity system. I started by examining the different CHAT elements within the global online MSC activity system: subject, tools, sociocultural norms, community, division of labor, object, and outcome (Engeström, 1987; Cole & Engeström, 1993).

I completed two iterations of data coding. During the first iteration of coding, I developed a codebook (see Appendix D) to organize the codes. The codebook included descriptions of the codes and as well as examples. During the second iteration of coding, I reviewed the codes to ensure that they had been categorized correctly. After coding the data, I explored the relationships between the codes and used the results to answer the second research question.

Object & Outcome

Upon exploring the object-oriented actions of the interview and survey participants, I found that teachers' actions within the MSC were shaped by the object of finding new knowledge, with the outcome of improving student engagement in learning math.

The survey participants were asked to share what motivated them to visit the MSC. Out of the 150 survey participants, 138 responded to this open-ended question. The majority of survey participants (87%) reported that they visited the MSC to "find new ideas and resources."

I probed this question further with the interview participants and found that the participants visited the MSC to look for ideas and resources that were "interesting, engaging, different, and interactive." Many of the interview participants shared that either their students were bored with learning math the same way or they were bored with teaching math the same way and the MSC provided access to new information and resources that would improve student engagement in their math

lessons. The following quotes provide insight about what types of knowledge the interview participants were looking for when they visited the MSC:

> Alex: I'm usually looking for interactive activities for the kids to do to support either learning in the classroom or at home. I look for anything that can spice up what we're already doing, things that are interactive, things like games; things like a two-minute Youtube video that can totally change a lesson plan from something boring to something engaging.
>
> Cecilia: I always have it in my head, that this is super boring (these lessons that I have), and Edmodo's going to have something magical that's going to make all of this fun and make more sense to the kids.
>
> Grace: When I'm scooping through [the MSC wall posts], I look for something that looks interesting, something that sounds different, or something I've not seen before.
>
> Christine: This is my 13th year teaching, but I get bored easily so I change things all the time. I know that if I get bored, the kids can. So I'm always looking for new ideas to integrate to keep the kids interested.

Ultimately, the interview and survey participants were driven by the object of finding new knowledge, with the overall outcome of improving student engagement in learning math.

Subject

The MSC had more than 250,000 members. These members, or *subjects*, were K-12 teachers, higher education faculty, and any individuals who were interested in creating and sharing knowledge related to the field of math education.

A common characteristic of the subjects was their confidence in using technology. All of the interview participants and the majority of the survey participants used technology on a daily basis in their classrooms. The interview and survey participants felt confident using technology to connect with other educators and to exchange knowledge. Since the participants were comfortable using technology as a teaching and learning tool, they were more willing to explore the MSC in order to acquire knowledge.

The subject's actions within the MSC are best exemplified by a quote from Heraclitus: "No man ever steps into the same river twice, for it's not the same river and he's not the same man." The subject shapes and is shaped by the MSC. Each subject brought a different background, experience, and expertise into the MSC. As the subject browsed the community wall and learned from other members, the subject's knowledge may change, and thus, the subject has changed. This meant that every visit to the MSC may change the subject. However, since the subject had new knowledge to share, the subject also shaped the stream of knowledge in the MSC. Thus, the subject and the MSC mutually shaped one another.

Tool

The MSC provided two tools to help teachers acquire new knowledge: the community wall and the search engine. The community wall (see Figure 4.2) was a virtual space for members to post questions and share resources. The wall was frequently updated with new discussion threads and it highlighted 15 to 20 of the latest threads. Additionally, the entire Edmodo site featured a search engine where members could search for specific posts or find members by name. Members could complete the following actions in the MSC:

- Read wall posts
- Respond to wall posts
- Post on the community wall
- Add resources to their Edmodo library
- Search for posts and members using the Edmodo site search engine
- Add a community member as a "connection"

The survey and interview participants were asked to share how they found new knowledge in the Edmodo MSC. An overwhelming majority of the survey participants (92%) reported that they acquired new knowledge by reading the community wall discussion threads (see Figure 4.3). Additionally, all ten of the interview participants also reported that they found shared knowledge by browsing the community wall.

Community wall. The community wall was frequently populated with new discussion threads. Members shared knowledge by posting on the community wall or replying to a post. *Posting* was the action of writing text and sharing it with the

community. Anything that was posted on the community wall was visible to all community members. Members could embed uploaded documents, hyperlinks to external websites, and resources from their Edmodo library in a wall post.

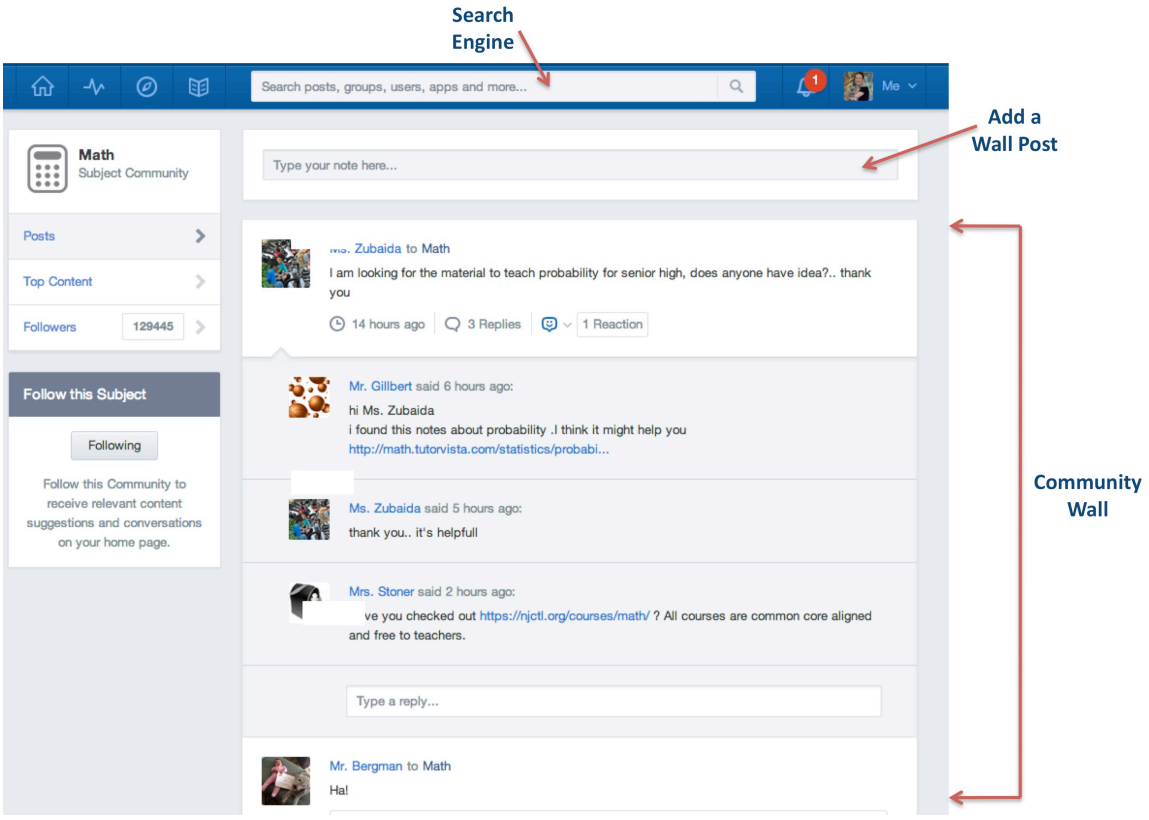

Figure 4.2. Edmodo Math Subject Community screenshot**.**

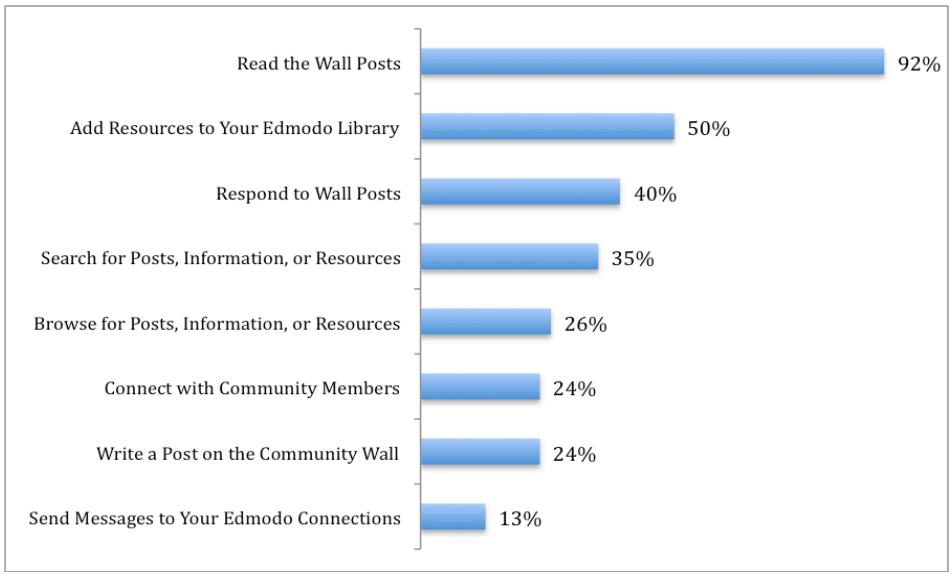

Figure 4.3. Actions performed in the Edmodo Math Subject Community.

The community wall was an ever-changing *knowledge stream* that was shaped by the MSC members. The community wall featured the latest 15 to 20 discussion threads, which meant that members would only see the most recent threads relative to when they logged in to visit the MSC. This could affect a member's ability to find knowledge if he or she browsed the community wall or posted a request for action and the collective knowledge of the individuals in the MSC was not sufficient for providing an effective solution or response. Three of the interview participants shared examples of times that they posted a request for a specific math resource or idea and received no responses. However, when they posted the request at a different time or posted about a different topic, they received multiple responses. Therefore, the ability to find and share knowledge was limited by the expertise of the individuals who were also visiting the MSC at the same time, or within the same time period.

The interview participants found the constant change and timeliness of the community wall to be a motivating factor for visiting the MSC. The participants felt that the community wall was a convenient tool that gave them access to new knowledge anytime and anywhere. The interview participants explained how they visited the MSC during their free time to view the latest shared knowledge. The participants liked the community wall's changing knowledge stream because every time they visited, they found something fresh, new, and different. Some of the interview participants visited the MSC on different days and different times of the day in order to access a wider range of shared knowledge. Alex shared that he visited the MSC multiple times every week in order to acquire more knowledge: "If you go in [to the MSC] on Sunday and you don't find anything, you might find more on Tuesday." Alex felt that frequent visits to the MSC allowed him to gain knowledge from a broader international audience.

One of the main challenges that interview participants faced while using the community wall as a tool to find knowledge was the disorganization of the knowledge stream. The interview participants described the community wall as a *messy*, *unorganized*, *hodgepodge* of shared knowledge. According to the interview participants, the discussion threads on the wall were not organized and they rarely included important details such as grade level or descriptive context. Sarah, explained how she had to "weed through" the wall posts to find relevant knowledge. Four of the interview participants reported having trouble finding a resource or post that they saw on the community wall and forgot to save or bookmark. Rachel shared that if she did not have a way of saving relevant ideas and resources from the

community wall, she would have trouble finding the shared knowledge at a later date: “Once somebody’s posted something in the Edmodo community, if you don’t bookmark it, you’ll never find it again.” James described this problem as one of Edmodo’s “main flaws.” In order to overcome this limitation, the participants had to be active in the knowledge acquisition process by collecting, organizing, and saving the shared knowledge.

Overall, even though the knowledge on the community wall was disorganized and limited by the MSC member’s collective expertise, the interview participants found ways to overcome these limitations and used the community wall as a tool for accessing new insights, ideas, and resources.

Search engine. The search engine did not seem to be a popular tool for acquiring knowledge in the MSC. Only 20% of the interview participants and 35% of the survey respondents reported using the Edmodo search engine to find specific posts. Sixty percent of the interview participants stated that they were not aware of the search engine. The following quotes provide examples of the interview participants’ knowledge seeking actions in the MSC:

> Alex: I’ve never searched anything on Edmodo. I go to math [Subject Community] and I’ll look at the last 20-30 posts, but I don’t even know how to search on Edmodo.

> Rachel: I don’t know how to use the search engine on Edmodo. When I go [to the Math Subject Community] I just read what people are posting and

what they're commenting about. I open a lot of the links that they share and bookmark them or email them to myself to look at work the next day.

Sarah: I just chime in and look, kind of like Facebook - who's posted what today? But I don't really do any searches, so I'm kind of like an amateur user as far as the math community goes.

Christine: I try to get on Edmodo every day and just go through the posts and see what might interest me. Every time I go through it, I find something like a great idea or a great app or website. If I'm looking for a specific topic, I will search sometimes. But if I'm looking for a specific topic, I'll probably need it in the next day or two, so, if I don't find something from the search, usually even if I do search for it, I'll just put a question there [on the community wall] because you just get immediate responses.

Alex, Rachel, and Sarah mainly found knowledge by browsing the community wall and reading the latest discussion threads. Christine browsed the community wall as well; however, if she needed a specific resource or idea, she used the search engine and posted a request for action on the community wall.

In summary, the majority of survey and interview participants tended to acquire new knowledge by browsing the community wall and reading the discussion threads.

Community

The MSC community consisted of a large, diverse group of individuals from around the world who had varying levels of expertise and performed different roles. The interview participants described the community as a group of likeminded individuals who had a shared vision or purpose. Cecilia, a middle school math teacher, shared that members were "all there for the same purpose…we all ultimately have the same goal and want the same things." Sarah, an elementary advanced topics teacher, described the members in the community as "people who are just like me." According to the interview participants, the community was made up of a group of individuals who shared the same values, goals, and experiences.

The interview participants also characterized the people in the community as risk-takers who were willing to try new things. Andrea, a sixth and seventh grade math teacher, felt that the MSC was an "authentic setting" that allowed members to connect with other educators who were "there to learn, share real information, and share things that have been tested in the classroom." James described how teachers in his school and local network were often afraid to fail or try new things. On the other hand, the teachers in the MSC were often willing to take risks—they shared their success, failures, and ideas and the whole community provided support and feedback—and that was what made the MSC community so unique and appealing.

It is important to note that although the MSC is a global community with members located in many different countries around the world, the significant majority of the members are located in the United States. Thus, even though I refer

to this community as a "global activity system," the object-oriented actions of the members are heavily influenced by U.S. cultural norms, rules, and roles.

Division of Labor

Individuals perform different divisions of labor, or roles, within a community since a single individual cannot have all of the knowledge and skills necessary to carry out all of the actions within the activity system (Tolman, 1999). Individuals participate in different roles based on their skills, knowledge, and interests (Jonassen & Rohrer-Murphy, 1999). In online communities of practice, participants also take on various roles depending on the object they are pursuing.

Within the MSC, the division of labor was sorted by the members' professions, years of teaching experience, and the roles they took on within the community. The members in the MSC worked in all grade levels and taught a variety of subjects. According to the survey results, the majority of participants were K-8 grade teachers and their years of teaching experience ranged from 0 (new teachers) to 38. All of the survey and interview participants were math teachers; however, some of the participants also taught other subjects, such as Science, Personal Finance, AVID, Computer Science, Technology, or Elementary Multiple Subjects. There were also members who were not teachers, but instead were teacher educators, technology specialists, higher education faculty, students, or just individuals who had an interest in math education.

The benefit of having a community that was made up of individuals from many different divisions of labor was that members could tap into the diverse

collective knowledge of the community to discover new ideas, resources, and information. MSC members had the benefit of being able to connect and communicate with individuals from around the world who had broad knowledge and diverse experiences.

Roles. Another way to examine the division of labor was by exploring the different roles that members performed within the MSC. Rodd Lucier's (2012) *7 Degrees of Connectedness* taxonomy (see Table 2.1) is a useful tool for understanding how members participated in an online community. Lucier's framework ranges from the stage one "Lurker" who does not interact in an online community and only learns from observing others to the stage seven "Confidant" who is the community expert. However, Lucier's taxonomy is more geared toward an online community that has members who interact with and build relationships with one another. Based on the content analysis of the MSC wall posts, the MSC seemed to be more like a virtual bulletin board for the distribution and acquisition of knowledge. Using the survey and interview participants' responses, I devised a new taxonomy to describe the roles that members perform within the MSC (see Table 4.6). The Four C's of Participation Taxonomy features four participant roles: Contemplator, Curator, Crowdsourcer, and Contributor.

Contemplators were members who perused the shared knowledge in the MSC. Lucier (2012) referred to these types of individuals as "lurkers" and the interview participants described these individuals as "voyeurs," "stalkers," and "observers." However, these terms were too passive. Contemplators actively browse through the shared knowledge on the community wall or used the search engine to

explore various topics. They analyze the shared knowledge and thought about how they could use the knowledge in their classrooms. Megan shared how her actions fit within the Contemplator role: "I guess I'm probably act more as a voyeur. For the most part, I'm just on the outside looking in, trolling to see what other people have posted."

Table 4.6

The Four C's of Participation

Role	**Description**
Contemplator	An individual who reads and assesses the shared knowledge in the community.
Curator	An individual who collects and organizes shared knowledge from the community.
Crowdsourcer	An individual who posts a request for action and pools the wisdom of the crowd to find a solution, resource, or idea.
Contributor	An individual who replies to requests for action or shares best practices, links, resources, and other relevant knowledge with the community.

Curators were similar to Contemplators; however, they actively assessed, collected, and organized the shared knowledge in the MSC. Curators used external tools, such as LiveBinders, Symbaloo, email, or the Edmodo Library, to save, categorize, and organize shared knowledge. Eight of the ten interview participants described how they curated the shared knowledge from the MSC. The following quotes highlight the different tools that the interview participants used to curate shared knowledge:

> Sarah: "I put new ideas and resources in a bit.ly list. I have some sites that I put in Livebinder also. I'm basically just curating information."
>
> Grace: "I've got one Symbaloo setup for each math standard which has all the games, activities, lessons, quizzes, and everything that you would need to do to introduce, cover, flesh out, RTI, differentiate that standard."
>
> Rachel: "I probably have 400 math games bookmarked on my school website and I have teachers across the district tell their kids, 'Go to Ms. Z's website' because they know that I've found games and resources for all of the math topics they cover."

Curators used external tools to collect and organize the shared knowledge in the MSC in order to access the knowledge at a later point or to share the knowledge with students, colleagues, or other networks.

Crowdsourcers were individuals who solicited advice, feedback, ideas, or resources by posting a request for help or action on the community wall. A little more than half of the 600 MSC wall posts that I examined were requests for action (see Table 4.1), which demonstrates that many members were actively seeking knowledge by posting on the community wall. Grace shared how posting a request for action in the MSC was her main way of finding knowledge: "I usually just put a question there [on the MSC community wall] because you just get immediate responses." Grace felt that posting a request for action and pooling the

wisdom of the crowd allowed her to receive quick responses that were geared towards her specific needs.

Contributors were individuals who wrote shared knowledge posts or responded to members' requests for action. Contributors believed that it was important to give back to the MSC. Sarah shared how she was willing to respond to other member's posts if she felt that she could help them. Rachel and Christine shared how they frequently posted on the community wall and participated in discussion threads.

Many Contributors also bridged multiple communities and networks. James, Alex, and Grace reported that they frequently found new ideas and resources from their online and face-to-face communities and shared this knowledge with the MSC. Humphreys, and Park described these types of teachers as "conduits" (p.7) who moved information, resources, and best practices back and forth between online communities of practice and their school communities. Alex explained that when he visited the MSC he didn't just look for resources and ideas for his classroom, he also looked for knowledge that he could share with all of the teachers in his school, "I share a lot with other teachers, so I'm not looking only for math and science resources. I'm looking for other stuff to share with them." Alex felt that it was his responsibility to find and share knowledge with all of the teachers in his networks.

Based on my observations of the MSC, it seemed as though the majority of the members were either Contemplators or Curators. The MSC had more than 250,000 members, yet there were only an average of 10-15 wall posts and 1-5 responses per post every day. When looking at the click counter on the posts, which

showed how many times members had clicked on a link embedded within a post, there were many posts with hundreds or thousands of clicks, and yet, no replies. This means that many members were browsing the community wall and viewing shared resources, but they were not actively responding to or writing posts.

Even though there appeared to be significantly more Contemplators and Curators, each of these roles played a part in shaping the MSC activity system. Contributors shared knowledge, which kept the MSC wall new and fresh and motivated members to return to the MSC. Crowdsourcers encouraged members to share their knowledge. Curators and Contemplators increased the click count for shared resources, which increased Contributors' willingness to share more knowledge. This also increased the "social presence" (Jones & Preece, 2000, p. 123) of the community. Social presence refers to the idea that participants do not feel alone or isolated in an online community. All of these roles were essential to maintaining a thriving online community.

Additionally, the roles that members performed in the MSC varied. As members become more comfortable and familiar with using the tools in the MSC, they were more likely to advance through the four C's of participation—moving from Contemplator to Contributor. However, these roles were flexible. Members could be a Curator during one visit to the MSC and then a Contributor during the next. The interview participants often performed different roles depending on their goals, amount of free time, and comfort with using the various tools in the MSC.

Overall, the MSC consisted of a large, diverse community of members with different professions and years of teaching experience. These members took on

different roles depending on their needs and the object they were pursuing. Since the MSC consisted of members with varying degrees of expertise and experiences, members were able to find more diverse ideas and resources for engaging students in learning.

Rules

Each community has a set of collectively negotiated rules, or sociocultural conventions. These conventions are either explicitly stated or implicitly understood guidelines for acting, behaving, and interacting within the community. The rules provide a lens for understanding how to become a full participant in a community. These rules are essential for developing a community of trust and for providing a safe space that facilitates open communication and relationship building.

When asked about rules for participating in the community, the interview participants were not aware of any explicit rules. However, the Edmodo website had a User Trust & Safety FAQ (https://support.edmodo.com/home#forums/20929590-user-trust--safety-faq), which described the privacy and safety rules and how members could report inappropriate content, language, or members, and cyber-bullying. None of the participants were aware of this resource. However, the interview participants described two main implicit rules that shaped members' actions within the MSC: professionalism and reciprocity.

Professionalism. All of the interview participants described the MSC as a professional community. The interview participants used the term "professional" to describe a practice-based community with members who were positive, respectful,

and helpful. The following two quotes provide examples of the implicitly enacted rule of professionalism that shaped the members' actions:

> Andrea: "I had noticed that people tend to be very positive. You don't get the negativity that sometimes comes with social media, like Facebook. You know people are professional and helpful. I don't really notice a lot of spam or things of that nature."

> Grace: "I believe the culture of the community is generally helpful and supportive. The comments are positive, professional, and respectful. I have never seen any spam, or anyone pushing an inappropriate agenda. I haven't witnessed any negative language."

Grace and Andrea felt encouraged and empowered to participate in the MSC because all of the members in the MSC shared an implicit understanding that posts and replies should be positive, professional, and helpful.

Upon exploring the theme of professionalism, the interview participants described three unacceptable practices in the MSC: spamming, writing nondescript posts, and stealing. The majority of members had not seen any spam (unwanted posts in bulk) from third-party companies. However, Alex and James reported that they had seen members frequently post links to their own paid online resources and they felt that these types of posts were spam. They felt that these posts diminished the professionalism of the community.

Another unacceptable action in the MSC was posting a request for action without details about the request. Grace felt that these posts lacked descriptive content and wasted members' time:

> If you really expect people to give you quality answers, then you really need to give them the information up front to help you with your issue. People that just post to the wall and say: "Looking for something about fractions." I'm like "Aren't we all? What grade? What are you doing? Which standard are you addressing?" It's an imposition on the other educators that are on the site.

Grace described how posts like these often resulted in many follow-up replies in order to figure out what the individual really needed. Many of the interview participants attributed these nondescript posts to the fact that new members may not know how to effectively ask for information and resources. However, the interview participants felt that members should observe how other members post before writing their own posts.

Additionally, Alex mentioned another problem that was not brought up by any of the other interview participants: stealing. Alex found out that a member was stealing, word-for-word, all of his shared knowledge posts and distributing the posts in another online community. While virtual spaces often encouraged the sharing of knowledge, Alex felt that members should understand copyright and attribution rules if they were going to share knowledge in multiple networks.

Reciprocity. The interview participants also shared that there was an implicitly understood rule that members should give back to the MSC. The

participants felt that members should not only be willing to help other members in the MSC, but also that they should share high-quality resources and ideas. Alex described how he would pilot test a resource with one of his other online communities and if other teachers liked it, he would share the resource in the MSC. Alex made sure that the resources he shared were well received by his other networks before sharing them with the MSC. He explained how individuals who posted self-promoting material or poor quality resources had a bad reputation in the MSC. Additionally, seven of the interview participants explained how there was a general understanding that if someone needed help, members should be willing to respond and provide assistance. This notion of reciprocity was essential to maintaining an active knowledge sharing community.

Overall, the interview participants depicted the MSC as a safe, professional community where they could share knowledge and connect with members without worrying about negativity. There seemed to be an implicit understanding in the MSC that members should be collegial and posts and comments should not be negative. The participants felt that since everyone in the MSC shared the same vision and purpose, the sociocultural norms for participating were relatively straightforward: stay positive, respond and help other members, don't post spam or nondescript requests for action, and give attribution to the individuals who freely shared their knowledge for other members to use. These implicit community rules motivated members to give back, share high quality resources, and act professionally and respectfully.

In summary, the MSC was an active virtual space for the distribution and acquisition of authentic and relevant knowledge that teachers could use to engage their students in learning. The process of acquiring new knowledge was dependent on having a large community of individuals who performed different roles, provided a diverse set of expertise, and collectively enacted the sociocultural norms. Although the more than 150,000 members in the MSC had different teaching positions, experience, knowledge, and roles, they were all collectively pursuing a shared vision. This division of labor resulted in diverse and rich knowledge sharing.

However, after examining the MSC as a global activity system, it seemed as though underlying principles of a community of practice did not support the actions, interactions, and conversations that occurred within the MSC.

Community vs. Practice

The MSC only supported the traditional notions of a community of practice in the broadest sense: it was a *community*, or group of people with varying levels of expertise, organized around a *domain* (e.g., math instruction), who shared resources and knowledge related to their *practice*. Yet, the actions of mentoring, relationship building, becoming a full participant, and solving authentic tasks did not appear to be common in the MSC.

In a community of practice, the entire community works together to help new members gain mastery of their practice (Lave & Wenger, 1991). While the MSC was an active space for knowledge sharing, there was no defined group of experts who worked together to create shared artifacts or assist other members in gaining mastery

of their practice. Out of the 600 posts and 1908 replies, only 2 members posted or replied on multiple occasions. This meant that every new post had a different set of people replying and that almost every post was written by a different member. The majority of posts (74%) received less than 5 replies, meaning that members were participating in short-lived interactions rather than sustained conversations. The members seemed to be visiting the community only to find and share knowledge rather than work together with other members in the community to help all new members successfully navigate their practice.

Wenger's (2006) revised definition of the term "community of practice" refers to individuals who interact with one another on a regular basis in order to share stories, create artifacts, and build a collective knowledge of the practice. However, the MSC wall was made up of thousands of one-time interactions and conversations. The members seemed to be visiting the community only when they needed help or new ideas, but they did not hang around to build relationships or mentor others. Because the MSC was so large, members may not have felt as though they needed to participate in sustained interactions or to work together to further the knowledge of the field of Mathematics.

Moreover, the MSC did not seem to be a place for relationship building, networking, or collaborating with others. Only 5.33% of the posts and 1.78% of the replies were related to networking and collaboration, which meant that the majority of members were not actively seeking to build relationships or connecting with one another via the community wall. Less than one-third of the survey respondents

reported that they added other members to their networks using the "connections" feature in the MSC.

To further probe this finding, I asked the survey respondents to share whether they visited the MSC for knowledge acquisition or connecting and collaborating with other educators. Out of the 150 respondents, 126 (84%) reported that their main reason for visiting the MSC was to find ideas and resources, while only 24 (16%) reported that they participated in the community to connect and collaborate with other educators.

The idea of a "community" seemed to break down in this virtual space. Alex described the MSC as a "bulletin board for new ideas and resources," which portrayed the MSC as a knowledge distribution platform rather than a community of members who worked together to help newcomers learn how to gain mastery of their practice.

Additionally, when a community of practice is expanded worldwide via the Internet, the practice of each member can vary substantially depending on sociocultural and contextual factors that shape their local activity settings (Tharp & Gallimore, 1988). Yet, in the MSC, 84% of the posts did not include the grade level or other descriptive contextual information and 58% of the posts did not include information about specific math content. The majority of the MSC members were searching for and sharing decontextualized ideas, resources, information, and knowledge without reference to authentic classroom learning settings. This was a significant deviation from the knowledge sharing opportunities that occurred in a face-to-face community of practice.

Ultimately, the underlying principles of communities of practice did not seem to apply to the MSC. The concept of becoming a "full participant," (Lave & Wenger, 1991, p. 105) was not relevant in this community where thousands of members came and went on an as-needed basis. There was no collective community of experts or an identified group of novices who needed assistance. Member participation was based on self-interest (e.g., finding and sharing knowledge) rather than for the greater good of the community (e.g., mentoring others). And, while there were shared artifacts, these artifacts were decontextualized and abstracted from the local contexts where they would be put into practice. Based on these initial findings, the MSC did not support the traditional notions of a community of practice.

Practice-based crowdsourcing platform. One way to conceptualize the MSC is as a Practice-Based Crowdsourcing Platform (PBCP). A PBCP is a virtual space that allows individuals connect with a large, diverse crowd of experts to find and share professional knowledge and what Shulman (1987) referred to as, "wisdom of practice" (e.g., advice, feedback, classroom experiences, best practices). It is a *global* site so that members can tap into the distributed expertise of other individuals from around the world. A PBCP has no defined geographical or temporal boundaries. Individuals can access a PBCP anytime and anywhere from any Internet-based device. A PBCP is a casual resource that members can visit when they need to achieve a goal.

A defining feature of a PBCP is the ability to pool the wisdom of the crowd to find the most effective and relevant shared knowledge. A PBCP provides access to knowledge that has been utilized, vetted, and approved for use in practice. PBCP's

can be social media groups, email listservs, and other virtual technologies that allow individuals to acquire and distribute knowledge related to their practice. A thriving PBCP consists of a large group of individuals who frequently share practice-based knowledge on an ongoing basis.

The difference between a PBCP and a social networking site is twofold: 1) individuals who visit a PBCP have a shared purpose of exchanging professional knowledge related to a specific practice, and 2) a PBCP allows individuals to connect with people who they would never meet through their local networks. Gee and Hayes (2011) referred to these types of individuals as "weak ties" (p. 34). Megan described how the MSC provided a virtual space for members to connect with people beyond their school walls and local networks:

> With Facebook you're not interested in anyone that you don't really know, but with this sort of community, that what's you're interested in. You work to find someone that you don't know because that's who you're going to learn from.

Megan felt that these "weak ties" connections often resulted in the discovery of richer, more effective ideas and resources for engaging students in learning.

A PBCP is different from an online community of practice, community of interest (Jones & Preece, 2006), and passionate affinity space (Gee & Hayes, 2011) because participation is based more on self-interest rather than becoming a full member of a community. Individuals participate in a PBCP to seek information and resources that meet their immediate needs, such as finding an online website that they can use for teaching a lesson the next day. Participation is short-lived, timely,

and occurs on an as-needed basis. This is different from a traditional community in which members work together toward a shared purpose.

Online community of practice. The term "online community of practice" has been broadly applied in the literature to listservs, discussion forums, social networking sites, social bookmarking tools, microblogging, and other interactive online environments (OET 2011; Preece, 2000). Yet, the landscape in a virtual space is significantly different than face-to-face communities that Lave and Wenger (1991) studied. The results from this study showed that the term "online community of practice" is not a one-size-fits-all description of virtual spaces, platforms, and tools. Further research is needed to explore the different types of so-called "online communities of practice" to determine whether the concept of a community of practice can support the object-oriented actions of groups of individuals who connect in cyberspace.

Additionally, much of the research on online communities of practice focuses on the motivating factors and barriers to becoming a full participant in the community. By reframing the Math Subject Community as a PBCP, researchers can shift their focus from community participation to how individuals tap into the wisdom of the crowd, learn from "weak ties," and exchange and implement practice-based knowledge. In chapter six, I will explore these implications by analyzing how teachers find and make use of the practice-based knowledge in the Edmodo MSC.

Conclusion

Using the CHAT framework, I was able to explore the sociocultural factors

that influenced the process of acquiring knowledge in the MSC global activity system. The MSC global activity system consisted of a complex network of elements (e.g., division of labor, tools, rules, community, subject) that interacted with and mutually constituted one another. The dialectical relationships between the elements within the global activity system influenced how subjects pursued the object of finding knowledge that would engage students in learning. The subjects also shaped the global activity system through their use of the MSC tools, the roles they performed, and the diverse range of knowledge they brought to the MSC.

In examining how these various elements shaped one another, I discovered that the MSC did not fit the traditional notions of a community of practice. Rather, the MSC could be conceptualized as a Practice-Based Crowdsourcing Platform in which members pooled the wisdom of experts from around the world to find and share practical and relevant knowledge that could be used to engage students in learning math.

CHAPTER V:

THE LOCAL ACTIVITY SYSTEM

In chapter 4, I explored how the interview and survey participants acquired knowledge from the Math Subject Community (MSC). I found that the process of acquiring new knowledge was shaped by the subject's actions and use of tools, the collective knowledge of the community, the roles that members performed, and the implicit understanding of sociocultural norms of reciprocity and professionalism.

Yet, exploring just the global activity system did not provide a comprehensive picture of how teachers found and shared knowledge. Each teacher participated in multiple activity systems that shaped his or her knowledge seeking actions. In this chapter, I will examine how the interview participants' local school activity systems influenced their process of acquiring knowledge in the MSC.

RQ3: How is the Process of Acquiring Knowledge Shaped By the Teacher's Local School Activity System?

In order to explore how the process of acquiring knowledge was shaped by the participants' local school activity systems, I conducted a theoretical thematic analysis of the interview data. I used the CHAT framework to guide my exploration of the patterns within the data. The unit of analysis was the activity system. I started by examining the different sociocultural factors within the participants' local school activity systems: *subject, tools, sociocultural norms, community, division of labor, object,* and *outcome* (Engeström, 1987; Cole & Engeström, 1993). I also explored

the contradictions between their sociocultural factors and within the participants' local school activity systems in order to understand what motivated the participants to seek knowledge from the MSC. In the following section, I will detail how each of the sociocultural factors in the participants' local school activity systems shaped their ability to pursue an object.

Object and Outcome

In the previous chapter, I found that the participants' actions in the MSC were shaped by the object of *finding* knowledge and the outcome of improving student engagement in learning. Upon examination of the participants' object-oriented actions in their local school activity systems, I found that the participants were driven by the object of *implementing* new knowledge with the shared outcome of improving student engagement in learning. The majority of the participants shared that they felt bored teaching a dull subject with a dry curriculum; therefore, their students were not engaged in learning. The participants described how visiting the MSC allowed them to find new teaching strategies, resources, educational tools, and information that they could implement in their classroom to achieve the outcome of improving student engagement in learning. Thus, the participants' main objective in their local school activity systems was to implement new knowledge that would improve student engagement by relieving boredom.

Subject

Each of the 10 interview participants was a subject in a different school activity system. However, even though the interview participants had different local

school activity systems, they shared two common traits: a willingness to try new things and the ability to make or find time to explore the MSC. These two traits influenced the subjects' abilities to find and implement new knowledge in their classrooms.

Robin, Christine, and James described how their successful acquisition and implementation of new knowledge from the MSC was a result of their willingness to take risks, try new things, and make changes in their classroom. Robin's risk-taking paid off when she tried a new program from the MSC over a period of four months and her student test scores significantly increased. Robin described her thought process when determining whether to implement the new math program in her classroom: "I thought I'm going to try it [the math program] and my students did amazing things with it. You just have to be willing to try. I didn't know how good it [the math program] was going to be, but it didn't hurt to try." Robin's willingness to take risks allowed her to implement new knowledge from the MSC without worrying about failing.

The culture of risk-taking in the MSC seemed to be in stark contrast to the teaching staff in the participants' schools. James felt that many teachers in his school were not willing to fail and Grace shared how most of her colleagues were unwilling to make changes in their classrooms. Grace explained how two teachers in her school were interested in visiting the MSC; however, they both had two children who were heavily involved in sports and activities and, thus, they did not have any free time to explore new ideas and try new things. Grace, on the other hand, shared,

> I'm in a different point in my life. My daughter's 20. She's in college. We only had one child. So my restrictions are very different than they used to be. I can't guarantee that I would've found Edmodo and been very receptive to it years ago when my daughter was overly involved in everything as she once was.

Grace felt that because she had more free time, she was able to explore the MSC and try new things—something she might not have been able to do when she was trying to keep up with her daughter's busy schedule.

Even the interview participants who did not seem to have a lot of free time still found a way to visit the MSC. James explained how he visited the MSC during his daughter's naptime and Cecilia shared how she visited the MSC while waiting in line at a store or at the doctor's office. The majority of the interview participants found time almost every day, whether it was during class breaks or right before going to sleep, to spend five or ten minutes exploring the MSC community wall.

Overall, the subjects' willingness to take risks and find time to explore the MSC shaped their pursuit of the object of implementing new knowledge. Further research is needed with a larger sample size to determine if there are additional characteristics that shape the subjects' actions within their local school activity systems.

Tools

The interview participants listed multiple tools in their local school activity systems that influenced why they acquired knowledge in the MSC and how they

implemented it in their classrooms. The tools included professional development, technology, curriculum, standards, and funding and resources.

Professional development. The participants felt that the lack of professional development opportunities within their schools affected their ability to find and implement new knowledge that would improve student engagement in learning.

In general, the interview participants tended to describe their professional development as nonexistent or a waste of time. Andrea, a middle-school math teacher, described her school's professional development as "going through the motions" where teachers talked about the "same old, same old, again and again." Alex, a 21-year veteran middle-school math teacher, felt that his school's professional development days were a waste of time. Grace, an elementary school teacher, explained how professional development in her district consisted of short-lived workshops on the latest trends:

> Professional development in school districts, in my opinion, has never been implemented as fully or as deeply as it needs to be in order for most of those things to take root. Most of the time it turns out to be kind of a passing fancy.

Megan, a 26-year veteran teacher, shared how the lack of professional development at her school left her feeling like she was stuck in a rut:

> What amazes me…I'll tell you what, I felt like I was just spinning my wheels for years. When we first got the laptops, I was like, 'what's there to do with math stuff?' I felt stifled, like there was something secret out there that I just couldn't find it.

Additionally, three of the interview participants believed that their professional development was neither timely nor accessible. They described how they often had to wait weeks or months to acquire new knowledge from a district workshop or out-of-state conference.

Without access to high-quality professional development opportunities, the participants felt "stuck in a rut." This significantly limited their ability to implement new knowledge in their classrooms.

Technology. All of the interview participants felt that technology was an important tool for engaging students in learning and, therefore, they wanted to increase their implementation of technology-based resources and ideas. Megan, Cecilia, and Christine explained how their students were growing up in a world that was filled with technology and instant access to information. They felt that it was essential to use technology as a learning tool because students were regularly using it outside of the classroom. Cecilia shared that her students' engagement "goes way up when technology is used." Christine told a story about one of her students who was failing because he never participated, completed assignments, or turned in work. Yet, when she introduced him to Zondle, an online math learning tool that has interactive games, he was a top performer. According to Christine, "He wasn't going to sit down and do a worksheet, but you give him a computer, he's on it." All three of these interview participants felt that technology opened a window into students' worlds and allowed them to reach students and engage them in learning.

However, all of the interview participants faced problems related to the implementation of technology in their classrooms. The main challenges that the

participants faced were access to technology and technical support. Seven of the participants reported that they had to compete with the other teachers in their school for the computer lab or laptop carts and they only had access to the devices for a limited amount of time. Three of the participants shared how their schools instituted BYOD (bring your own device), but the students' devices were not able to connect to the Internet or they could not bypass the firewall restrictions.

The participants also had trouble accessing online resources, such as interactive online math games. Many online resources required students to log in, which often required email accounts. According to Cecilia, schools couldn't require students to have email accounts, which meant that the teachers have to create logins or general class email accounts, and this was too time consuming. Additionally, some of the online resources were on sites that had been blocked by the school district, which meant that teachers had to put in a request to the district to have the block removed and then they had to wait a few weeks for the request to be approved.

Another critical problem was the lack of technical support. When a technology device broke down, teachers often had to wait weeks for a district technology specialist to provide technical support. The majority of the interview participants described that the online resources they found in the MSC often required installing new software, java, flash, software updates, or had other technical challenges. They shared that actions such as installing new software, bypassing blocked websites, or updating java and flash could typically only be done by the district technology specialist.

Ultimately, all of the interview participants felt that it was essential to implement more technology-based resources and activities in their classrooms; however, they faced many challenges that affected their ability to use technology as a tool to engage students in learning. These challenges limited the participants' knowledge seeking and implementation actions.

Curriculum. Another tool that shaped the participants' ability to implement new knowledge in their classrooms was their school curricula. The participants described curriculum as the learning activities, materials, teaching manuals, and other resources that teachers have as guides to help students meet the state standards. Posner (1995) referred to this type of curriculum as the "official curriculum" (p. 10). According to Posner, the purpose of the official curriculum was to hold teachers accountable. The district or school administrators often decide on the official curriculum, rather than allowing teachers to choose or create their own.

The majority of the interview participants felt that their curricula were restrictive tools. Five of the interview participants described their curriculum as *dry*, *boring*, and *monotonous*. Rachel, a 7th grade math teacher from Texas, was so disappointed with her textbook that she decided to create her own curriculum. Grace shared how her students strongly disliked a software program that was a required part of her district's curriculum: "The kids hate it. They hate every second of it." Cecilia, a 7th grade math teacher in California, described how her curriculum consisted of abstracted content that was not meaningful to students:

> The way we teach math is ridiculous – in isolation of application. The way that textbooks are setup is: "Here's one way to solve x…" Like systems for

> example: “Here’s the way to eliminate to solve systems,” and we’ll do an entire lesson on that, and: “Here’s a way to substitute to solve systems,” [and we’ll do a lesson on that] in isolation, but you don’t do that in real life. So, I think that if math is taught within a context that students will learn and be more engaged because it’s more meaningful to them.

For these five teachers, the dullness of the curriculum provided a significant challenge to engaging students in learning. Since the majority of the participants had to follow their school curriculum, their ability to implement new knowledge was significantly limited.

Standards. The State Standards are a tool for ensuring all students in a state are taught the same content. Teachers use the standards as guide for determining what and how they teach. Districts, schools, and teachers also use the standards to assess student achievement. All of the interview participants viewed their state standards as restrictive tools. Grace shared that she never had time to explore content that was outside of her fifth grade standards:

> If it’s not a coverable standard for 5th grade, I’m really not touching it. We’ve got enough to do just to get through what we need to have adequately covered and proficient at by the time they walk out of the 5th grade door.

The majority of the interview participants felt that the state standards significantly limited their ability to implement new knowledge in their classrooms.

Funding and resources. The interview participants also mentioned how availability of funds influenced their ability to implement new knowledge. Most of

the participants reported that they did not have any funding for buying resources, textbooks, or materials for students during the previous school year. The lack of funding often resulted in the teachers having to use the same worn-down materials every year. This also restricted their ability to try new ideas and resources that cost money. Only James, who worked in a private school, said that funding was not an issue. If he found a new textbook, technology device, or online resource that looked appealing, either he or his school would buy it for the students. The rest of the interview participants described how they disregarded any posts in the MSC that required money because they had no funding.

In summary, the participants believed that the their local school activity system tools were prohibitive to pursuing the object of implementing knowledge and achieving the outcome of improving student engagement in learning math. As a result of these perceived limitations, the participants felt that they had to seek knowledge beyond their school walls. However, the limitations of the local school tools also restricted the participants' ability to find knowledge from the MSC.

Community

The interview participants described three different communities within their local school activity systems: classroom, school, and local. The classroom community includes the teacher and his or her students. The school community consists of the administrators, teaching staff, and support staff. The local community consists of parents and any other individuals who have an invested interest in the school. The teacher acts as a bridge between all of the communities. However, the

teacher also has to balance the needs of all of the communities. The divisions of labor and rules within each of the communities influence how teachers implement new knowledge in their classrooms.

Division of Labor

Each of the three communities consists of members that perform different divisions of labor (see Figure 5.1). All ten of the interview participants listed the same four divisions of labor that influenced their actions within their local school activity systems: students, teaching staff, administrators, and parents.

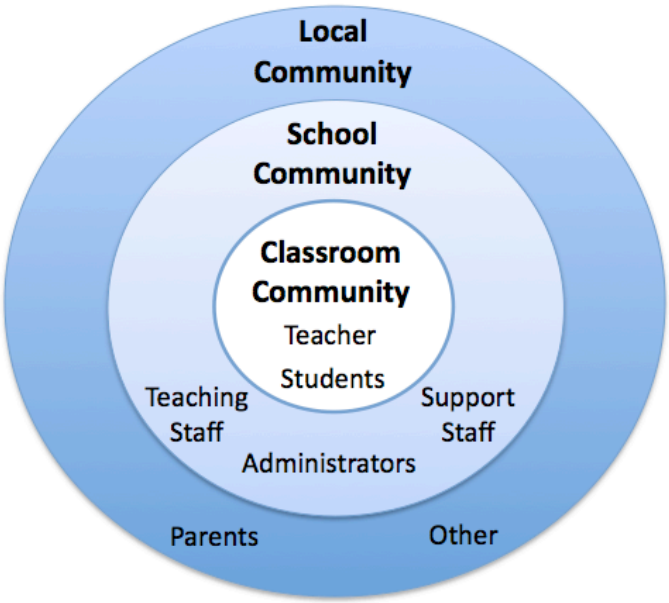

Figure 5.1. The three communities that shape teachers' actions within their local school activity systems.

Students. Teachers generally have the same group of students throughout the entire school year, with the exception of a few students who may change classes or move away from the school. The number of students the participants had ranged from 30 in elementary school to more than 120 in middle school. When asked about the different groups of learners in their classrooms, such as English Language Learners or students with disabilities, the interview participants shared that they focused more on students' math abilities than their sub-groups.

Each of the ten interview participants described how their students typically had a wide range of math abilities. During the previous school year, Rachel had 120 students who ranged from two grade levels below to two grade levels above seventh grade math. Rachel shared that her goal was to meet all of her students' needs, from the "ones who can't multiply all the way to the ones who need eighth grade geometry but their parents won't let them take an advanced class for whatever reason." Both Rachel and Sarah were amazed that they had students in middle school who did not know the basic multiplication facts. Cecilia also found that she had eighth grade students who did not understand fractions, a topic that was typically taught in third or fourth grade. All three participants shared how they worked extremely hard to find lessons, activities, and technologies that would engage all of their students in learning.

Some of the interview participants created different learning activities in order to address the varying levels of math abilities in their classrooms. Alex described how he tried to attend to the wide range of math levels in his classes through differentiation: "I had so many different levels. I'd have different versions of

tests. I'd have different things going on in the room." Alex felt that the best way to address the range in math levels was to provide different activities for each of the students. Christine, on the other hand, tried learning activities first with her advanced students, and if she had success, then she would try them with her "all-level classes." Rachel described her advanced students as, "guinea pigs" who were willing to try new things. And, since her students were advanced, she had more leeway in trying things outside of the standard curriculum and not worrying about her students falling behind. Grace shared how her curriculum required teachers to focus on students' individual needs:

> Everything that we teach comes from the students themselves, their knowledge of what they're proficient at and what they're not proficient at, and then we build on strengths and weaknesses from there.

For Grace, differentiating learning experiences to meet each student's math ability was a critical part of her teaching strategy.

Ultimately, the range of students' math abilities brought about significant challenges and opportunities for implementing new knowledge. Many of the participants had to differentiate ideas, resources, and information, or try out the knowledge with certain groups of students before implementing it in their classrooms.

Teaching staff. The teaching staff in any given school ranges from one teacher per grade or subject to multiple teachers who shared the same subject and grade level. Grace was the only fifth and sixth grade teacher at her school and Sarah

only had one other upper elementary math teacher to share ideas and collaborate with. On the other hand, Cecilia had seven teachers in her math department.

Interestingly, the majority of the interview participants described the teachers in their schools as unsupportive and unwilling to try new things. Alex explained how he was the only one who would "go out of his way to do research and find resources" that would improve his teaching. He shared that his teachers didn't have time to collaborate with him; instead, they only visited him when they needed resources or new ideas. These same teachers were not willing to use Edmodo or learn any of the other tools that Alex offered to teach them about. Christine felt that if she tried to share ideas with her staff, they would say something like, "Don't you just know everything nifty girl," and she did not want to be considered the "know-it-all" in her school. Grace described how the teachers in her school thought that she was "crazy" for trying all of the new things that she found in the MSC. Grace shared that the majority of teachers in her school have been doing the exact same thing for 20 years:

> Our kindergarten, first grade, and second grade teachers have all got twenty or more years in the same classroom and so they're really not all that interested in generating new ideas, or interested in what else is out there, or what else can we be doing…they're not interested in new technology and not interested anything that causes them to lose comfort in their teaching skills.

Without a supportive teaching staff, Grace, Alex, and Christine were left to their own devices to figure out how to implement new knowledge in their classrooms.

Additionally, both James and Sarah described the process of acquiring new knowledge and implementing it in their classrooms as a solo process. James felt that the teachers in his school "could not care less" about the new ideas that he tried in the classroom or the fact that he had done multiple keynote speeches and conference presentations about using new technologies. Sarah felt that the teachers in her school did not have time to collaborate with her in the process of finding and implementing new ideas and resources to improve student engagement in learning.

Overall, the interview participants depicted their relationship with their teaching colleagues as one-sided—they shared ideas and resources with their colleagues, but most of the time their colleagues were not willing to share back or collaborate. These one-sided relationships often left the participants on their own to figure out how to implement new knowledge in their classrooms.

Administrators. Another key division of labor in the interview participants' local school communities was the administration. While the majority of the interview participants described their administrators as supportive, all of the participants felt that their administrators inhibited their ability to try new things and implement new knowledge. Alex expressed frustration with the requirements that his administrators imposed on him:

> When our administrators say: "Hey we want you to take attendance every period and we want you to do this and that. For Joe fill out this behavior sheet while you are teaching the class and for Sally you've got to fill out this homework tracker and is Jason participating?" And you have to do that every

> day for a month. The administrators don't realize that they're spreading the teachers thin when they have us doing these many things.

Alex felt that his administrators were asking him to do too many things without providing any support. Since Alex felt that he had to keep up with all of his administrators' demands, he had limited time to explore and implement new knowledge in his classroom.

James also experienced frustration with his administrators. He explained how he set up his entire classroom based on his students' needs during the summer, and on his first day of class, he was given a new list of students. He felt that his administrators constantly overrode his decisions and made changes in his classroom without his permission. James felt that the one thing he needed the most from his school community was "trust" from his administrators. Grace also felt that her administrators were not supportive. She described how her administrator told her that he had to rein in her creativity rather than support her willingness to find new ways to improve student engagement.

In general, the interviewees reported that their administrators provided more obstacles and barriers than support. Many of the participants felt that keeping up with the administrators' demands and requirements limited the time they had for exploring new ideas and resources and implementing this knowledge in their classrooms.

Parents. Parents are an integral part of the local community in a school activity system. Parents often have their child's best interests in mind, but they can be overbearing to teachers. The majority of the interview participants found the

students' parents to be problematic rather than supportive community members. Cecilia and Rachel shared how parents influenced their teaching. Cecilia explained that her students' parents did not feel comfortable with their kids having email addresses to log in to online math websites, so she was not allowed to use those math websites for classroom instruction. Robin shared that when she got rid of the textbook for her students, the parents "freaked out" and she had to reinstate the use of a textbook to please the parents. James explained how his district was afraid of being sued by parents, so teachers had to do whatever the parents wanted them to do. Additionally, Alex felt that the parents' demands took away from his ability to teach all of his students. Alex believed that it was "silly" for parents to make demands, such as focusing more on one student, when he had hundreds of students to teach.

Overall, the interview participants felt that parents were influential members of the local community. They felt that they had to address parents' needs, regardless of how "silly" they were. Adhering to the parents' demands limited the participants' free time and ability to implement new knowledge that would improve student engagement in learning.

In summary, the interview participants were part of three communities (classroom, school, and local) within their local school activity systems and each of these communities had one or more divisions of labor that influenced the participants' actions. The students' varying math abilities and knowledge, teaching staff's lack of support, administrators' requirements, and parents' demands were all influential variables that shaped the participants' abilities to implement new knowledge in their classrooms.

Rules

According to the interview participants, the main rule, or sociocultural norm, that permeated all three of their communities was that *teachers can always improve*. The appropriation of this rule by the teachers and enactment of the rule by administrators was driven by the need to improve student learning. Megan described this rule as a push to do better: "There's this push to go from good to great. There's this idea that there's always something more out there to learn and there's a different way to reach the child." Many of the interview participants were driven by this idea to make changes and improve their pedagogies.

However, rather than allowing teachers to find their own ways to improve, administrators often had explicit rules that defined the changes they wanted teachers to make. The interview participants mentioned how this idea of continual improvement resulted in three explicit rules, or "pushes," from their administrators: a push to integrate technology, a push to meet or exceed the Common Core State Standards, and a push to try new pedagogical trends.

Push to integrate technology. All of the interview participants shared that their administrators required them to use more technology in their classroom. According to Cecilia, the idea behind this rule was that students would be more engaged if they used technology, and if they were more engaged, they were more likely to be learning. Regardless of the fact that this was an unproven assumption, the majority of the teachers felt that they had to integrate technology to please their administrators.

The participants described using various technologies, such as cell phones, tablets, computers, interactive whiteboards, student response systems, and digital cameras to adhere to their administrators' requests. However, as previously noted, the participants faced multiple challenges when incorporating more technology into their lessons. These challenges included lack of technical support, lack of access to technology, and no support or professional development opportunities for learning how to effectively use different technologies as learning tools.

Push to meet or exceed the Common Core State Standards. All ten of the participants mentioned that, regardless of whether their state was implementing the Common Core State Standards (CCSS), they felt pressured to meet or exceed the standards. Alex, Megan, and Christine shared how they noticed that a lot of teachers in their schools and in the Edmodo MSC were "freaking out" about the CCSS. When asked to describe why teachers were feeling anxious about the CCSS, Megan explained how the curriculum required more in-depth coverage of specific topics. Many of the participants felt that they needed more support and professional development opportunities in order to successfully implement the CCSS and prepare students for the new assessments.

Even the two teachers who were located in states that were not implementing the CCSS were affected by new standards. Rachel was given a directive by her district to "meet or exceed the Common Core Standards" and James was told that his students should be ready for taking the CCSS standardized tests, regardless of whether he used the CCSS to guide his instruction.

Push to try new pedagogical trends. The third type of "push" came from administrators who wanted to be on the cutting edge. These administrators often required all of the teachers in their school to implement the latest best practices and new ideas in the field of Education, regardless of their effectiveness in improving student engagement or learning. Grace shared how her school has implemented new pedagogical strategies every year:

> We did read alouds one year. Well then read alouds were out, and you don't really feel like you had enough time to fully investigate read alouds before they were gone. Then pBits [problem-based instructional tasks] were in but you didn't get those fully integrated. Then came MDPs and I have no idea what those are even though I took the class for professional development for an entire year. I still could never wrap my head around what that was. Then, those went away and that turned into something else. So professional development within my district, I don't feel like I have enough control over, time with, or ability to fully look into, develop, and become comfortable with.

While exploring the latest educational trends could help teachers learn new teaching strategies, the problem with this type of rule was that it often occurred without any support.

In summary, the interview participants felt pressured by the sociocultural norm of continual improvement. This norm was driven by the discursive practice and performative requirements of top-down governance. The participants felt that they did not have the appropriate tools, support, or knowledge to meet these requirements.

Thus, the implicit rule of continual improvement created multiple contradictions between the subject, tools, community, and outcome within the participants' local school activity systems. These rules also significantly limited the participants' abilities to implement new knowledge in order to improve student engagement in learning.

Contradictions

Teachers work in complex, ever-changing environments with competing demands, and yet, they are often given little support for keeping up with changes or learning how to navigate their local school activity system. The participants described the following contradictions in their local school activity systems: professional development, curriculum, funding, school community, new standards or curriculum, push to integrate technology, and new trends in the field of Education.

Upon further examination of the data, I noticed that the contradictions stemmed from *extrinsic change* and often resulted in the participant's desire to make *intrinsic change. Extrinsic change* refers to the idea that external forces transform the teacher's local school activity system, while *intrinsic change* refers to the teachers' desire to create change within their local school activity system.

Extrinsic change. Teachers often face extrinsic changes that affect their ability to pursue an object. Extrinsic changes are the external forces, such as new requirements, rules, and policies, which are imposed upon teachers by administrators, government officials, or other external agencies. The interview participants reported that the most common types of extrinsic change were related to

the implicit rules in their local school activity systems. These changes were the new standards or curriculum, a push to integrate technology, and new trends in the field of Education.

Common Core State Standards. With the implementation of the CCSS set to take place over the next 1-2 years, the majority of teachers in the United States had been given a significant challenge of learning the new standards and being able to incorporate them into their lesson plans without a lot of support or guidance. This extrinsic change directly affected the teachers' actions within their local school activity system and influenced their ability to pursue the object of finding knowledge that would improve student engagement in learning.

Andrea, a 14-year veteran teacher, described how she felt overwhelmed by all of the changes that were happening in her school district, especially the implementation of CCSS:

> We have curriculum changes, expectations of how we're going to assess changes, we're going to do the common core, then we're not going to do the common core, then we're going to do the common core again—that's legislatively up in the air right now. I guess they're thinking about pulling out of that after we just rewrote our curriculum to align with that…If we could just do the same thing for a while, I'd be good at it then.

Although Andrea had been teaching for more than a decade, she felt as though she could never quite get a handle on teaching because of the constant changes, especially changes related to curriculum and standards.

Push to integrate technology. Another substantial extrinsic change was the push to integrate technology in classrooms. All of the interview participants shared that their administrators were requiring them to use more technology in their classroom without providing them with technical support, high quality technology tools, or opportunities to learn how to effectively incorporate technology into lessons. The main challenges that the participants faced were access to technology and technical support. Although technology was often viewed as a tool for improving student engagement, the teachers did not have the instructional or technical support for effectively incorporating various technologies into their classrooms.

New trends in the field of education. The third most commonly discussed extrinsic change was new trends in teaching and learning best practices. Four of the interview participants described how their administrators liked to be on the cutting edge and often required all of the teachers in their school to implement the latest best practices and new ideas in the field of Education. While exploring the latest educational trends could help teachers learn new teaching strategies, the problem with this type of extrinsic change was that it often occurred without any support. The following quotes demonstrate the extrinsic changes that two of the interview participants faced during the previous school year:

> Alex: It had to do with this year when they told us "okay we're switching to common core" and nobody (of my higher ups) could tell me what that meant, so I had to go do some research.

> Grace: A good example, we're starting standards-based report cards and our first meeting was in May and our principal had no guidance for how he wanted us to do this. He just pretty much sent us five or six samples from other school districts somewhere around the world and said, "Here they are." No guidance, no backup, no nothing. He just likes the fact that we're discussing standards based report cards and he considers that to be pretty cutting edge at the moment, but he has no idea what he needs to do to support you in order to make that happen.

Alex and Grace were both forced to make changes, and yet they were given little direction as to how to effectively make those changes. Andrea shared how extrinsic changes made it difficult to be successful as a teacher:

> In Michigan it feels like every year we're expected to do something different and it makes it very hard. It makes it very hard to become a good teacher. I've been doing this for 14 years but when the roles keep changing it makes it hard to keep up.

As Andrea's local school activity system changed on an ongoing basis, she sought knowledge in the MSC in order to keep up with all of the changes.

All three of the contradictions caused by extrinsic change occurred as a result of tensions between the rules (e.g., integrating new technology), tools (e.g., lack of professional development and funding), and object (e.g., implementing new knowledge) in the teachers' local activity systems. The introduction of new rules led to changes in the local school activity systems. As a result, the teachers had to find a

way to adapt to their new school activity systems. These extrinsic changes motivated the teachers to seek help beyond their school activity system by soliciting knowledge and support from the MSC.

Intrinsic change. Intrinsic change occurs when teachers are motivated to transform their local school activity system. Intrinsic change often stems from contradictions between the subject, tool, community, and object. In school settings, tools (e.g., curriculum, resources, and funding) and an unsupportive community can limit the subject's ability to achieve an outcome (e.g., engaging students in learning).

Professional development. All ten of the interview participants shared how the tools in their local school activity system shaped their ability to engage students in learning. The most commonly cited tool that affected the participants' pursuit of the object was professional development. Four of the participants did not have professional development opportunities due to budget cuts. For the participants that did have professional development opportunities, they felt that these opportunities were a waste of time. Additionally, the interview participants felt that professional development was neither timely nor accessible. Without access to learning opportunities, the teachers did not have the tools they needed to pursue the object of implementing new knowledge in order to achieve the outcome of engaging students in learning.

Curriculum. Another tool that influenced the subjects' pursuit of the object was the curriculum. Five of the interview participants described how their curriculum was *dry*, *boring*, and *monotonous*. For these five teachers, the dullness of the curriculum provided a significant challenge to engaging students in learning.

This contradiction between the local tool and the object motivated these teachers to branch out beyond their local activity system in order to find more effective ways of achieving the object.

Funding. The interview participants also mentioned how availability of funds influenced their ability to engage students in learning. The majority of the participants reported that they did not have any funding for buying resources, textbooks, or materials for students during the previous school year. Without funding or high quality resources, the interview participants struggled to achieve the outcome of improving student engagement in learning.

School community. The interview participants also felt that their local school community affected their ability to find new ways to engage students in learning. The participants described how the lack of collaboration opportunities in their schools hindered their ability to learn or create new strategies for improving student engagement. More than half of the participants shared that they were not able to find the knowledge and support they needed from the teachers and administrators in their school community and this significantly impacted their ability to implement new knowledge in order to achieve the outcome of improving student engagement in learning.

In summary, all of the interview participants reported that they were not satisfied with the *status quo* of their local school activity system. They were given the task of engaging students in learning a challenging subject with little support and few, if any, tools. These teachers were experiencing contradictions between the tools available, their school community, and the object they were pursuing. This resulted

in a desire to transform the activity system. Rather than waiting for professional development opportunities or adhering to the dull curriculum, the interview participants were motivated by intrinsic change to transform their activity system.

Intrinsic and extrinsic change. Interestingly, the interview participants described both a desire to make changes to their local school activity systems and a desire to find ways to keep up with the extrinsic changes that transformed their local school activity systems. They wanted to change the *status quo*, and yet, they were also bombarded with new rules, regulations, requirements, and standards. The most pressing problem that teachers faced as they navigated their local school activity systems was the lack of support and professional development opportunities for acquiring knowledge that would help them keep up with all of the changes or to make new changes. Ultimately, the interview participants faced multiple contradictions between the tools, rules, communities, and object in their local school activity system.

These contradictions were a driving force that motivated the participants to seek shared knowledge in the MSC. The participants used the MSC as a tool to create change within their local school activity system and to keep up with the extrinsic changes. The MSC was both a tool for transformation and a tool for stability.

Overall, as the participants pursued the object of implementing knowledge to improve student engagement in learning, they faced multiple contradicting variables. As a result of these contradictions, the participants used the MSC as a tool to support their pursuit of the object.

Culture and History

After exploring both activity systems, I found that the culture and history of teacher learning in the participants' local schools differed significantly from the culture and history of teacher learning in the MSC. The participants' local schools were shaped by rules, regulations, parents' demands, students' needs, and limited budgets. The participants' local schools seemed to be shaped by hierarchies of power with student learning at the top of the school model and teacher learning at the bottom. The participants felt that their local schools' tools and rules restricted their ability to pursue the object of implementing new knowledge in order to achieve the outcome of improving student engagement in learning. Since the participants faced multiple contradictions, they had to branch out beyond their school walls to find a more supportive culture of teacher learning.

As opposed to the participants' school culture of regulations and requirements, the culture of teacher learning in the MSC was defined by autonomy and risk-taking. The MSC was a space for freely exchanging knowledge and ideas, enacting different roles, and using tools shaped by the community. The members did not face prohibitive rules or regulations. They could take on varying roles and share their expertise. There was no hierarchical model of power. Instead, learning was a teacher-centered process in which members shared knowledge with one another.

Ultimately, the participants' knowledge seeking actions were shaped by two contrasting cultures: local and online. The culture of teacher learning in the participants' local school activity systems was shaped by rules, regulations, restrictions, limitations, and an unsupportive community. On the other hand, the

culture of teacher learning in the online MSC was shaped by openness, risk-taking, and transformation. Both of these cultures played a role in shaping the participants' abilities to acquire and implement shared knowledge in order to improve student engagement in learning.

Conclusion

Using the CHAT framework as a guide, I was able to explore the tools, communities, divisions of labor, rules, and contradictions that shaped the interview participants' local school activity systems.

The interview participants seemed to face many dualisms that affected their ability to pursue the object of engaging students in learning. The participants described how technology could be used to improve student engagement; yet, their technology usage was limited by access to technology and technical support. The participants believed that professional development opportunities would help them get out of being "stuck in a rut" and find new ways to engage students in learning; yet, they considered their professional development opportunities a waste of time. The participants also seemed to work in schools where their main support community (e.g., teaching staff and administrators) disregarded their efforts, and sometimes even created additional obstacles, for pursuing the outcome of engaging students in learning. Additionally, the local school activity system rules challenged the teachers to improve; yet, they were not given the tools or support for adhering to the rules.

Overall, the interview participants faced multiple contradictions that affected their ability to engage students in learning. The main theme underlying the participants' perceptions about their local school activity systems was the lack of support and professional development opportunities. Without access to new knowledge, resources, ideas, and collaboration opportunities, the participants were left to their own devices to figure out how to manage all of the challenges in their local school activity systems.

The combination of contradictions and isolation motivated the participants to seek knowledge beyond their school walls. The participants found that they could use the MSC as a tool to both make changes and keep up with the changes in their schools. The MSC provided the participants with access to new knowledge and the collective wisdom of thousands of educators around the world.

Thus, in an effort to achieve the outcome of engaging students in learning, the participants realized that they had to use an external resource (the MSC) to overcome the competing elements and contradictions within their local school activity systems.

CHAPTER VI:

NAVIGATING MULTIPLE ACTIVITY SYSTEMS

In the previous two chapters, I examined two activity systems that shaped the participants' acquisition of new knowledge from the Edmodo Math Subject Community (MSC). Both of these activity systems were made up of a complex web of competing, and often, contradictory, sociocultural factors that influenced the teachers' technology-mediated knowledge acquisition process.

In this chapter, I will describe how the interview participants navigated between these two activity systems to acquire knowledge. I will then examine how this process of acquiring knowledge in a global online community influenced the interview and survey participants' beliefs about their teaching and learning strategies.

RQ4: How do Teachers Navigate Between Their Local School Activity System and the Global Math Subject Community Activity System in Order to Acquire New Knowledge?

The MSC is a Practice-Based Crowdsourcing Platform (PBCP) that provides access to valuable knowledge that has been vetted and endorsed by other educators. However, the shared knowledge in the MSC was often abstracted from the local contexts in which it was used. Teachers had to find knowledge in the MSC that they could adapt and implement in their classrooms. This required the ability to navigate between the local school and the global MSC activity systems. This process of

navigating between two overlapping activity systems was shaped by multiple sociocultural factors (see Table 6.1).

Table 6.1

Local and Global Activity System Sociocultural Factors That Influence the Knowledge Acquisition Process

	Local Activity System	Global Activity System
Subject	Willingness to try new things Free time	Confidence in using technology
Tools	Technology Curriculum & Standards Funding & Resources Professional Development	Community Wall Search Engine
Community	Classroom Community School Community Local Community	MSC Members
Division of Labor	Students Parents Administrators Teaching and support staff	Grade level Subject taught Years of teaching experience MSC Roles
Rules	"Teachers can always improve" Push to integrate technology Push to try new pedagogies Push to meet or exceed CCSS	Reciprocity Professionalism
Object	Implement knowledge	Acquire knowledge
Outcome	Improve student engagement in learning math.	

The ability to acquire knowledge in the MSC was influenced by the subject's role, the knowledge and division of labor of the community, the MSC tools, and the community members' efforts to enact the rules and norms of reciprocity and sharing high-quality resources, information, and ideas. Additionally, the process of

implementing knowledge in the classroom was shaped by the tools, communities, and rules that made up the subject's local school activity system. Ultimately, the dialectical relationships between these elements and within the local and global activity systems influenced how subjects pursued the objects of finding and implementing knowledge that could potentially improve student engagement in learning.

Model of Teacher Knowledge Acquisition

I asked the participants to describe the sociocultural factors that influenced how they navigated between two activity systems to acquire new knowledge. Based on the participants' responses, I developed a Model of Teacher Knowledge Acquisition (see Figure 6.1) that displays the fluid, ongoing process of navigating between two overlapping activity systems to find new knowledge. This model builds on Shulman's (1987) Model of Pedagogical Reasoning and Action by integrating the sociocultural elements and activity systems that shape the process of knowledge acquisition.

In this model, the process of knowledge acquisition begins with the definition of the main goal, or *object*. The teacher then *finds* knowledge in the global activity system in order to achieve the object. The action of finding knowledge bridges the local and global activity systems. Finding knowledge is a three-step process (assess, select, and curate) that is shaped by both the global and local school activity systems. After finding and curating new knowledge, the teacher *adapts* the knowledge to meet the students' needs before *implementing* it in the classroom. In the final step, the

teacher *evaluates* the effectiveness of using the new knowledge in the classroom, and then, redefines the object or defines a new object.

The process of knowledge acquisition is shaped by the dialogical nature of the internalization-externalization phenomena. The teacher participates in the interpsychological process of co-constructing knowledge with an external community, then internalizes the knowledge, and finally, utilizes the knowledge in an external setting (e.g., their classroom). Throughout this process the teacher and the MSC global activity system were mutually transformed.

In the following paragraphs, I will provide additional details about each part of the Model of Teacher Knowledge Acquisition.

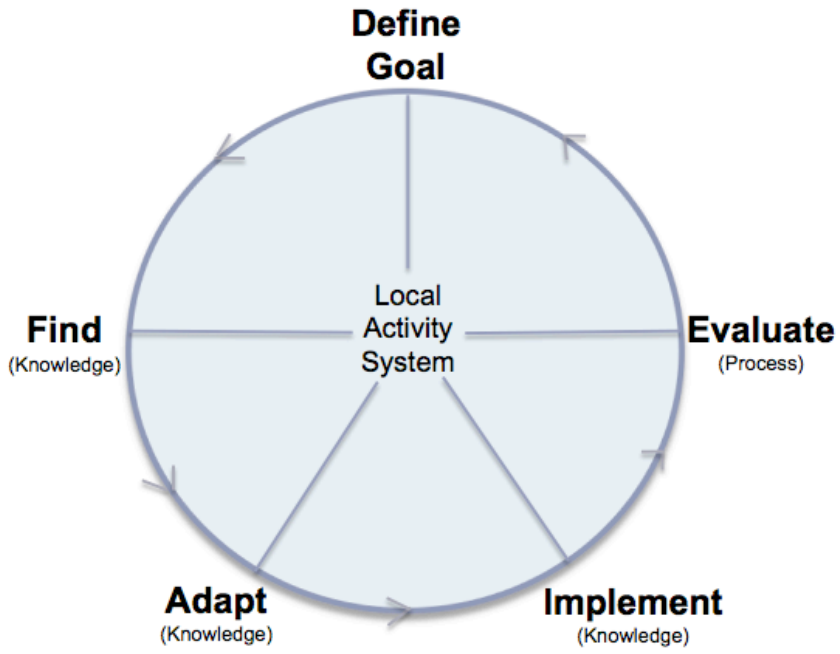

Figure 6.1. Model of Teacher Knowledge Acquisition in a global Practice-Based Crowdsourcing Platform.

Define goal. The first part of the knowledge acquisition process is defining the goal. The process of defining the goal occurs in response to the contradictions that shape the local activity systems. The interview participants faced many contradictions, such as having to teach a dull *curriculum* with limited *funding* for new *resources* without *support*, *collaboration*, or *professional development* opportunities. For the interview participants, their goal was implementing new knowledge in the form of information, resources, and ideas that would improve student engagement in learning math. The participants described how they typically looked for interesting, different, and new Curricular and Pedagogical Content Knowledge that they could use to make learning more interactive, relevant, and meaningful for their students.

Find knowledge. The action of defining a goal shapes the way a teacher acquires knowledge. The participants mentioned three methods of finding knowledge in the MSC: 1) browsing the community wall, 2) using the Edmodo search engine, and 3) posting a request for action. The interview participants who had specific goals, such as finding new ways to engage students in learning probability, would generally use the search engine or post a request for action on the community wall to find knowledge. The participants who defined a general goal of finding knowledge to improve student engagement typically browsed the community wall.

The action of finding knowledge was influenced by the sociocultural factors within the MSC global activity system. The community wall was an ever-changing source of information. The community wall only featured 20-30 of the most recent

discussion threads. Therefore, members who browsed the community wall would only find knowledge that had been shared relative to when they visited the community. This meant that the knowledge that members found depended on the expertise of the other community members who had logged into the MSC within a similar timeframe. In order to access the entire collective knowledge of the community, a member had to use the Edmodo search engine. However, the search engine only showed previous discussion threads. So, if a member searched for a topic that had not yet been discussed in the community, he or she would not be able to find that specific knowledge.

The action of finding knowledge was also influenced by the MSC click-counter tool. The click counter was embedded into every post that included a shared resource, such as a link to an external website. Any time a member clicked on the shared resource, the click counter increased. The majority of the interview participants described how they were more likely to look at posts with a high click counter number. Thus, the action of finding knowledge was shaped by the social influence of the other members in the MSC.

Additionally, the participants' roles shaped the way they used the MSC tools to find knowledge. The participants who described themselves as Contemplators and Curators were only willing to browse the community wall to find knowledge. The participants who described themselves as Crowdsourcers posted requests for action on the community wall. Contributors actively exchanged knowledge and engaged in conversations in the MSC.

Finding knowledge in the MSC was also influenced by the community members' enactment of the implicitly understood rules and norms. These rules included being positive and professional, sharing high quality resources, and responding to other members' requests. These implicit rules created a culture of knowledge sharing, reciprocity, and respect. These rules were also essential for maintaining an active flow of authentic knowledge sharing on the community wall.

Iterative Process of Finding Knowledge. According to the interview participants, finding knowledge in the MSC was an iterative process of assessing, test, and curating the shared knowledge (see Figure 6.2). One of the main challenges that interview participants faced while using the community wall as a tool to find knowledge was the disorganization of the knowledge stream. The interview participants described the community wall as a *messy*, *unorganized*, *hodgepodge* of shared knowledge. According to the interview participants, the discussion threads on the wall were not organized and they rarely included important details such as grade level or descriptive context. In order to overcome this limitation, the participants had to be active in the knowledge acquisition process by assessing, pilot testing, collecting, organizing, and saving the shared knowledge.

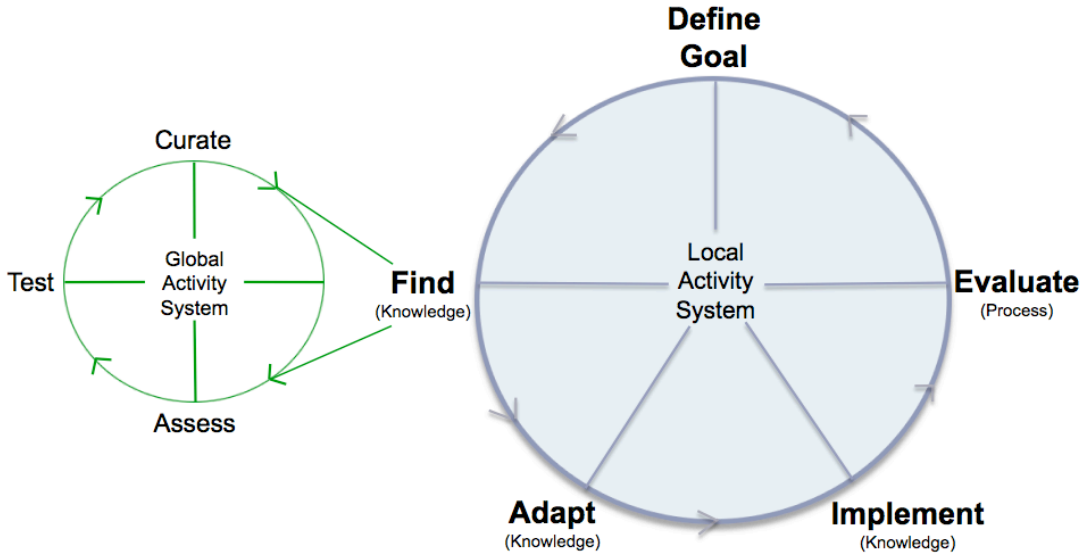

Figure 6.2. The Iterative Process of Finding Knowledge in the Model of Teacher Knowledge Acquisition.

Assess. After a teacher found a discussion thread with knowledge worth exploring, the next step was to assess the credibility and effectiveness the shared knowledge. The interview participants described two means of assessment: members' replies and selection criteria.

Members' Replies. The majority of interview participants read the replies to a shared knowledge post to determine whether to use the shared knowledge in their classroom. If a member replied that the shared knowledge did not work with a specific grade level or with a certain sub-group of students, this would help the interview participants evaluate whether to use the shared knowledge in their classroom. Additionally, if multiple members showed appreciation or support for a shared knowledge post (e.g., "I love LearnZillion!"), the interview participants were more willing to try the knowledge. Andrea gave an example of a time she was

motivated to explore and implement a new resource based on other members' replies to the post:

> I saw somebody had posted something about the website Mathelicious.com and there were a lot of people who had commented under that [post] who had said, "Oh I love that! That's a great site. Good idea!" So, I thought okay, I'll go check it out and I did. I thought it seemed to fit with what I was teaching and it was engaging so I added it as something I did in the classroom.

The community members' replies to the post played an important role in shaping how the Andrea assessed the shared knowledge. Because Andrea read so many positive reviews about the Mathelicious website, she was more willing to explore the resource and try it in her classroom.

Cecilia also found members' replies to post to be just as valuable as the post itself. Cecilia explained how members' replies to shared knowledge posts often included ideas for adapting and implementing the shared knowledge as well as alternative options:

> If there's a lot of responses, I'll read the comments and see what people said, because a lot of times people will say, "Hey this website is good for whatever," and then somebody will say, "This website is kind of like that but it's a little bit different." There are multiple resources within the comments sometimes, so I'll go through and look at those as well.

Ultimately, members' replies to posts helped the interview participants assess the effectiveness and credibility of the shared knowledge. This action of assessing

knowledge was shaped by the social influence of the members in the global activity system.

Selection Criteria. The interview participants also developed a set of selection criteria, based on their local school activity system, to assess the credibility and effectiveness of the shared knowledge. While each participant had specific selection criteria related to his or her local classroom contexts and goals, there were four main selection criteria shared among multiple participants: fit within state standards, perceived level of engagement, perceived difficulty of using technology, and funding.

Fit within state standards. The majority of interview participants listed the state standards as the number one criterion for selecting new knowledge. These participants only looked for shared knowledge that was directly aligned with their state standards. Grace explained how she barely had enough time to cover all of the state standards in her classroom, and therefore, if a shared knowledge post did not fit within her state standards, she would immediately skip it. James shared that since he had been teaching for such a long time, he knew exactly which shared knowledge posts fit within the standards he had to cover, which allowed him to quickly scan the MSC community wall to select the most relevant knowledge for his classroom.

Perceived level of engagement. The second most important selection criterion, according to the interview participants, was the perceived level of engagement. The interview participants used terms such as *fun, appealing, interesting, interactive,* and *authentic* to describe the types of shared knowledge they selected in the MSC.

Grace thought it was essential to select new knowledge that was engaging because if students were not actively engaged in learning in her classroom, they were not giving their full effort; and therefore, she could not assess their true math abilities. As a result, Grace often sought out and selected new knowledge that could improve her students' engagement in learning:

> If the kids are bored out of their mind, then the answers I'm getting aren't accurate. So [the new knowledge] has to explicitly fit the standard and it has to give enough student engagement that I can guarantee that their answers are valid.

Grace often selected online games because she felt these were appealing and attractive to her fifth grade students. For example, Grace described why her students enjoyed the Zondle website: "It looked more like a game and it was more play inspired. It was colorful and it was engaging and there were levels to go through and things blew up." Grace felt that the interactivity and playfulness of games would help improve students' engagement in learning.

Additionally, many of the interview participants felt that it was essential to only select knowledge that was authentic and meaningful. Sarah and Cecilia specified that they only selected online resources and new ideas that did not have any resemblance to worksheets or activities that they would find in textbooks because these tasks rarely piqued their students' interests. Megan shared how she only selected knowledge that was realistic and relevant to the students' lives. Megan provided an example of an online website that claimed to provide real-world problem-solving tasks; yet, the tasks were trivial, like measuring pieces of fabric.

Megan felt that the shared knowledge had to be authentic and relevant in order to improve students' engagement in learning. Rachel also felt that it was essential to select new knowledge that could help prepare students for the real world. Rachel explained: "I try to find a lot of math stuff that can connect students with possible careers in the future." All four of these participants felt that if they were going to find new knowledge to try in their classrooms, they had to select the most relevant, meaningful, and engaging shared knowledge.

Perceived difficulty of using technology. The interview participants also weighed the challenges of using technology when deciding whether to select new knowledge. Mia, Megan, and Andrea shared how they had limited access to technology in their schools, and therefore, they tended to select knowledge that could be implemented without technology. The majority of the interview participants also evaluated the complexity of using technology when selecting new knowledge. The participants often selected online resources or new learning activities that were simple to setup, easy to use, did not require logging in or passwords, and did not have too many directions. If the participants perceived the use of technology to be too demanding or complex, they would not select that shared knowledge.

Funding. Eight out of the ten participants listed funding as another essential selection criterion. These participants felt that the limited availability of funding for resources in their schools restricted their ability to select new knowledge. Andrea shared an example of how funding shaped the shared knowledge that she selected:

> There's a great school 21 app in Edmodo that I'd really like and I was able to get a free trial, but it's $50 for each period and I would need five of them for

> next year. There's no money in the budget for that so that will probably not happen for me next year. So funding is an issue.

Andrea felt that her school's limited budget affected the types of knowledge she was able to select and implement in her classroom. Many of the participants reiterated this same point—if a shared knowledge resource or learning activity required funding, they did not have the support to try it in their classrooms.

Overall, the action of selecting knowledge seemed to be shaped by the tools and classroom community in the participants' local school activity systems.

Test. Testing, or pilot testing, is the action of trying out the shared knowledge before implementing it in the classroom. Pilot testing often only occurs when teachers have selected *online resources* that they would like to implement in their classroom. Teachers often pilot test these resources to determine whether they will help them achieve the goal.

Nine out of the ten interview participants stated that they pilot tested all of the shared knowledge resources that they selected from the MSC. While the majority of the interview participants pilot tested resources to determine whether they met their selection criteria, some of the participants also pilot tested resources to determine how the resources would influence students' learning.

Cecilia, James, Christine, and Alex described similar pilot testing strategies. They created student accounts and explored the online resource the way a student would. Christine explained how she often put in wrong answers to see what type of feedback her students would get. Cecilia described how she pilot tested online resources to find out whether they were just "drill and kill" type games or whether

they actually provided effective learning opportunities. James pilot tested online resources to examine what type of features they provided. For example, James often looked for online resources that had chat rooms in order to allow for collaboration between students. James also tested the workflow to determine what type of product or end-result the students would have after completing the online activity. Alex felt that he had to pilot test all of the shared knowledge posts in order to select the ones that were of the highest quality. He felt that with so many free online resources available, it was his job to find the best and most effective ones to share with his students.

Grace was the sole participant who did not pilot test everything she found in the MSC. She discovered the hard way that some of the online resources that she introduced in her classroom were not high quality. For example, Grace found that a few of the games on Zondle provided incorrect solutions or flawed examples for solving problems. She also found that some of the online resources forced all of her students to learn math at the same level, while other resources were too boring. Grace considered her trial and error method to be ineffective: "I have a tendency to jump in with both feet and not flesh things out as well as I should and I really got nailed square in the head with it a couple times last." Grace planned on pilot testing all of the shared knowledge posts from the MSC in the future.

Overall, the participants found pilot testing to be an essential part of selecting knowledge to use in the classroom.

Curate. Curation refers to the action of collecting and saving shared knowledge. The interview participants described the MSC community wall as a

constant stream of knowledge that was messy and unorganized. Therefore, members had to find ways to collect, organize, and save relevant shared knowledge for use at a later date. Alex described how there were so many resources and ideas in the MSC, that rather than reinventing the wheel, his goal was to curate the shared knowledge and use it in his classroom. Megan and Cecilia explained how browsing the MSC community wall could be "frustrating" because if they did not organize and save the knowledge they found, it would be hard to find again. Ultimately, curation helped reduce the cognitive load of acquiring new knowledge in an online environment that was messy, unorganized, and overflowing with shared knowledge.

The action of curating knowledge was shaped by the global activity system tools. All Edmodo users had access to a virtual library where they could store resources, ideas, documents, and other shared knowledge that they found in the various subject communities and groups. The library stored the users' data in the *cloud*, which meant that it could be accessed from any device at any time. However, only two of the interview participants used the Edmodo library to curate the shared knowledge from the MSC. The library did not allow users to organize or filter shared knowledge by grade level, subject, or standard. I did not have a chance to probe the interview participants' responses in order to determine whether their lack of use of the Edmodo library was due to its inability to sort and categorize knowledge or whether the participants were just unaware of the library tool.

The majority of the interview participants used other information aggregation tools such as Symbaloo, Livebinders, classroom websites, and email to curate information. Rachel curated all of the useful shared knowledge resources from the

MSC on her classroom website. Sarah, Grace, and James used Symbaloo and Livebinders to collect and organize the shared knowledge from the MSC. Symbaloo and Livebinders are free social bookmarking tools that allow individuals to store, organize, and share online resources. Grace described how she curated knowledge from the MSC: "I've got one Symbaloo setup for each math standard. Each Symbaloo has all the games, activities, lessons, quizzes, and everything that you would need to do to introduce, cover, flesh out, RTI, differentiate that standard." Grace preferred using Symbaloo because it was easy to setup and navigate, visually appealing, and allowed her to organize knowledge by standards.

Some of the interview participants described a two-step process to knowledge curation. First, they would bookmark the website or email the shared knowledge to themselves. Then, they would assess the shared knowledge when they had more free time. If they found the shared knowledge to be appropriate for their students, they would organize it on a website or social bookmarking site. This two-step process often occurred when interview participants only had a few minutes to browse the MSC wall. In order to curate the most amount of knowledge possible in the shortest timeframe (e.g., before bed or between class periods), the participants would quickly browse the wall and email or bookmark the relevant shared knowledge. When they had more time, they would assess the knowledge and then organize it.

The type of tool a participant used to curate shared knowledge from the MSC was shaped by the participant's role in the community. The interview participants

who described themselves as Contemplators were more likely to use the Edmodo library or email to curate shared knowledge.

On the other hand, the interview participants who described themselves as Curators or Contributors were more willing to use third-party sites, like Symbaloo, or their own websites to curate knowledge. They often used these third-party tools in order to be able to share their collections with students and teachers in their schools, districts, and other networks. Rachel described how teachers in her district benefited from the knowledge that she curated:

> I probably have 400 math games bookmarked on my website and I have teachers across the district tell their kids, 'Go to Ms. H's website and play one of the games,' because they know that I've got everything from fractions to geometry available for free, so they might as well take advantage of it.

Sarah, Alex, and James also shared that they distributed their websites to teachers in their schools and individuals in their online social networks. For these participants, the action of curating knowledge was a socially constructed process since they found, assessed, and organized knowledge that could also benefit their networks of colleagues.

It was also possible that the Curators and Contributors were more confident in using technology in general, and therefore, more willing to try third-party information aggregation tools. Further research is needed to explore the relationship between the member's roles, use of tools, and confidence in using technology.

Overall, a teachers' ability to find new knowledge required the capacity to navigate between two overlapping activity systems. The action of finding new

knowledge in a global activity system was shaped by the tools available and the knowledge and social influence of the community. Moreover, the local school activity system sociocultural factors, such as standards, funding, and technology, shaped the types of shared knowledge the teacher found and curated.

Adapt. The knowledge that is shared in a global online community is often general and abstracted from the local contexts in which a teacher works. Therefore, the teacher needs to adapt the shared knowledge from the global activity system so that it can be used in the classroom. All ten of the interview participants stated that they adapted the shared knowledge from the MSC before implementing it in their classrooms. When I probed the idea of adapting shared knowledge more in-depth, I found that the participants performed three different types of adaptations: differentiation, augmentation, and transformation. The action of adapting the shared knowledge was typically shaped by the classroom community and the availability of tools in the participants' local school activity systems.

***Differentiation*.** The participants described how they adapted the shared knowledge from the MSC to make it accessible to all of the students in their classes. Sarah and Rachel shared how they adapted the shared knowledge by differentiating it for their students. For example, Sarah found the popular math games website Zondle in the MSC and adapted it to her students' math levels. She assigned her students to play games at varying levels of difficulty. Sarah also had her advanced students create their own games in Zondle rather than just playing games. Rachel also described how she adapted the shared knowledge that she found in the MSC.

The following two quotes provide examples about how Rachel and Sarah adapted the shared knowledge they found from the MSC:

> Sarah: I can tell who knows their time tables and who doesn't, so I might put the ones that I think need practice on that game and others that are ready to do something with the time tables on another game. I might adapt the game or adapt which games students are on depending on what I know about them.

> Rachel: I use a lot of stuff from the Math Subject Community. I pretty much have to adapt everything. I don't think there's anything that I use straight out of the box. But, of course, I can't tweak a website, but maybe I'll say, "I really want you to play this level of this game" or "Work on this portion of this activity."

In these examples, Sarah and Rachel describe how they adapted the shared knowledge from the MSC in order to meet the varying math levels of the students in their classes.

Augmentation. Another form of adaption, according to the interview participants, was supplementing the shared knowledge. Christine explained how she created graphic organizers to help students learn from videos, websites, and other online resources that she found in the MSC. Megan, Alex, and Sarah adapted the resources they found by adding worksheets, quizzes, or other types of formative assessments in order to examine how their students used the online resource or learned from the new activity.

Transformation. The third type of adaptation was the transformation of the shared knowledge. For Mia, transforming the shared knowledge was as simple as changing the landmarks or places in a word problem to ones that her students would recognize.

Conversely, Sarah, James, and Cecilia conducted more comprehensive transformations of the shared knowledge they found in the MSC. Sarah transformed an online game into a hands-on, interactive activity. Sarah shared how she found a fun online probability game that involved selecting a certain ratio of different colored fish in an aquarium. Sarah created a low-tech version of this game, in which her students were given real aquariums and different colored goldfish. The students could manipulate the ratio of fish in the aquarium by hand. Sarah felt that her students enjoyed this version of the activity much more than the technology-based online game.

James did the opposite of what Sarah did and incorporated more technology into the activity he found in the MSC. James shared,

> Somebody said they did a project on how would you spend $1 million and I thought, "Oh that sounds kind of fun." Each year we would just adapt that project. The first year we actually made the collage, then I was like, we could make a Glogster and save paper. Then we moved over to Padlet, and now students make it into an iMovie video or Animoto animation. So, you can just keep adapting the same project but make it a lot cooler as the technology gets better.

James found that new technologies could vastly improve the shared knowledge that he found in the MSC.

Cecilia, on the other hand, asked her advanced students to transform the ideas, resources, and activities that she found in the MSC. Cecilia explained how she would share the knowledge that she found in the MSC with her students and ask them to "create questions to go along with the website" or "create a learning activity" to go along with a resource she found. Cecilia felt that her students were more invested in the activities and in using the online resources when they could adapt them to their own skill levels.

Overall, adapting shared knowledge was a multi-dimensional process that could be done in many ways. All of the interview participants agreed that adapting the shared knowledge they found in the MSC was essential in order to ensure that it met the math abilities of their students. Additionally, the action of adapting shared knowledge was critical when teachers found new knowledge outside of their local school activity systems. Adapting shared knowledge allowed teachers to transform general, and often abstract, knowledge into something practical, relevant, and ready to be implemented in their classrooms.

Implement. The implementation phase of the Model of Teacher Knowledge Acquisition refers to the way that teachers use the shared knowledge in their classrooms. When examining the MSC community wall posts, I found 62 replies in which a teacher mentioned that he or she was interested in implementing the shared knowledge in his or her classroom. Here are some examples of the replies related to implementation:

- “Excellent! I'll use this for math intervention.”
- “Thank you! Great idea on working backwards. I'll definitely try some of these. I know they'll love the robber concept.”
- “These are awesome! Change of plans for tomorrow....Thanks for sharing!!”
- “Thanks for sharing! I'll be using the transformation lessons next week!”
- “Thank you! I'm going to use this as a social skill lesson involving teamwork and sneak some math in there.”

In these replies, the teachers showed appreciation for the shared knowledge in the MSC and expressed enthusiasm for trying the new knowledge in their classrooms.

To further examine the implementation phase, I asked survey respondents to give examples of how they implemented shared knowledge from the MSC in their classrooms. Out of the 87 respondents who shared examples, 48 (55%) integrated a resource (e.g., online website, new app, homework tracker document) into their lessons, 36 (41%) used new strategies or ideas for teaching a math topic, and 3 (4%) tried new lesson plans. In general, the survey respondents were using the shared knowledge to enhance or supplement their lesson plans.

I continued to probe the action of implementation with the interview participants. I found that the interview participants implemented shared knowledge in a variety of ways. Christine explained how she used the shared knowledge from the MSC as “overall instruction, as individualized instruction, and then as

remediation." Christine shared how she often used videos that she found in the MSC to introduce lessons and online math websites to supplement lessons.

Alex implemented the shared knowledge he found during the daily warm-up activity. For example, Alex once used a short music video that he found in the MSC as a warm-up activity. He explained how he showed only part of the video and told the students that if class went well, they could finish the video at the end of class. He found that his students' behavior changed significantly because they wanted to see the rest of the video.

Direct instruction. The majority of the interview participants implemented the shared knowledge directly into their lessons. James shared how he integrated a Fantasy Football resource into his Football Friday lessons. Grace used the online resource, PowerMyLearning, for direct classroom instruction. Sarah explained how she integrated new resources or ideas into her lessons; however, there were also times when she created new lessons to fit the shared knowledge she found in the MSC.

Supplemental instruction. Another way the interview participants implemented the shared knowledge was as a supplement to class instruction. Megan and Cecilia often assigned the online resources they found in the MSC as homework for their students. Sarah shared the resources she found in the MSC with her students in case they needed extra practice. Sarah explained, "I post the online resource on my Edmodo class page and I'll say, 'You guys learned how to do probability today, go out on this site, you're going to love this game.'" Sarah felt it was important to share the online resources and enrichment activities that she found in the MSC with

her students so that they could spend additional time learning the content that she taught in class. Alex also posted online videos, games, math websites, and other resources he found in the MSC on his Edmodo class pages. He felt that if he connected students to the supplemental resources through Edmodo, they would be more willing to try these resources on their own.

The interview participants also used the shared knowledge to provide supplemental instruction for groups of students or specific individuals. Sarah stated that her English Language Learner (ELL) students were struggling with multiplication facts, so she sought out multiplication resources in the MSC and shared these with her ELL students. Andrea explained how she shared relevant online resources with students who needed additional practice with certain math concepts. James explained how he sought out and shared online resources with a student who was at least one grade level behind in his math skills:

> I used to give him extra stuff all the time. I was always trolling and looking for stuff. I would give that extra stuff to his mom and ask her to have him practice on his own because what we were doing in fourth grade was way over his head.

In this example, James used the shared knowledge in the MSC to help bring a student up to his grade level. All three of these interview participants used the resources and ideas they found in the MSC to provide differentiated enrichment for students in their classrooms.

The action of implementing shared knowledge seemed to be shaped by the participants' local school activity systems. The classroom community played an

important role in how the participants implemented new ideas and resources. According to Grace and Rachel, the students' willingness to try new resources, activities, and lessons encouraged their use of shared knowledge in the classroom. Additionally, the interview participants who had a wide range of math skill levels in their classes were more likely to implement the shared knowledge as a supplemental or enrichment activity. On the other hand, the participants who felt that most of their students were on the same level (e.g., teaching an advanced class) were more willing to integrate the shared knowledge directly into their lesson plans.

The local activity system tools also shaped the action of implementation. The set curriculum restricted the use of new ideas and resources due to timing. For example, when James found a useful geometry resource, he had to wait months to implement the resource because his curriculum did not cover geometry until the end of the school year. To overcome this problem, some of the participants used their Edmodo class pages as a tool for curating and distributing knowledge to students year round.

Ultimately, the interview participants had to take into consideration their students' math skill levels, the timing of the curriculum, and the tools available for sharing knowledge in order to determine when and how to implement the shared knowledge.

Evaluate. In the final step of the iterative process of knowledge acquisition, the teacher evaluates the effectiveness of using the knowledge he or she acquired to achieve the object. For the interview participants, the goal was to implement knowledge with the outcome of improving student engagement in learning. The

participants listed two main ways of evaluating whether the acquisition of new knowledge helped them achieve their goal: observation and student feedback.

Observation. Five of the interview participants used observation to determine the effectiveness of implementing the newly acquired knowledge in the classroom. James described how he would look for student excitement and increased interest in participation. Grace evaluated the reactions of the students when trying new ideas or resources in the classroom. Cecilia observed the students' body language and the way they interacted with one another. Cecilia looked at how active the students were, whether they were leaning in or slouching, whether they were listening attentively, or whether "their eyes rolled up at the ceiling." Mia and Andrea also observed students' behaviors to evaluate the new ideas, strategies, resources, or lessons that they acquired in the MSC.

Student feedback. Another common evaluation strategy was student feedback. More than half of the interview participants shared examples of using student feedback to determine whether the knowledge acquisition process helped them achieve their goal. Sarah and Andrea used the Edmodo class groups to solicit feedback from students. While Andrea used the Edmodo survey tool to solicit more formal feedback, Sarah asked her students to share their thoughts freely on the class group wall.

Grace, Cecilia, James, and Rachel solicited direct feedback from their students during or after implementing new knowledge in their classrooms. Grace worked "side-by-side" with her students when trying new ideas or resources in her classroom and if the students became frustrated or did not like the resource or

activity, Grace would quickly scrap it and try something else. Rachel often asked her students what they thought about the new ideas, resources, and activities that she found in the MSC. Cecilia explained how would ask students questions such as: "Was it fun? Was it confusing? Do you like these types of activities? Where do you guys as a class stand on stuff like this?" She would use the students' responses to evaluate the shared knowledge.

James evaluated new ideas and resources by talking to students and asking them to share their opinions:

> The best way [to evaluate] is just to talk to the students and figure out if they really like it and what they really like about it. We also have them do App reviews or respond to a prompt like, 'What did you like this week?'

James actively sought feedback from students through dialogue, student presentations, and observations. He felt that if his students enjoyed the resource, idea, or activity, then they would be more actively engaged in learning.

Overall, the action of evaluation took place in and was shaped by the local activity system. The action of evaluation was influenced by the subject's observations and interactions with students, the students' feedback, and the tools available to solicit student feedback. The participants who had Edmodo class groups were able to use this as a tool to solicit feedback. The participants also sought feedback through informal conversations and assigned presentations. Additionally, the participants needed to know what and how to observe students' body language and actions in order to determine whether they were engaged in learning.

Evaluation was an essential step in the knowledge acquisition process as it allowed teachers to reflect on their actions and learn from their experiences. As the entire process of knowledge acquisition was driven by the pursuit of a goal, the action of evaluation allowed the teacher to determine whether he or she was successful in achieving that goal. However, the goal, or object, in an activity system is never truly achievable since it changes and grows with the activity system. At this stage in the knowledge acquisition process, teachers often redefine the goal or transform the goal to better suit their needs, and then, repeat the process.

Online Pedagogical Knowledge Literacy

The Model of Teacher Knowledge Acquisition is a complex process with multiple steps and variables. Participating in this process requires an understanding of how to define an appropriate goal, assess the credibility of the shared knowledge, pilot test resources, and curate, adapt, implement, and evaluate effective learning tools. In order to effectively participate in this process of acquiring and implementing shared knowledge from a Practice-Based Crowdsourcing Platform, teachers need online pedagogical knowledge literacy skills. Online pedagogical knowledge literacy is ability to identify, evaluate, organize, and make use of shared knowledge in an online community. Based on these findings, I developed a Model of Teacher Knowledge Acquisition Checklist to support teachers as they develop their online pedagogical literacy skills (see Table 6.2). This checklist will help teachers explore the local and global activity system factors that shape their knowledge acquisition process.

Table 6.2

Model of Teacher Knowledge Acquisition Checklist

Stages	Questions to Ask
Define Object	What is your pedagogical goal?
Find Knowledge	What kinds of knowledge do you need to achieve that goal? How will you find that knowledge? What tools will you use to find that knowledge?
Assess Knowledge	How credible is the knowledge? Have other teachers tried to implement that knowledge in their classrooms? If so, what did these individuals learn and share about the knowledge?
Select Knowledge	How will the knowledge help you achieve that goal? Does the knowledge fit within your curriculum? Does the knowledge fit within the state standards? Does the knowledge fit within your budget? If implementing a technology-based knowledge resource, what are the logistics that you need to consider (e.g., access, technical support, workflow, pilot testing, ease of use, passwords, students' technology literacy)?
Curate Knowledge	What tool(s) will you use to organize, save, and share the knowledge?
Adapt Knowledge	How will you differentiate the knowledge to meet each student's math abilities? How will you supplement the knowledge (e.g., providing a graphic organizer, handout, worksheet, activities)? How can you transform the knowledge to make it more applicable, meaningful, and authentic for your students?
Implement Knowledge	Will you implement the knowledge in direct instruction, for homework, or as a supplemental learning tool?
Evaluate Knowledge	How will you evaluate the effectiveness of the knowledge (e.g., student feedback, student engagement, observation, formative assessments)? How effective is the knowledge in achieving your goal? How can you improve the use of this knowledge for future lessons? How will you reflect and learn from this process? How will you share your findings and solicit feedback from other teachers?

RQ4: Conclusion

In the Model of Teacher Knowledge Acquisition, the teacher navigates between two overlapping activity systems in order to find knowledge in a global online activity system that he or she can implement in the local school activity system. The entire process is driven by the defined goal and shaped by a complex network of sociocultural factors.

The action of *finding* knowledge is the essential part of the process that bridges the two activity systems. During the action of finding knowledge, the teacher must take into consideration the tools (e.g., curriculum, funding, technology), implicit school rules, and the varying demands and needs of the community members in the local school activity system. Additionally, the teacher's ability to find knowledge is shaped by the network of elements in the MSC global activity system that interact with and mutually constitute one another. The teacher must also be willing to take risks and try new things, have time to explore the MSC and find knowledge, and be comfortable using technology as a tool for learning and teaching.

Overall, the Model of Teacher Knowledge Acquisition demonstrates how teachers learn through a socially mediated process of discovery, trial and error, and reflection. In the traditional teacher knowledge acquisition models, a teacher is given knowledge from an outside expert and is expected to implement that knowledge in the classroom. Conversely, the Model of Teacher Knowledge Acquisition is an object-oriented, iterative, social process of navigating between multiple activity systems. Throughout this process the teacher is discovering new knowledge, assessing its credibility, testing it in the classroom, and evaluating the effectiveness

of this process. As the same time, the entire process is socially mediated by the MSC community members, students, teaching staff, and administrators. The Model of Teacher Knowledge Acquisition presents teacher learning as a complex, socially constructed process that is influenced by a web of sociocultural elements that interact with and shape one another.

Further Research

Further research is needed to explore how teachers participate in the different stages of the Model of Teacher Knowledge Acquisition. The Model of Teacher Knowledge Acquisition is a complex process with multiple steps and variables. The participants in this study engaged in this process of acquiring and implementing shared knowledge on their own. The participants did not have training or support for effectively engaging in this process. Many of the participants had not considered the idea of assessing the credibility of the shared knowledge. Additionally, it seemed as though the participants' selection criterion was based on student engagement and state standards rather than whether the shared knowledge would enhance and facilitate learning.

One way to improve how teachers participate in the process of acquiring knowledge from the MSC would be to provide teachers with support and direction. For example, administrators could set up a Professional Learning Community in which the teachers use the MSC as a tool for collaborative inquiry. This would provide teachers with support and allow them to develop appropriate goals, co-construct knowledge, and reflect on their process with other teachers in the school.

The Model of Teacher Knowledge Acquisition could also be strengthened by incorporating Action Research Principles into the process of collaborative inquiry and teacher learning (Winter, 1987). Action Research requires teachers to become reflexive researchers and use theory to inform practice. Incorporating Action Research principles may help teachers identify, assess, and select the most useful ideas and resources for their classrooms. Further research is needed to explore how teachers can be supported and empowered to participate in the stages of the Model of Teacher Knowledge Acquisition.

RQ5: What Are the Ensuing Effects of Participating in This Process of Knowledge Acquisition?

In order to examine the ensuing effects of participating in the process of navigating between two overlapping activity systems to find and implement knowledge, I asked the survey and interview participants to share their beliefs about how this process changed the way they learn and teach. Seventy percent of the survey participants felt that participating in this process changed the way they learned and 64% of the survey participants believed that participating in this process changed the way they taught. Nine out of the 10 interview participants believed that their teaching and learning strategies had changed as a result of participating in the knowledge acquisition process. This section will detail the interview and survey participants' beliefs about their changes in teaching and learning strategies.

Transformation of Learning

Two themes surfaced in regards to the survey and interview participants' beliefs about how this process changed the way they learn: 1) they had more control of their learning and 2) their learning community expanded beyond their school walls.

Control. The interview and survey participants felt that they had more control over their learning compared to traditional teacher learning opportunities, such as workshops and conferences. These participants felt that they no longer had to wait to find knowledge. Instead, they could access ideas, resources, and advice anytime and anywhere. Andrea shared how the MSC provided instant access to knowledge:

> The Math Subject Community made it [the knowledge] more available. You don't have to sign up for a conference and wait for it and drive to it. It's there whenever you want. It's [the MSC is] good for downtime when you're waiting you can just go online and browse.

Andrea appreciated the fact that she could access knowledge whenever she needed it.

Christine described the process of knowledge acquisition as self-paced learning. When she had free time, she could access the knowledge that she needed. If she felt overwhelmed or did not have time, she was not forced to learn. Grace also valued the opportunity of self-paced learning:

> Professional development within my district, I don't feel like I have enough control over, time with, or ability to fully look into, develop, and become comfortable with. The Edmodo stuff is mine. I can decide what I like, what I

> don't like, what I think I want to look into more. I can thoroughly dig around through and figure out how it works for me and be able to actually implement it and mess with it and work with it because it's mine and it's not being dictated by any other form of professional development other than my own personal.

Grace felt that she had much more control over and time for learning when she participated in the process of finding knowledge in the MSC.

The interview and survey participants also felt that they were able to find more practical and relevant knowledge in the MSC. The majority of the interview participants shared how they were able to find knowledge that they could implement directly into their classrooms the next day. This is in stark contrast to typical teacher learning opportunities, such as district-wide workshops, in which teachers are given generalized, and often abstracted, knowledge that may or may not be relevant to their specific needs.

With instant access to authentic, relevant, and practical knowledge, the survey and interview participants felt that they spent more time learning. One of the survey participants shared that, as a result of participating in this process, she now spends time learning on a daily basis. More than half of the interview participants visited the MSC every day during the 2012-2013 school year.

Overall, the survey and interview participants believed that participating in this process allowed them to proactively take control of their learning and find authentic knowledge that met their specific needs. Learning, for the participants, was

teacher-centered and practical, which was in stark contrast to the typical teacher learning opportunities provided by schools, districts, or professional organizations.

Beyond school walls. The survey and interview participants also felt that learning was often confined by the limitations of their schools or districts. More than half of the interview participants shared that they were not able to find the knowledge and support they needed from the teachers and administrators in their school community. Andrea had only two other math teachers in her building that she could share ideas with. Grace was the only math teacher in her elementary school district. Cecilia explained how the teachers in her school had the same constraints and were "stuck in the same box." Thus, the process of learning tended to be limited by the community knowledge and support as well as the tools in the participants' local school activity systems.

Therefore, branching out beyond school walls to learn was a transformative process for many of the participants. These participants were able to tap into the collective knowledge of educators from around the world. Learning was no longer limited by the local school activity system. Instead, learning took place on a global scale. In the following examples, the survey participants share how their learning was shaped by the global collective of educators in the MSC:

- "In the math community, I have colleagues that are sharing from across the planet not just from down my street. This is a tremendous benefit—it enables forward and progressive thinking."
- "Edmodo gives me access to educators and teachers all around the world. Through the Edmodo community, I learned and implemented so many

ideas. In a time in which professional learning opportunities are limited due to expense, Edmodo brings an unlimited amount of the professional community to me."

- "I love that there are many professionals from around the globe in this community. It gives a global perspective rather than just a local one to what I teach."
- "It has helped me grow by being able to share and get ideas from many fantastic educators that I may never meet face to face."

These examples highlight how participating in the process of finding knowledge in the MSC allowed the participants to tap into the expertise of a global community of educators.

The survey and interview participants also described how they felt supported throughout their learning process, which was significantly different from the isolation that many teachers experienced. Rachel and Cecilia felt more confident in learning through trial and error because they knew that if they failed, they could return to the MSC to get feedback and support. Cecilia shared her thoughts about having support from the MSC members:

> Having a network like Edmodo makes you feel like we're all in this together. It makes you think, 'Oh, I'm going to try this and see what happens,' and you feel like you have that support and you can go back and say, 'Now that failed, what do I do now?'

Cecilia believed that learning was not a one-time, isolated experience. Instead, learning occurred through exploration and feedback within a global network of educators. Many of the survey respondents also reported that they felt their learning was no longer isolated or solitary.

Ultimately, participating in the process of finding knowledge in the MSC transformed the way participants learned. The participants felt that they had more control over their learning, they could access personalized and relevant knowledge anytime and anywhere, and the process of learning was supported by a global network of educators.

Transformation of Teaching

Sixty-four percent of the survey participants and 9 out of the 10 interview participants felt that participating in the process of finding knowledge in the MSC changed the way they taught. The participants described three main types of changes: willingness to take risks, increased use of technology, and becoming a better teacher.

Willingness to take risks. The majority of the survey and interview participants believed that engaging in this process increased their willingness to take risks and try new things, such as resources, activities, lessons, and ideas. The survey participants listed increased access to new knowledge and support as the two main reasons they were willing to try new things in their classrooms. One survey respondent shared:

> It [participating in this process] has definitely changed the way I teach. It is easier to learn about new ideas. I have really grown. I am more willing to try new things because I can talk to other educators that are already using the ideas and resources.

This participant felt that she was more willing to take risks because she had instant access to effective ideas and resources as well as the ability to solicit feedback from other educators.

Increased use of technology. An overwhelming majority of the survey and interview participants also felt that they were more willing to use technology in their classrooms. The survey participants felt that using more technology allowed them to keep up with the technological changes in their schools (e.g., 1:1 iPad initiatives), to stay connected with students outside of class time, and to provide differentiation and enrichment activities for different groups of students. Alex explained how he transformed his classroom by using technology in all of his lessons. He also used technology to connect with his students outside of the classroom and to share resources with his classes. Christine and Grace used Zondle, PowerMyLearning, LearnZillion, and other online math websites and games to engage their students in learning. Both of these teachers described how this was a big shift from previous years in which they used very little technology for direct classroom instruction. For the 2013-2014 school year, Grace planned on setting up blogs for all of her students and using ePals to connect her students with other classes around the world.

Additionally, some of the survey and interview participants incorporated more technology via the "flipped classroom" model. Six of the survey respondents

and two of the interview participants discovered the "flipped classroom" model in the MSC. The "flipped classroom" model refers to when teachers deliver class lecture content to students via videos and tutorials that they view at home. Teachers then use class time for interactive exercises and group work. One of the survey respondents wrote about how the MSC provided insight and support for trying the flipped classroom model: "By joining this community I learned about the Flipped model and with the help of the community members I was able to implement that in my class." Rachel, one of the interview participants, shared how she also learned about the "flipped classroom model" from the MSC and implemented it in her classroom:

> One of the teachers on there [in the MSC], she flips her classes and she has a blog now about flipping and was just giving so much information and feedback. So I was like, 'You know, I'm going to try it.' I started flipping two years ago. I'm not saying it's 100% success, but I would never do my advanced math class any other way.

Rachel felt that she became a more innovative teacher as a result of trying the flipped classroom model and for implementing the other ideas and technology resources that she found in the MSC.

Overall, the survey and interview participants reported that participating in the process of finding knowledge in the MSC opened their eyes to new technologies and provided them with support for implementing the new technologies and technology-enhanced activities in their classrooms. However, according to the survey results, the majority of the participants were already using multiple

technologies at least on a weekly basis in their classrooms during the previous school year. Further research is needed to explore how the participants' comfort with and use of technology influenced their actions in the MSC and willingness to try new technologies in their classrooms.

It is also important to note that increased use of technology is not necessarily correlated with the quality and effectiveness of the use of technology as a learning tool. Future studies should explore whether the participants' use of the MSC to implement new technologies in their classroom enhances student learning.

Becoming a better teacher. The survey and interview participants also felt that participating in the process of knowledge acquisition helped them become better teachers. Some of the participants felt that they were more creative and innovative teachers. Three of the survey participants felt that acquiring knowledge from the MSC helped them find innovative and diverse ways to teach math. Cecilia and Megan shared how participating in this process of knowledge acquisition empowered them to be more creative. Rachel also felt that she was a better, and more innovative, teacher as a result of this process. Even though Alex has taught math for more than 20 years, he believes that he is currently "at the top of [his] game" because he constantly finds new ideas, resources, and activities to improve his teaching. Cecilia also explained how she has been able to branch away from the textbooks and curriculum and try more innovative ways of teaching the content.

Many of the teachers also felt that participating in the process of knowledge acquisition allowed them to become more student-focused teachers. A few of the survey participants shared that they were more likely to provide differentiation to

meet students' needs and they were willing to give students more independence as learners. Christine and Andrea used online math resources to differentiate instruction and to collect data about student achievement. They used the data to provide students with feedback and to create more personalized assignments. Grace shared how she used multimodal technologies, such as videos, math games, and tutorials, in order to engage as many students as possible.

Interestingly, three of the interview participants shared how their changes in teaching practices influenced other teachers in their schools to make changes. Christine's use of Zondle to engage students in learning math inspired many teachers in her school to try Zondle for their subjects. Cecilia described how she used examples and resources from the MSC to motivate the teachers in her department to make changes in their classrooms. Cecilia also discovered that when students enjoyed a resource or activity that she had found in the MSC, they would let the other teachers in the school know about it, and then, these teachers would go to Christine to learn more. Alex explained how many of the teachers in his school went to him for new ideas, resources, and teaching strategies because of the vast knowledge he had gained from the MSC. These three teachers were not only making changes in their own classrooms, but they were also change agents for their schools.

RQ5: Conclusion

Overall, it seemed as though teachers who participated in the process of acquiring knowledge from the MSC believed that they were more willing to take risks, try new things, and make changes in the way that they taught and learned. The

interview and survey participants described their learning as an ongoing process of discovery, and trial and error. The participants felt that the process of learning was no longer limited by their school or district constraints. Instead, they could connect with and learn from thousands of educators from around the world.

Nine of the interview participants provided examples of how participating in this process of finding knowledge in the MSC changed the way they taught. For some of the participants, these changes were small-scale, such as trying a new resource in the classroom. For participants like Grace, Alex, and Rachel, and Christine, these changes were more significant. Alex used new technologies to bridge his students' informal and formal learning experiences. Grace and Christine were able to differentiate their instruction using online math websites. They were also able to use the data from these websites to provide instant feedback and more personalized learning opportunities. Rachel flipped her classroom and provided her students with more hands-on, interactive activities and group work during class time. Christine, Cecilia, and Alex also became change agents within their schools.

The process of finding knowledge in the MSC gave participants control over their learning and support from a global collective of educators. The participants enjoyed the freedom and flexibility of finding practical and relevant knowledge that they could implement in their classrooms. This empowered the participants and motivated them to try new things. As a result, the participants seemed more willing to make changes in their teaching strategies. While some of the participants described small-scale changes, others shared larger classroom transformations. Many of the interview participants felt that they had become better teachers. Ultimately,

participating in the process of acquiring knowledge in the MSC resulted in an increased willingness to make some sort of change in the classroom.

Further Research

Further research is needed to explore whether these changes in teaching and learning were sustained and ongoing or whether they were only one-time, short-term changes. Further research is also needed to explore the extent to which these changes influenced student learning. Future studies should also explore how the knowledge that teachers acquire in online communities compares to the research-based knowledge that experts often share in traditional professional development settings.

CHAPTER VII:

CONCLUSION

Increasingly more teachers are participating in online communities of practice to find and share knowledge with educators around the world. However, the majority of the studies on teacher learning in online communities of practice often fail to examine the process of learning as a complex, dynamically evolving practice that is shaped by local classroom and school contexts as well as other sociocultural factors. The majority of the studies of online communities of practice address how discrete elements (e.g., motivation, social presence, trust) affect teacher participation in researcher—or administrator—designed online communities. Very few studies have focused specifically on teacher-driven online communities of practice for the purpose of understanding how teachers contribute and make use of the shared knowledge in the community. Additionally, much of the research on how teachers learn is focused on the effectiveness of the learning opportunity rather than the intricate web of sociocultural factors that influence how teachers acquire and make use of new knowledge.

This study was designed to address the need for a more comprehensive and multifaceted exploration of teacher learning in an online community of practice. For this study, I focused on the process of knowledge acquisition in order to examine the complexity of teacher learning in an online community of practice. Specifically, I examined the sociocultural factors that influenced how teachers acquired knowledge in the Edmodo Math Subject Community (MSC), a so-called online community of

practice. Using a Cultural Historical Activity Theory (CHAT) (Leontiev, 1978; Engeström, 1987; Cole & Engeström, 1993; Vygotsky, 1978) framework, I analyzed how teachers navigated between their local school activity system and the MSC global activity system in order to acquire new knowledge.

I developed five research questions to guide this study:

1. What types of knowledge do teachers share in the Math Subject Community?
2. How is the process of acquiring knowledge shaped by the Math Subject Community global activity system?
3. How is the process of acquiring knowledge shaped by the teacher's local school activity system?
4. How do teachers navigate between their local school activity system and the Math Subject Community global activity system in order to acquire new knowledge?
5. What are the ensuing effects of participating in this process of knowledge acquisition?

In order to answer the first two research questions, I conducted a content analysis of 600 discussion threads and analyzed the survey and interview responses to learn how members exchanged knowledge with one another. I found that MSC members are looking for and sharing broader, adaptable Curricular and Pedagogical Content Knowledge, instead of focusing on specific math content. This allowed teachers who worked in a variety of contexts to find shared knowledge that met their needs.

I also discovered that the MSC global activity system consisted of a complex

network of sociocultural factors that interacted with and mutually constituted one another. The dialectical relationships between the factors influenced how the participants pursued the object of finding knowledge to improve student engagement in learning. The participants also shaped the global activity system through their use of the MSC tools, the roles they performed, and the diverse range of knowledge they brought to the MSC.

Additionally, I discovered that the MSC only supported the traditional notions of a community of practice in the broadest sense: it was a *community*, or group of people with varying levels of expertise, organized around a *domain*, who shared resources and knowledge related to their *practice*. Yet, the actions of mentoring, relationship building, becoming a full participant, and solving authentic tasks did not appear to be common in the MSC. Instead, the MSC could be conceptualized as a Practice-Based Crowdsourcing Platform, in which members pool the wisdom of experts from around the world to find and share practical and relevant knowledge.

Upon examination of the third research question, I found that the interview participants faced many contradictions that affected their ability to pursue the object of finding knowledge to engage students in learning. The participants described both a desire to make changes to their local activity system and a desire to find ways to keep up with the extrinsic changes that transformed their local school activity system. The participants felt that the lack of support and professional development opportunities in their local school activity systems limited their ability to find

knowledge that would help them keep up with extrinsic changes or make intrinsic changes.

The contradiction between the tools (e.g., professional development, funding, curriculum, time), community (e.g., collaboration and support), rules (e.g., push to integrate more technology in the classroom), object (e.g., finding knowledge), and outcome (e.g., improving student engagement in learning) were a driving force that motivated the participants to seek shared knowledge outside of their local school activity system. The MSC provided the participants with access to new knowledge and the collective wisdom of thousands of educators around the world. The participants used the MSC as a tool to create change within their local school activity system and to keep up with the extrinsic changes. The participants described the MSC as both a tool for transformation and a tool for stability.

Using the fourth research question as a guide, I explored how the interview participants navigated between their local school activity systems and the MSC global activity system in order to acquire knowledge. I found that the tool-mediated actions of the participants were shaped by the culture and history of the both the MSC and their local school activity systems. The participants acquired knowledge through a socially mediated process of discovery, trial and error, and reflection. I also discovered that the participants had three common characteristics which allowed them to successfully navigate between the two activity systems: willingness to take risks and try new things, free time to explore the MSC, and comfort with using technology for teaching and learning.

I developed a Model of Teacher Knowledge Acquisition in order to display the participants' fluid, ongoing process of navigating between two overlapping activity systems to find new knowledge. The Model of Teacher Knowledge Acquisition portrays learning as an object-oriented, iterative process of navigating between multiple activity systems. Throughout this process the teacher discovers new knowledge, assesses its credibility, tests it in the classroom, and evaluates the effectiveness of this process. The entire process is shaped by the social influence of the communities in both activity systems. The Model of Teacher Knowledge Acquisition presents teacher learning as a complex, socially constructed process that is influenced by multiple activity systems that interact with and shape one another.

In order to answer the fifth research question, I examined the participants' beliefs about whether participating in the process of acquiring knowledge from the MSC influenced the way they learned and taught. I discovered that, as a result of participating in this process, the majority of the participants felt that they were more willing to take risks, try new things, and make changes in the way that they taught and learned.

The main change in learning was that the participants took control of their learning. Rather than waiting for their school or district to provide professional development workshops, the participants were able to find practical and authentic knowledge in a timely manner and implement the new knowledge immediately into their classrooms. The participants felt that they could connect anytime and anywhere to the MSC and learn from thousands of educators from around the world. The participants described the knowledge acquisition process as a manner of play,

discovery, and trial and error. The process of acquiring knowledge was teacher-centered, which is in stark contrast to the typical top-down teacher teacher-learning model, in which outside experts provide knowledge to the teachers.

Additionally, the majority of the survey and interview participants felt that participating in this process changed the way that they taught. For some of the participants, these changes were small-scale, such as trying a new resource in the classroom. For other participants, the changes were larger, such as flipping classroom instruction, creating differentiated learning opportunities, and using data from online websites to provide students with instantaneous, personalized feedback.

Overall, the participants were driven by the contradictions and limitations of their local school activity systems to take control of their learning and find knowledge in the MSC. The participants' ability to find knowledge was defined by the roles they performed in the community, the tools they used, the collective knowledge of the community, and the implicit community rules of reciprocity and sharing high quality resources and ideas. The participants' ability to select and implement the knowledge they found in the MSC in their classrooms was also shaped by the local school activity system tools, the support of their colleagues and administration, their students' range in math abilities, and the community rules. In order to successfully participate in this process of acquiring knowledge, the participants needed a comprehensive understanding of the sociocultural factors in their local school activity systems, a motivation and willingness to try new things, free time to explore the MSC, and confidence in using technology for teaching and learning. Ultimately, the participants felt that engaging in this process of acquiring

knowledge through discovery and trial and error allowed them to make changes, both small and large, in their teaching and learning strategies.

Discussion

The literature on teacher learning consists of a collection of disjointed studies that focus on how isolated variables affect teacher learning and result in changes in teaching practice. These studies often explored the cause-and-effect relationships between a distinct variable, such as learning style, activity, or task, and teacher learning. However, these types of cause-and-effect approaches resulted in an oversimplification of the process of teacher learning. Opfer and Pedder (2011) and Wilson (2013) argued that teacher learning needs to be examined using a comprehensive framework in order to understand the complexity of the network of variables that influence the process of learning.

Based on the need for a more complex understanding of the process of teacher learning, I adopted the CHAT framework in my examination of how teachers acquired knowledge from an online activity system. I found that the process of acquiring knowledge in the MSC was influenced by the subject's role, the knowledge and division of labor of the community, the MSC tools, and the community members' enactment of the rules of reciprocity and professionalism. Additionally, the process of finding and implementing knowledge in the classroom was shaped by the tools, communities, and implicit rules that made up the subject's local school activity system. The dialectical relationships between the elements within the local and global activity systems influenced how subjects pursued the

object of finding knowledge that would improve student engagement in learning. These findings support Opfer and Pedder's (2011) and Wilson's (2013) insights that teacher learning is shaped by a complex network of variables.

By using a comprehensive framework for exploring teacher knowledge acquisition in the MSC, I also found that the MSC did not support the traditional notions of a community of practice. The term "online community of practice" has been broadly applied in the literature to listservs, discussion forums, social networking sites, social bookmarking tools, microblogging, and other interactive online environments. Yet, the landscape in a virtual space was significantly different than face-to-face communities that Lave and Wenger (1991) studied. The results from this study showed that the term "online community of practice" was not a one-size-fits-all description of virtual spaces, platforms, and tools. Upon closer examination of the subjects' actions within the online activity space, I found that the MSC was not a space for relationship building, mentoring, or becoming a full participant in a community. Instead, the MSC can be conceptualized as a Practice-Based Crowdsourcing Platform (PBCP), which is a virtual space that allows individuals connect with a large, diverse crowd of experts to find and share professional knowledge.

Adopting a comprehensive framework also provided the opportunity to synthesize some of the divergent theories and models in the literature on teacher learning. The literature is filled with many dualisms (e.g., intrapersonal and interpersonal learning) and classifications (e.g., knowledge for/in/of practice) that reduce the complexity of the knowledge acquisition process. Wilson and Berne

(1999) argued that the literature on teacher learning was an "incoherent and cobbled-together nonsystem," and as a result, "we have little sense…of what exactly it is that teachers learn and by what mechanisms that learning takes place" (p. 174). The studies on teacher learning seem to be divergent rather than building on a foundational set of findings.

By adopting the CHAT framework, I was able to see how the field of teacher learning could be strengthened by bringing together the theories, models, and classifications in the literature. I developed the Model of Teacher Knowledge Acquisition to integrate an intrapersonal learning model (e.g., Shulman's (1987) Model of Pedagogical Reasoning and Action) with an interpersonal learning framework (e.g., CHAT). Rather than focusing on specific variables or ways to acquire knowledge, the Model of Teacher Knowledge Acquisition provides a more comprehensive overview of the multiple variables and overlapping activity systems that shape teacher learning.

In conclusion, by adopting a comprehensive framework, I was able to explore the vast web of elements that shaped how teachers acquired knowledge in an online community and to develop a model that details the complexity of the knowledge acquisition process.

Implications for Research

This study suggests that teacher learning is a complex process in which the teacher must navigate between multiple activity systems in order to acquire new knowledge. One way to reduce the simplification of the research on teacher learning

is by adopting more comprehensive frameworks, such as CHAT or Complexity Theory. This will allow researchers to explore the network of variables and activity systems that shape the process of teacher learning. Additionally, it is critical for researchers to take into consideration the local school contexts that shape how teachers acquire knowledge through formal and informal learning opportunities.

This study only focused on how teachers navigated between two overlapping activity systems. Many of the survey participants reported that they were members of multiple networks, online communities (e.g., Twitter, EdWeb), and professional groups (e.g., professional learning communities, NCTM). Future studies should explore the multiple, diverse activity systems that shape how teachers find and implement new knowledge.

Another implication for research is that the MSC does not seem to support the traditional notions of a community of practice. The MSC consists of a large group of individuals who have varying levels of expertise. However, the actions of mentoring, relationship building, becoming a full participant, and solving authentic tasks do not appear to be common in the MSC. Rather, the MSC is a virtual space for crowdsourcing knowledge by tapping into the collective expertise of educators from around the world. These findings suggest that a closer examination of so-called "online communities of practice" is needed in order to determine whether the underlying principles of a community of practice can support the actions of a group of individuals in a virtual space. Future studies should explore the different types of so-called "online communities of practice" to determine whether the concept of a community of practice can support the object-oriented actions of groups of

individuals who connect in cyberspace. Further research is also needed to determine whether a community of practice can exist in a virtual landscape.

Additionally, much of the research on online communities of practice focuses on the motivating factors and barriers to becoming a full participant in the community. By reframing the Math Subject Community as a PBCP, researchers can shift their focus from community participation to how individuals tap into the wisdom of the crowd, learn from "weak ties," and exchange and implement practice-based knowledge.

Future studies are also needed to examine the math content that teachers share in the MSC. The majority of interview participants did not agree on one main reason that would explain why certain math topics were more frequently discussed than others in the MSC. Further research is needed to analyze why certain math topics are popular for discussion in the MSC and what the implications are for math educators. And, finally, with the implementation of the Common Core State Standards, researchers should consider exploring how these new standards influence the participants' knowledge sharing actions in the MSC.

Additionally, the participants felt that the lack of support and professional development opportunities significantly shaped their knowledge-seeking actions. However, the participants only seemed to describe the general professional development opportunities provided by their school and districts rather than focusing on professional development and instructional support specifically for math instruction. Further research is needed to examine the participants' support and

professional development opportunities for math instruction in order to gain a more comprehensive understanding of the participants' local school activity systems.

Implications for Practice

This study suggests that the MSC might be a useful support tool for teachers who are interested in implementing new knowledge and strategies or who need support for keeping up with the changes in their schools. The interview participants described both a desire to make changes to their local school activity systems and a desire to find ways to keep up with the extrinsic changes that transformed their local school activity systems. They wanted to change the *status quo*, and yet, they were also bombarded with new rules, regulations, requirements, and standards. The most pressing problem that the participants faced as they navigated their local school activity systems was the lack of support and professional development opportunities for acquiring knowledge that would help them keep up with all of the changes or to make new changes. Rather than wait for support and professional development to learn how to deal with the contradictions in their local school activity system, the participants actively sought out new knowledge from the MSC.

As a result of participating in the process of finding knowledge in the MSC, the participants felt that they made changes in the way they taught and learned. The participants used the MSC as a tool to take control of their learning. They felt that they could connect to a global collective of experts anytime and anywhere for ideas, resources, information, and advice. They also felt empowered and inspired by the collective insights of the individuals in the MSC. Since the participants had

unlimited access to new knowledge, they were able to explore, play, and learn through trial and error. Ultimately, the participants believed that they were more willing to make changes in their teaching practice, such as implementing new technologies in their classrooms or using new resources and ideas for teaching different math topics. Therefore, the MSC seems to be a useful tool for supporting teachers as they make changes in their practice.

However, this study focused on the participants' *beliefs* about the changes they made in their classrooms. Future studies should consider using classroom observations and other ethnographic data collection techniques to determine whether the participants actually made these changes. Further research is needed to explore whether these changes in teaching and learning are sustained. Additionally, Gibson and Brooks (2013) argued that there was a connection between how teachers learned and how they practiced. Future studies should examine the link between teacher learning and teaching practice. One research question to explore is: "How does participation in a teacher-centered, technology-mediated learning opportunity shape a teacher's practice and influence students' learning?"

Further research is also needed to explore the idea of "crowdsourcing" in a PBCP. In this study, many participants tried flipping their classrooms because it was a popular topic in the MSC. However, does the "crowd" really know best? How does the social influence of the "crowd" shape the teachers' willingness to implement new ideas, strategies, and resources in their classrooms? Further research should explore how the knowledge that teachers acquire in online communities compares to the

research-supported knowledge that experts often share in traditional professional development settings.

Participation in the process of acquiring new knowledge from the MSC seemed to increase the participants' use of technology in their classrooms. Additional research is needed to explore whether the MSC can be a useful tool for supporting technology integration in schools. It is important to note that increased use of technology is not necessarily correlated with the quality and effectiveness of the use of technology as a learning tool. Future studies should explore whether teachers' use of the MSC to implement new technologies in their classroom enhances student learning.

It is also critical for researchers to disentangle the participants' characteristics from their participation in the MSC. The MSC seems to be especially useful for teachers who are interested in and willing to make changes in their teaching practice. On the other hand, new teachers may not have enough time or knowledge of their local school activity system to find appropriate resources and ideas in the MSC. The MSC also seems to be most beneficial to teachers who are comfortable with using technology for teaching and learning. Additional research is needed with a larger sample size to examine the demographics and characteristics of the individuals who find knowledge in the MSC and implement it in their classroom.

Further research is also needed to explore how teachers participate in the different stages of the Model of Teacher Knowledge Acquisition. The Model of Teacher Knowledge Acquisition is a complex process with multiple steps and variables. Participating in this process requires an understanding of how to define an

appropriate goal, assess the credibility of the shared knowledge, pilot test resources, and select, adapt, implement, and evaluate effective learning tools. The participants in this study engaged in this process of acquiring and implementing shared knowledge on their own. The participants did not have training or support for effectively engaging in this process. Many of the participants had not considered the idea of assessing the credibility of the shared knowledge. Additionally, it seemed as though their selection criterion were based on student engagement and state standards rather than whether the shared knowledge would enhance or facilitate learning. Further research is needed to explore how teachers can be supported and empowered to participate in the stages of the Model of Teacher Knowledge Acquisition.

One way to improve how teachers participate in the process of acquiring knowledge from the MSC would be to provide teachers with support and direction. For example, administrators could set up a Professional Learning Community in which the teachers use the MSC as a tool for collaborative inquiry. This would provide teachers with support and allow them to develop appropriate goals, co-construct knowledge, and reflect on their process with other teachers in the school.

The Model of Teacher Knowledge Acquisition could also be strengthened by incorporating Action Research Principles into the process of collaborative inquiry and teacher learning (Winter, 1987). Action Research requires teachers to become reflexive researchers and use theory to inform practice. Incorporating Action Research principles may help teachers identify, assess, and select the most useful ideas and resources for their classrooms. Further research is needed to explore how

teachers can be supported and empowered to participate in the stages of the Model of Teacher Knowledge Acquisition.

Ultimately, the MSC seems to be a useful tool to support teacher learning. Administrators should continue to encourage teachers to find and share knowledge using Practice-Based Crowdsourcing Platforms like the MSC. However, since the MSC is just a *tool,* administrators need to provide teachers with training and support for using the MSC. Administrators should also take into consideration the local school activity system variables that may shape or be shaped by the use of the MSC as a tool. The participants in this study had to worry about all of the local school factors, such as rules and student needs, as well as logistics, such as computer access, on their own. It is important to explore how administrators can help teachers deal with the obstacles and challenges they face while implementing the shared knowledge in their classrooms. Future studies should examine how schools and districts can prepare teachers for effectively using the MSC as a learning tool.

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APPENDIX A:

INFORMED CONSENT

PURPOSE:
You are being asked to participate in a research study. The purpose of the study is to examine how K-12 teachers make use of the information and resources that are shared in the Edmodo Math Subject community.

PROCEDURES:
If you decide to participate, you will be asked to complete a short survey (approximately 5 minutes) about your experiences in the Edmodo Math Subject Community. You may also be asked to participate in a follow-up phone or Skype interview (approximately 45-60 minutes). With your permission, the interview will be audio recorded.

RISKS:
There are minimal risks for participating in this study. The data will be collected and stored in a secure manner and no identifiable information will be shared in the research report.

BENEFITS:
The benefit of participating in this study is the opportunity to share your experiences, knowledge, and expertise with the researcher. The information you share will help other teachers better understand how they can use the Edmodo Math Subject community to find and share knowledge.

CONFIDENTIALITY:
Absolute confidentiality cannot be guaranteed, since research documents are not protected from subpoena. The Faculty Advisor, Richard Duran, Ph.D., and the Student Associate, Torrey Trust, are the only persons with access to the survey and interview data. Collected data will be saved in a locked location on the Associate's computer. No one else will have access to the data. The audio recordings of the interviews will be destroyed after completion of the study.

COSTS/PAYMENT:
If you are selected to participate in the follow-up interview, you will receive a $10 Amazon.com gift card. The gift card will be emailed to you. If you withdraw from the interview before completing it, you will still receive the full amount of the gift card.

RIGHT TO REFUSE OR WITHDRAW:
You may refuse to participate and still receive any benefits you would receive if you

were not in the study. You are free to change your mind about being in the study and quit after the study has started at any time without giving a reason. You are free to skip questions in the survey and not answer interview questions.

QUESTIONS:
If you have any questions about this research project or if you think you may have been injured as a result of your participation, please contact:

Torrey Trust
ttrust@education.ucsb.edu
760-525-6807

If you have any questions regarding your rights and participation as a research subject, please contact the Human Subjects Committee at (805) 893-3807 or hsc@research.ucsb.edu. Or write to the University of California, Human Subjects Committee, Office of Research, Santa Barbara, CA 93106-2050

PARTICIPATION IN RESEARCH IS VOLUNTARY. BY CLICKING THE "NEXT" BUTTON AT THE BOTTOM OF THIS PAGE, YOU ARE INDICATING THAT YOU HAVE DECIDED TO PARTICIPATE AS A RESEARCH SUBJECT IN THE STUDY DESCRIBED ABOVE.

APPENDIX B:

SURVEY

Edmodo Math Subject Community Survey

2. Demographics

Name:

Email Address (so that I can email you the K-12 Tech Tools website membership):

Country:

Age:

Gender

- ◯ Female
- ◯ Male

Other (please specify)

How many years have you worked as a K-12 teacher?

What grade level(s) did you teach during the 2012-2013 school year?

What subject(s) did you teach during the 2012-2013 school year? (e.g., algebra, geometry, multiple subject)

Edmodo Math Subject Community Survey

3. Technology in the Classroom

How often do you use technology for classroom instruction?

- ◯ At Least Once a Day
- ◯ At Least Once a Week
- ◯ At Least Once a Month
- ◯ Less than once a month
- ◯ Never

Which of the following technologies do you use in classroom instruction?

- ☐ Computers/Laptops
- ☐ Interactive Whiteboards
- ☐ Tablets (e.g., iPad)
- ☐ Mobile Phones
- ☐ Gaming Systems
- ☐ Document Camera
- ☐ Digital Cameras
- ☐ Clickers (e.g., i>Clicker)

Other (please specify)

Edmodo Math Subject Community Survey

4. Community & Group Membership

What other professional, online, or local communities do you participate in? (e.g., NCTM, Classroom 2.0, Diigo Groups, Twitter, Facebook Math Teachers Group, School/District Professional Learning Community)

Do you participate in any Edmodo Math groups (e.g., Algebra or Statistics Teacher Group)? If so, please list the name(s) of the groups you participate in.

Edmodo Math Subject Community Survey

5. Edmodo Math Subject Community Experience

In which year did you first join the Edmodo Math Subject community?

During the past school year, how frequently did you visit the Edmodo Math Subject community?

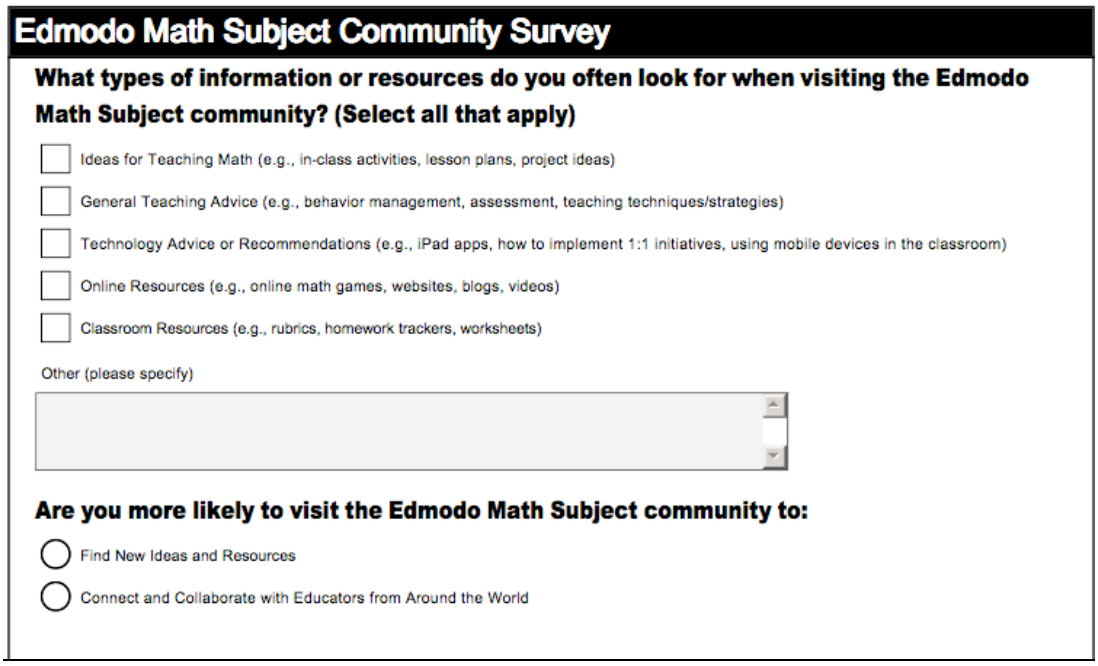
- ◯ At Least Once a Day
- ◯ At Least Once a Week
- ◯ At Least Once a Month
- ◯ Less than once a month
- ◯ Never

When you visit the Edmodo Math Subject community, which of the following actions do you perform? (Select all that apply.)

- ☐ Read the Wall Posts
- ☐ Respond to Wall Posts
- ☐ Write a Post on the Community Wall
- ☐ Add Resources to Your Edmodo Library
- ☐ Search for Posts, Information, or Resources Using the Search Tool
- ☐ Browse for Posts, Information, or Resources Using the Topics Tab
- ☐ Connect with Community Members (e.g., Add Them as "Friends")
- ☐ Send Messages to Your Edmodo Connections

Other (please specify)

Why do you visit the Edmodo Math Subject community (e.g., What are your goals? What do you get out of participating in the community?)?



Edmodo Math Subject Community Survey

What types of information or resources do you often look for when visiting the Edmodo Math Subject community? (Select all that apply)

- [ ] Ideas for Teaching Math (e.g., in-class activities, lesson plans, project ideas)
- [ ] General Teaching Advice (e.g., behavior management, assessment, teaching techniques/strategies)
- [ ] Technology Advice or Recommendations (e.g., iPad apps, how to implement 1:1 initiatives, using mobile devices in the classroom)
- [ ] Online Resources (e.g., online math games, websites, blogs, videos)
- [ ] Classroom Resources (e.g., rubrics, homework trackers, worksheets)

Other (please specify)

Are you more likely to visit the Edmodo Math Subject community to:

- ◯ Find New Ideas and Resources
- ◯ Connect and Collaborate with Educators from Around the World

Edmodo Math Subject Community Survey

6. Implementing Information & Resources from the Edmodo Math Subject Commu...

How many times have you implemented something you learned or discovered (e.g., new idea, resources, learning activities) from the Edmodo Math Subject community in your classroom?

- ◯ 0
- ◯ 1-5
- ◯ 6-10
- ◯ 11-19
- ◯ 20 or more times

Please share an example of how you successfully implemented something you learned or discovered in the Edmodo Math Subject community in your classroom.

Has participation in this community changed the way you learn and grow as a professional? If so, please explain.

Has participation in this community changed the way you teach? If so, please explain.

Edmodo Math Subject Community Survey

7. Call for Follow-Up Interview Participants

I would greatly appreciate a chance to learn from you!

I am looking for 15-20 teachers to interview via phone or Skype (approximately 45-60 minutes).

If you have implemented ideas or resources from the Edmodo Math Subject Community in your classroom and you are willing to share how you go about finding, selecting, adapting, and evaluating these ideas and resources, please consider sharing your expertise with me in an interview.

I will work around your schedule to set the interview date and time.

Note: You will receive a $20 Amazon.com gift card for participating in the interview.

Would you be willing to be contacted for a follow-up phone or Skype interview? Note: You will be given a $20 Amazon.com gift card for participating in the interview.

- ◯ Yes
- ◯ No

APPENDIX C:

INTERVIEW GUIDE

Interview Protocol

Topic A:

- Can you walk me through an example of how you found a new idea or resource in the Edmodo Math Subject community and implemented it in your classroom?
    - Did you start with a goal or did you just browse the community wall?

Topic 1: Information & Resources

- What type of information or resources (e.g., new ideas, classroom materials, technology tools, advice, help, feedback) do you often seek when visiting the Edmodo Math community?
    - When you go to the community are you looking for anything specific or do you just browse and see what piques your interest?
    - What are the local classroom or school factors that motivate you to seek out information or resources?
        - What about lack of professional development opportunities?
        - What about new curriculum, standards, or assessment requirements?
        - What about classroom challenges, so you can get advice or help from the Edmodo community?
        - What about technology? Do you go to Edmodo because you are interested in using the technology available to you to engage students in learning? Is there a push to integrate technology more in the classroom in your school?
        - Is your administration supportive?
    - What math concepts and topics do you typically seek to learn more about in the Edmodo Math Subject community? Why these topics?
        - One thing I noticed was that the majority of wall posts did not mention any specific math topics. Why do you think that is?
        - Top: operations, geometry, fractions, algebra
        - Bottom: measurement, number sense, functions, ratios
    - Why do you use Edmodo to seek out information/resources?
        - How does Edmodo compare to a typical Internet search engine for finding information/resources?
        - How does Edmodo compare to other online communities or in-person professional development opportunities?

Topic 2: Finding Information & Resources

- Tell me about how you find information or resources in the Edmodo Math Subject community.
    - Do you search for a topic? Write a post? Read other members' posts? Ask one of your Edmodo connections?
    - What about when you are searching for something **specific**? How do you find that information or resource then?
    - I've noticed that that members rarely include key descriptive information, such as grade level, learning objectives/state standards, or learners' needs when writing a post. How does this affect the way you find information and resources?

Topic 3: Selecting and Adapting Information & Resources

- There are tons of resources and new ideas shared everyday in the community. Tell me about how you determine whether or not to use a specific idea or resource.
    - Credibility of sharer? Shared from an individual who teaches the same grade level? High "shared resource" rating in Edmodo?
    - Do you test out the resource first?
    - What is your criteria for selecting a new resource? Engaging? Fits with curriculum?
    - How do local classroom or school factors (e.g., students' needs, timing, funding, support, technology availability) influence the type of information and resources you select to use in your classroom?
- The resources and information shared in the community seem to be generic and abstracted from local classroom contexts. How do you adapt the generic information or resources that you select to meet your students' needs?
    a. Do you have to change the level of complexity? Do you pilot test it with a small group of students? Do you improvise it on the spot while you are teaching?
    b. Do you adapt the information/resources on your own or collaborate with other teachers?

Topic 4: Using and Evaluating Information & Resources

- Tell me about how you use the information or resources in your classroom.
    - Do you incorporate the information or resources into a new lesson or revise an existing lesson?
    - Do you use the information or resources as a resource for specific groups of students (e.g., English Language Learners, students with disabilities, advanced students)?
    - Do you use them as supplemental learning tools?
- How do you evaluate the effectiveness of implementing the information or resources in your classroom?

- Do you assess student learning? Student Engagement? Achievement of learning objectives?
- If the implementation of the new information/resource works well, do you report your success story back to the Edmodo Math Subject community?

Topic 5: Participating in the Process of Finding and Using Information & Resources

- Tell me about how this process of finding and utilizing information and resources from the Edmodo Math Subject community has changed the way you teach.
  - Are you more likely to integrate technology into your lesson plans? Are you more willing to try new ideas?
- Tell me about how this process has changed the way you learn and grow as a professional.

Topic 6: Bridging School and Online Communities

- Do you act as a bridge between your local school community and the Edmodo Math Subject community?
  - Do you share information and resources from the Edmodo community with your colleagues? Do you share best practices (e.g., successful ideas, projects, and lessons) from your school with the Edmodo community?

Topic 7: Navigating the Online Community

- Let's pretend for a minute that you have to show teachers how to use the Edmodo Math community to find information and resources to use in their classrooms. What recommendations would you have for the teachers?
  - What are the rules, etiquette, and guidelines that influence how you participate in the community? For example, is it implicitly understood that members will search for an answer before posting a duplicate question? What about spammers?
  - Is appropriate to lurk and learn or should all members give back by sharing knowledge? Do you need to reply "thank you" if you like or want to use a shared resource/idea?
- How would you describe the culture of community (characteristics, actions, behaviors)? Positive? Respectful? Professional? Do people spam or use negative language? Do people take on different roles?
- How did you learn to navigate and participate in this online community (observation? Cultural guide? Trial & error?)?

APPENDIX D:

CODEBOOKS

Types of Initial Posts

	Code	Description	Example Post
Q	Request for Action	Asking for help, advice, ideas, resources, feedback, or solution to a math problem.	"I have a student that always finishes his work in 15 minutes while the rest of the class takes 40 minutes to complete. I would like to do some enrichment with this student but not sure how to go about it…I feel that I am not challenging him enough. I would appreciate any advice, help, ideas that anyone has to offer as to how I can go about helping this student....Thanks!"
S	Knowledge Sharing	Sharing online resources (e.g., videos, websites) or uploaded documents (e.g., rubrics, lesson plans, quizzes)	"This is a great site for giving your students some cool, challenging puzzles. I use them to keep my higher level students engaged and they are a lot of fun!"
C	Comment	General statement that does not fit in the other two categories.	"Just joined. Just got here. Hi all 31,454 followers (please don't say hi back). I teach 5th grade math in WA state. Looks like some great resources people have shared. I'll have to pay it forward and figure out something to share."

Types of Teacher Knowledge

	Code	Shulman's Description	Examples	Example Post
PCK	Pedagogical Content Knowledge	The ways of representing and formulating the subject to make it comprehensible to others.	Activities, projects, lessons	"Does anyone else have other ideas for learning games to help students remember math vocabulary..."
Cu	Curricular	With particular grasp of the materials and programs that serve as "tools of the trade" for teachers.	Tools, materials, resources, worksheets	"Here is a livebinder I've created full of educational resources I thought I would share"
L	Learners	Knowledge of learners and their characteristics.	Questions about specific students or groups of students (e.g., Advanced)	"I have a mathematically gifted student this year in my fifth grade class. For the past two or three years he has simply went to the next grade's classroom for math instruction, however this year he is staying with me because his parents don't wish to accelerate him completely to the next grade…"
C	Content	Depth of understanding, the "truth" of the field.	Math problems and solutions	"I am having trouble with a problem. I can answer it by reasoning but I can't put it into an equation. Can anyone help???"
Cx	Context	Ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures.	Community, classroom culture	"My school is re-doing our schedule for next year. I was surprised that my math periods are only 40 minutes long and am asking for much longer periods next year. I am find it extremely difficult to fit a full curriculum into these short periods. I am curious...how long are your math periods? What do you think is an acceptable amount of time for a math class at the middle school level?"

A	Aims	Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.	Policies, goals, history	"High-stakes testing will dominate classrooms throughout NY state this week. Students in grades 3-8 will spend hours at their desks silently answering poorly constructed questions. Education is suffering because of this!"
P	Pedagogy	With special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter.	Behavior management, teaching techniques (e.g., flipped learning)	"Hi, all. Can you help to share me resources related to 'generative model' of teaching and learning math."

Types of Replies

	Code	Examples	Example Quote
I	Idea	Sharing an activity, lesson, teaching strategy	"What about a painting job for the pyramids of Giza? Or the Leaning Tower? They research and figure out how much paint is needed for a coat for one square foot then have to research the dimensions for famous landmarks…Just an idea."
R	Resource	Sharing an online website, uploaded document (e.g., rubric, quiz), online video	"http://www.desmos.com is a great graphing site. I found it particularly helpful for showing systems involving linear & quadratics."
F	Feedback	Sharing personal opinion about effectiveness of idea or resource	"This is a good review assignment. There is a good balance between multiple choice questions and open-ended questions."
A	Advice	Providing additional ideas, suggestions, or options	"Something you could do to spice it up a little if you have not done it already is to make that into a scavenger hunt…It can be made into a competition also by having rewards for the first groups finished. If you have questions let me know."
S	Solution	Providing or discussing a solution to math problem	"To do this, construct circles with center A, B and C of radius 3 cm. Place the points E and F such that (EF) parallel to (AB), E belonging to the circle with center A and F the circle with center B (EF) must be tangent to two circles. Do the same for the other sides of the triangle. This gives a rounded triangle, which is what we seek."
App	Appreciation	Sharing thanks	"Thank you, thank you, thank you!! I was trying to figure out what I was going to do with my classes between their semester finals and the days before winter break. NOW I know!!"
Co	Compliment	Complimenting the resource or idea	"What a great idea!"
FR	Follow-Up Reply	General response to a reply	"You are welcome. Feel free to come back from time to time. I

			create and borrow badges all the time.”
C	Comment	Showing interest, sharing a general statement	“I am also interested in sharing about Singapore Math. We are in our first year of implementation of the ‘Math in Focus’ series.”
FQ	Follow-Up Question	Asking for clarification or more specific information of a *reply*	“Many of my students have Internet access at home, but many don't. How do you handle that? I have a freshman academic class.”
Cl	Clarification	Asking for clarification about context of a post or asking for more specific information about the question in the *post*	“Can you clarify your question regarding "how the state will handle testing of students...”
N	Networking	Sharing contact information for connecting, sharing Edmodo group or other online network information	“Profe de Mates Española al habla :) Doy 5º y 6º de Primaria...Si alguien da los mismos niveles que yo estaría muy interesada en compartir material y posibles clases "globales"...Hablamos!!!” [Translation: “Hi, this is Spanish Math Teacher speaking. I teach fifth and sixth grades... If anyone teaches the same grades as me, I would be very interested in sharing material and possible ‘global’ classes. Let's talk!”]
E	Empathy	Sharing emotion or frustration	“I feel for you - I have been there, too.”

CHAT Analysis

	Code	Examples	Example Quote
SL	Subject - Local	Personal traits and characteristics	"I've been teaching, this is my 13 year, but I get bored easily so I change things all the time. I know that if I get bored, the kids can. So I'm always looking for new ideas to integrate to keep the kids interested."
SG	Subject - Global	Online persona/roles	"So I've got 2 facebook sites going right now, one is brainymiscellany, that's a fun one, the other one's called common core math resources. Not so much fun, but I've got close to 1000 followers who are all math teachers."
TL	Tools - Local	Local tools for achieving the object (e.g., professional development, funding, curriculum, standards)	"You've got to compete with other teachers [for access to the computer lab]. I don't use it because I can't plan that stuff in advance and my curriculum is so packed"
TG	Tools – Global	Global tools for achieving the object (e.g., search engine, community wall)	"There's no organization to it, I guess it's like reddit. It's the luck of the draw when you decide to turn it on. So is Facebook."
OL	Object – Local	Classroom goal	"I'm usually looking for interactive activities for the kids to do to support either learning in the classroom or home learning or videos or activities, but there's not usually a specific concept or content area that I'm looking for."
OG	Object – Global	MSC goal	"My goal is not specifics when I'm on there. I'm looking for general."
CL	Community – Local	Description of classroom, school, or local community	"We're also a very small school district. There are only 2 math teachers in my building. I'm one of them. So, as far as having people to talk to its very restricted."
CG	Community – Global	Description of MSC community	"You can really go into the Edmodo community and there's a bunch of people in there. The thing that I like about the Edmodo community is you're getting all

			sorts of different countries and things too."
RL	Rules – Local	Implicit (e.g., push to integrate technology) or explicit rules (e.g., meet or exceed Common Core State Standards)	"The information came out to use two years ago and my district is asking, well requiring, teachers to phase in the new concepts so that there are no gaps so when the new test does come in (2014-2015) that the kids have all the information they need and teachers aren't have to fill the holes and it's being taught at the appropriate grade level."
RG	Rules – Global	MSC etiquette (e.g., how people in the MSC act, behave, and share knowledge)	"I had noticed that people tend to be very positive. You don't get the negativity that sometimes comes with social media like Facebook but you know people are professional it seems to me and helpful and I don't really notice a lot of spam or things of that nature."
DL	Division of Labor – Local	Different groups of individuals in a school community (e.g., students, parents, administrators, teaching staff)	"So I went to my principal and said, 'boy these iPads are really cool, you should get five right now for the special ed department or to help the struggling kids,' and he's like 'oh no, no, no.'"
DG	Division of Labor – Global	Years of teaching experience, age, subject, MSC role (e.g., lurker, connector)	"I guess I'm probably more as a voyer. I've probably replied maybe once or twice. For the most part, I just on the outside looking in, trolling to see what other people have posted."
T	Transformation	Change in teaching or learning strategy	"I feel like I'm at the top of my game right now and a lot of that is that I'm getting ideas from tons of different people that I don't even know."
C	Contradiction	Tension between one or more of the elements in the local or global activity system	"There is a push to integrate technology, however, it doesn't seem like they have the trust in the teachers to give them the access to the Internet and websites that are useful and that's very frustrating."

O	Outcome	Overarching goal that bridges local and global activity systems	"It [my goal] is more looking for ways to make it [math] engaging, more ways to make kids want to learn about it than it is to actually know the concept"