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Replacing the "Raise Your Hand to Speak" Rule with New Social and Sociomathematical Norms in an Elementary Mathematics Classroom

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REPLACING THE "RAISE YOUR HAND TO SPEAK" RULE WITH NEW SOCIAL AND SOCIOMATHEMATICAL NORMS IN AN ELEMENTARY MATHEMATICS CLASSROOM

by

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ABSTRACT

This qualitative study documents the establishment of new social and sociomathematical norms in a second grade classroom. The teacher allowed students to speak directly to one another without having to raise their hands first during whole group mathematics instruction. Reform efforts in mathematics and the standards for mathematical practice contained in the Common Core State Standards call for students to discuss their reasoning with each other.

Data were collected through interviews with the teacher and students, field notes, and video-recorded lessons over the course of 23 days. An online survey tool was utilized to share selected video of the teacher's instruction. Initial professional development topics were chosen from research in mathematics education related to the social construction of understanding. Ongoing professional development was responsive to what occurred during instruction.

The literature suggests that teachers often utilize traditional teaching methods and struggle to deviate from established patterns regardless of their desire to implement change. The teacher in this study learned that allowing students to talk openly provided him with insight into their mathematical conceptions and misconceptions. The students initially viewed mathematics as a set of rules to follow and exhibited the role of passive recipients of information. This changed as students were provided opportunities to participate in discussions and in doing so developed a new understanding of their role during mathematics lessons. Mathematical errors became a catalyst for communication and were viewed by students as opportunities for assisting their peers.

This is dedicated to my mom and dad. Thank you for always believing in me. I did it!

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CHAPTER ONE: INTRODUCTION

As most of the United States works to implement the Common Core State Standards for Mathematics, there is a renewed interest in assuring that students are college and career ready. If teachers are to meet this challenge, mathematics instruction needs to be more engaging. We need students to retain what they learn and to build on those skills. When our students graduate from high school, they should be able to think critically about complex issues. Our instruction, beginning in elementary school, should develop higher level thinking skills. The establishment of Common Core State Standards resulted in a clear vision of what should be taught to prepare students to be successful in their future endeavors.

The content of mathematics instruction is established within the standards, but the way in which teachers choose to implement these content standards is important as well. One move in this direction is the establishment of eight Standards for Mathematical Practice (CCSSO, 2010) included in the standards. The Standards for Mathematical Practice (CCSSO) call for a shift in instructional focus. This shift is grounded in student engagement with peers. One of these standards, Standard for Mathematical Practice Three (SMP3) is especially focused on student engagement and discourse that promotes depth of understanding. The standard is, "Construct viable arguments and critique the reasoning of others." The expectation is that students will "justify their conclusions, communicate them to others, and respond to the arguments of others" (CCSSO, p.3). This standard requires students to move beyond being able to solve mathematical problems on their own. Rather, the expectation is that they understand and explain their own reasoning as well as that of their peers. As students engage in this practice, as well as other standards for mathematical practice, there is a need to utilize student dialogue in ways that are

sometimes different than what has been established as typical practice in elementary mathematics classrooms in the United States. If students are to respond to the arguments of others, then it is logical to assume that they must speak to others. The focus of this study is to examine how norms that involve student discourse are established in a second grade mathematics classroom.

Because traditional mathematics lessons tend to focus on the teacher's dialogue, there is a mismatch in expectations as described in the standards and enacted practices, as depicted in research in elementary mathematics classrooms (Hiebert, Stigler, Jacobs, Givvin, Garnier, Smith, & Gallimore, 2005). Research has provided ways in which teachers can engage their students in mathematical discourse, but has not addressed the issue of how established social norms interact with the sociolinguistic development of student discourse through direct interactions with peers.

There are missed opportunities for students to make their own connections to the content of lessons. Instead, students are expected to passively absorb information that is presented by the teacher. A shift in perspective to classroom actions grounded in a constructivist theory provides opportunities for students to be active participants as they create understanding. This shift has the potential to help students make new connections based on their understanding and to establish a different perspective of what it means to *do* mathematics.

Numerous studies have established the merit of focusing on students constructing their own knowledge during mathematics instruction (Bauersfeld, 1992; Brownell, 1945; Bruner, 1966; Carpenter, Fennema, & Franke, 1996, Cobb, Hodge, & Gresalfi, 2011; Inoue, 2011; Lampert, 1990; Schifter & Fosnot, 1993). These researchers have provided a wealth of data to support the need for teachers to allow and highlight student discourse during instruction.

Walshaw and Anthony (2008) conducted a comprehensive review of recent research in mathematics education. They state that it is a widely accepted understanding that mathematics plays a critical role in the lives of students. In reference to one of the common themes established by research, they state: "Current thinking among researchers and reformers bears this understanding out by putting the spotlight squarely on the social and cultural aspects of mathematical development" (p. 516). Research indicates that establishing norms in the classroom can serve the purpose of promoting meaningful student exchanges as students work to develop understanding in mathematics.

Students need to develop ways of knowing mathematics that enable them to have a practical understanding that can be applied in meaningful ways. To accomplish the goal of ensuring that students are prepared for the mathematical tasks encountered in college and careers, classrooms need to be transformed. A focus on reasoning, argumentation, and a depth of understanding through classroom discourse has the potential to provide such a transformation.

The purpose of this study is to answer the following questions:

1. How are new discourse patterns established during mathematics instruction?
2. What qualities of social and sociomathematical norms exist in a classroom in which a teacher allows the students to speak directly to one another without first raising their hands during whole group instruction?
3. How do the teacher and students react when traditional social norms are challenged?

Throughout this study, terminology will be used to describe various aspects as they are encountered. Terminology and definitions for these topics are as follows.

Social Norms: "Acceptable behavior, beliefs, and values by most of the members of the society. A cultural unwritten rule with social consequences, but not a law" (Collins & O'Brien, 2003, p. 243).

Sociomathematical norms: "Normative aspects of mathematical discussions that are specific to students' mathematical activity" (Yackel & Cobb, 1996, p. 458).

Sociolinguistics: "How language serves and is shaped by the social nature of human beings. In its broadest conception, sociolinguistics analyzes the many and diverse ways in which language and society entwine" (Eble, 2005, p. 1).

When we understand the social construct of engaging in mathematical discourse, we are provided with a clearer picture of what we, as educators, can do to ensure that our methods align with our goals. It is important that the messages we send to students during mathematics instruction are consistent with our expectations for their participation in and establishment of sense-making strategies. Carefully dissecting discourse patterns during mathematics instruction can provide insight into the process of building understanding within a classroom culture. Building an understanding of how these topics manifest within the dynamic social system of an elementary mathematics classroom has the potential to move the field of mathematics education forward.

Determining the qualities and depth of discussion within the context of elementary mathematics lessons requires an examination of existing literature. Cultural aspects of

mathematics classrooms, including reform efforts in mathematics, established practices, the role of teachers and students, and sociolinguistics will be explored.

CHAPTER TWO: LITERATURE REVIEW

Introduction

> Hello! I am a Brevard County teacher in a Title I school that has gone from an "A" to a "B" (which is really an "F" had it not been for the new law). I found your article, "Changing the Rules to Increase Discourse", in the September issue of NCTM's Teaching Children Mathematics, to be life changing (or at least paradigm changing) for me! It is such a logical and sequential idea which I see as an essential part of the Gradual Release Model that we now will be facilitating. As I read the article I thought about the fact that you had used this in a second grade classroom… I teach first grade and was thinking that my first grade students would benefit in using this model at six and seven year old. I was excited! I'm considering making it my Professional Growth Plan (PGP), which is a large part of the way I will be observed and evaluated. I feel like students of all ages should have the opportunity to have these student-driven conversations in math. Question: Do you see any reason why first grade students could not use this same method of communication about math? (Personal Communication with a first grade teacher, Florida Public School, September 19, 2013)

This teacher highlighted many of the key issues associated with challenging traditional social norms and establishing sociomathematical norms in an elementary mathematics classroom. She states, "I feel like students of all ages should have the opportunity to have these student-driven conversations in math," and also, "I found your article…to be life changing (or at least paradigm changing,)" which begs the question, What is the paradigm? This question will be addressed in the review of literature.

Within this message there is an underlying concern for school grading and teacher evaluation. This teacher also states an interest in student-driven conversations in mathematics. The issue of school grading and teacher evaluation, while beyond the scope of this review, provides a backdrop for the issues affecting the implementation of anything new. Teachers should be critical consumers of new ideas and it is necessary to support the need for change with existing literature.

It is interesting to note that although the teacher writing the message above had yet to implement a changed "hand-raising rule," she viewed the idea as life changing or paradigm changing. This raises the question of the underlying "paradigm" and why the paradigm connected with allowing students to speak freely to one another is regarded as being contradictory to the normal course of action taken in elementary mathematics classrooms. These are a few of the issues that I will address within this chapter. The following research questions provide structure and focus for the review of literature.

1. How are new discourse patterns established during mathematics instruction?
2. What qualities of social and sociomathematical norms exist in a classroom in which a teacher allows the students to speak directly to one another without first raising their hands during whole group instruction?
3. How do the teacher and students react when traditional social norms are challenged?

To adequately answer these questions, it is helpful to understand the current state of elementary mathematics education in the United States. A review of the literature on traditional and reform methods of mathematics instruction indicates the need for a careful consideration of social norms in the classroom.

These study questions address the implementation of discourse norms in a second grade classroom. The classroom setting was one in which the students were allowed to speak directly to one another during whole group mathematics lessons. The study began with a review of the related literature.

The Current Paradigm

Many elementary mathematics classrooms in the United States look very similar to how they looked back in 1945 when one author (Brownell, 1945) lamented on the state of mathematics education and the lack of meaning that was being espoused in elementary classrooms. He argued, "To remedy the evils of current mathematical deficiency what seems to be needed is not more of the same kind of instruction which produced these evils, but a fundamental re-organization in the subject matter and teaching of arithmetic" (p. 498). His call to action was to move away from "telling" students procedures and instead to allow them to build an understanding that could be transferred to new situations. While this seems to be a logical disposition that is grounded in a constructivist theory, the shift to new practices has yet to be realized in many schools today.

Jackson's (1990) portrayal of life in schools provides a sense of the classroom culture and how it is affected by the crowded conditions. Because so many students spend time in close quarters, their experiences are often determined by crowd control. For example, a common scene includes students holding their raised arm at the elbow because of the lengthy time often spent waiting to be called upon.

Jackson (1990) notes that despite the proximity to their peers, there is an expectation that students largely ignore one another. They are often placed side by side and across from one another, yet taught to work in isolation much of the time. "Indeed, in the early grades it is not uncommon to find students facing each other around a table while at the same time being required not to communicate with each other. These young people, if they are to become successful students, must learn how to be alone in a crowd" (Jackson, p. 16).

General classroom practices often carry over into mathematics instruction. These practices have the potential to influence the way in which students measure and perceive their success. Lampert (1990) describes the culture of mathematics education in this way, "These cultural assumptions are shaped by school experience, in which *doing* mathematics means following the rules laid down by the teacher; *knowing* mathematics means remembering and applying the correct rule when the teacher asks a question; and mathematical *truth is determined* when the answer is ratified by the teacher" (p. 32).

There are likely many reasons why traditional methods prevail. Rather than delve into why, my goal is to describe some typical components of many elementary mathematics practices. Of particular interest is what would be described as "typical" in regard to teacher practices and student behaviors during mathematics instruction.

An examination of the literature through this lens provides the topics to contrast with reform-based methods. If traditional elementary methods led to greater understanding then there would be no need to delve into the question of how to increase conceptual understanding by challenging traditional social norms. On the other hand, research that supports the engagement of students through discourse as a means to build their conceptual understanding, establishes that the premise of this study is supported.

Several studies provide a glimpse into mathematics instruction in the United States. Common topics within this research are related to the academic focus of instruction. "The data show that teachers rely heavily on lecture, recitation, and seatwork, teaching students mostly how to use standard procedures or algorithms to do basic arithmetic operations and solve simple word problems" (Rowan, Harrison, & Hayes, 2004, p. 104). The data were collected from 509

teachers in 53 schools in an effort to understand the practices of teachers of grades one, three, and five. The researchers found that when number concepts and operations were the topics, approximately 70% of those days consisted of direct teaching in which the teacher covered material the students had previously been taught. Another finding was that "only about 3% involved analytic reasoning" (p. 113). While the authors cautioned against looking too broadly at the implications of the findings, they nonetheless were provided with a great deal of data to support the notion that many of the students in the study were not engaged in meaningful learning opportunities. This research is closely related to the findings of the TIMSS study, which examined changes in instructional patterns between 1995 and 1999. "Students still were spending a large amount of time during each lesson reviewing material already learned in earlier lessons, and most of the lessons were devoted to practicing mathematical procedures rather than developing conceptual understanding" (Stigler & Hiebert, 2009, p. 184).

When mathematics lessons in the United States were compared to lessons in Japan, there was a distinct difference in regard to the nature of mathematics, the nature of learning, and the role of the teacher. Teachers in the United States focused more on the steps to solve problems and providing a structure for students to focus on procedures without making many mistakes. On the other hand, teachers in Japan provided opportunities for students to make sense of difficult problems on their own terms and focused more on students making connections between ideas (Stigler & Hebert, 1997).

Classroom Discourse

Learning is a natural process. Children possess a curiosity that fosters their development in a variety of ways. Anyone who has spent time with a five year old would recognize the

constant stream of "why?" questions. Unfortunately, when children are then sent off to school, often their questions are met with a stifling response. When we compare the complex process of learning that occurs naturally outside of school with what happens inside most schools we notice a stark contrast.

The social context of learning has been the subject of many scholars. The work of Vygotsky and Luria (1930) created a foundation of theory that established the necessity of engaging students through discourse. After conducting a series of experiments with young children, they determined that children use speech as they make sense of tasks in which they are involved. They found that as tasks within the experiments became increasingly more challenging, the speech of the children also increased. They also determined that when researchers attempted to interrupt the speech of children, the children stopped engaging in the task at hand. Their research included these two findings.

1. A child's speech is an inalienable and internally necessary part of the operation, its role being as important as that of action in the attaining of a goal. The experimenter's impression is, that the child not only speaks about what he is doing, but that for him speech and action are in this case *one and the same complex psychological function,* directed toward the solution of the given problem.
2. The more complex the action demanded by the situation and the less direct its solution, the greater the importance played by speech in the operation as a whole. Sometimes speech becomes of such vital importance that without it the child proves to be positively unable to accomplish the given task. (Vygotsky & Luria, 1930, p. 109)

These two findings support the important connection of speech to learning. When we allow students to talk in class, we provide necessary experiences for them as they make sense of difficult problems. Unfortunately, students are often prohibited from participating in sustained opportunities to speak in school.

A related study that focused on sociocultural theory, explored the social context of learning in schools. Gallimore and Tharp (1988) describe a less than ideal set of circumstances that students face in elementary schools. They lament that, "since the last century, teaching in North American classrooms has consisted only of providing tasks and assessing individual development" (Gallimore & Tharp, p. 21). While it is important for teachers to provide meaningful tasks and to assess student learning, students also need time and opportunities to talk. All too often, student talk in schools is indicative of superficial nuances associated with learning (Stigler & Hiebert, 2009).

IRE and IDE Discourse Patterns

Dialogue between the teacher and the students often portray a traditional view in many elementary mathematics classrooms (Stigler & Hebert, 1997). This has been attributed to the number of students with whom a teacher must engage in the course of the day (Jackson, 1990). Jackson depicts traditional classroom dialogue in this way:

> Teaching commonly involves talking and the teacher acts as a gatekeeper who manages the flow of the classroom dialogue. When a student wishes to say something during a discussion it is usually the teacher's job to recognize his wish and to invite his comment. (Jackson, 1990, p. 11)

A long-standing traditional method of teacher and student interactions occurs during an initiate, respond, and evaluate (IRE) sequence of dialogue (Mehan, 1979). This sequence begins with a teacher asking a question of the students. It is common that the question is one that requires a short response with one correct answer. Next, a student is chosen to respond to the question. Finally, the teacher evaluates the response and provides an indication of whether the student is correct.

This method of questioning has an undercurrent of expectations for students and for teachers. Students are likely to believe that their utterances are to be focused on providing correct answers. It is apparent to students that the teachers already know the answers, so the real issue becomes focused on determining what students can regurgitate. There is little room for higher-level thinking or for analysis on the part of the students. The teacher is established in a position of authority and control over the conversations and there is little room for discussion that models any kind of naturally occurring interactions.

When teachers utilize direct instruction and structure the dialogue in a traditional IRE fashion, students are taught to simply repeat the information they have heard as they receive several unspoken messages about what it means to *do* mathematics. "The classroom-speech event in which this IRE pattern is most obvious is the teacher-led lesson, or recitation, in which the teacher controls both the development of a topic (and what counts as relevant to it) and who gets a turn to talk" (Cazden, 1988, p. 30). The expectations are centered on the teacher maintaining ownership of information and making instructional decisions that lead the responses of students. This gives an impression that the teacher is simply looking for a specified answer rather than providing the opportunity for more depth of discussion. This view is incongruous with reform methods in mathematics education. An alternate view emphasizes the social context in which students acquire meaning.

> "Our records show that from the very earliest stages of the child's development, the factor moving his activities from one level to another is neither repetition nor discovery. The source of development of these activities is to be found in the social environment of the child and is manifest in concrete form in those specific relations with the experimentalist which transcend the entire situation requiring the practical use of tools and introduce into it a social aspect." (Vygotsky & Luria, 1930, p. 115)

A group of researchers working in a sixth grade classroom observed an exchange between students that provides a representation of discourse patterns that establish this type of social context (Nathan, Eilam, & Kim, 2007). The teacher in this class embraced "principles and practices of socially mediated classroom learning" (p. 528). Students participated in an environment in which they discussed their solution methods and justifications during a problem solving activity. Students talked directly to one another as the teacher facilitated and guided the discussion.

The exchanges seen were described as IDE (Nathan, et al., 2007) and differ in important ways from the traditional IRE sequence. Initiation, demonstration, and evaluation/elaboration (IDE) patterns of discourse engage students in meaningful ways. During initiation, the teacher is likely to include open questions as opposed to closed questions, which often occur in IRE exchanges.

Another difference between the two structures is that students are equally likely to initiate a questioning sequence and to direct these towards other students. When students demonstrate, they do so with the expectation that their demonstrations will enhance the understanding of other students as they develop a shared meaning. This may take the form of using objects, visual cues, or pictures. Students also actively evaluate their own methods as well as that of others in the classroom.

One of the main contrasting features of IDE is the cyclical and generative nature of the discourse patterns that are established. The evaluation and elaboration structure often spurs the need for further discourse whereas the traditional IRE pattern is often concluded when the teacher makes an evaluation of a student response.

IDE patterns of discourse closely align with reform methods in mathematics education. Depth and quality of student dialogue is evident through student engagement and sense-making activities. “What developed was a healthy, sustained mathematical discourse. Students posed solutions, asked questions, critiqued one another, and reformulated ideas in hopes that the next round would be better-more accurate, more widely understood, and more persuasive” (Nathan, et al., 2007, p. 553). Table 1 provides an overview of IRE and IDE patterns of discourse.

Table 1 Contrasting Discourse Patterns

IRE Pattern of Discourse	**IDE Pattern of Discourse**
Initiation of a question by the teacher	Initiation of question or problem by either the teacher or a student in the class Questions often open-ended
A response is provided by a student	Students demonstrate their understanding with the expectation that it will be beneficial to other students
The teacher evaluates the response given by the student	Students evaluate their understanding and that of their peers Students elaborate on their thoughts in response to their peers

IDE patterns of discourse provide more opportunities for students to be active participants during instruction. They are likely to experience mathematics differently than students in IRE patterns of discourse. These experiences have the potential to provide a view of mathematics as something in which to actively engage.

Reform in Elementary Mathematics

For decades, there has been a debate within mathematics education focused on the way in which mathematics is taught. There seems to be two distinct schools of thought (Schoenfeld, 2004). On one hand, there are proponents of direct instruction and teacher-based instructional

strategies. This traditionally-based mode of delivery has well-established roots in elementary schools in the United States. Another approach, which places more emphasis on what students are doing as they actively engage to make sense of mathematics, falls under the broad category of constructivism. The emphasis of social interactions between students is social constructivism. For the purpose of this study, social constructivism will be examined in comparison to the traditional methods for teaching elementary mathematics previously mentioned.

It is interesting that there has been a call for reform in mathematics education in the United States that dates back to the 1800s (Colburn, 1849). While there may have been efforts to specifically address the content of what is taught, more often the focus has been on the process of teaching and learning mathematics.

The Learning Environment

Benjamin Bloom is perhaps most widely recognized for his contributions on a hierarchy of cognitive development known as Bloom's taxonomy. He also described a theory focused on "favorable learning conditions" (Bloom, 1978, p. 567) as opposed to the inherent qualities of the learner. In regard to the effect of accumulated success or failure experienced by students, he stated, "Thus, while this research is beginning to draw parallels between immunization against physical diseases, such as polio or smallpox, and immunization against emotional diseases, it is also helping us to understand how schools may actually infect children with emotional difficulties" (Bloom, p. 568). Teachers should strive to provide a learning environment that addresses the needs of all students, not just the top performing students. Bloom offered many specific suggestions, which could be defined as best practice. Avoiding rote memorization,

emphasizing social interactions, and incorporating quality learning experiences are included in his recommendations.

One of the main tenets of the call for reform is the need to focus on authentic learning experiences. Bruner (1966) highlighted the importance of active participation when he compared the learning patterns that emerged in children living in tribes in Kalahari and Senegal with children attending French-style schools. What he noticed were the differences marked by playful exploration in the tribal children versus showing and abstract teaching in a formal school setting. He cautioned on the danger of schools teaching skills out of context and relying too heavily on unrelated skills that are too far removed from what will ultimately be expected. He found that students are more likely to develop intrinsic motivation, rather than look to fulfill seemingly arbitrary requirements from the teacher or the school setting, when they have personal connections to what is being learned.

Reform efforts in mathematics education provide recommendations for practice that is grounded in authentic experiences for students. "At every level of schooling, and for all students, reform documents recommend that mathematics students should be making conjectures, abstracting mathematical properties, explaining their reasoning, validating their assertions, and discussing and questioning their own thinking and the thinking of others" (Lampert, 1990, p. 32). These recommendations closely mirror the actual practice of mathematics in the discipline and establish the importance of developing new social and sociomathematical norms in the classroom to support these practices. It is often up to the teacher to negotiate the establishment of these norms.

The Role of the Teacher

It is difficult to discuss reform in elementary mathematics without examining the role of the teacher during instruction. The instructional decisions made by the teacher are often an indication of traditional or reform based methods. Teachers typically desire to help their students. Some of the instructional decisions that are made with the best intentions of helping are actually harmful to the development of autonomy and productive dispositions towards mathematics. "No matter how lucidly and patiently teachers explain to their students, they cannot understand for their students" (Schifter & Fosnot, 1993, p. 9). Unfortunately, this does not seem to stop teachers from trying to accomplish this impossible task.

When teachers hold traditional views of what teaching involves, they are likely to have difficulty embracing reform-based methods when teaching mathematics. "Despite reform efforts aiming to change the evaluative ways in which teachers tend to listen in mathematics classrooms, the notion of teaching as telling (speaking, explaining) rather than listening (hearing, interpreting) still pervades most mathematics classrooms" (Crespo, 2000, p. 156).

A new model of teacher-student interaction is necessary if students are to engage in meaningful mathematics. Rather than taking the stance of being the only one with control over conversations in the classroom, the teacher may choose to embrace a different role. Teachers may not be aware of alternatives to traditional roles and how they perpetuate them through their teaching strategies.

The Role of the Students

As the role of the teacher changes, the role of the students in response also changes. Teachers who establish themselves as the sole authority in the classroom are likely to get a

different response from students than teachers who embrace a mindset that places students in a more central role (Bruner, 1966; Glasser, 1992). Students are likely to perceive their role in the classroom based on the established norms. Social and sociomathematical norms are closely linked to the expectations of students in the class. As social and sociomathematical norms are described, the role of the teacher and the students are better defined and understood in the broader context of what occurs during mathematics instruction at the elementary level.

Social Norms

Social norms in the classroom are centered on the expectations for behavior and speaking patterns of the teacher and the students in the class. These norms may be explicitly formed and deliberately developed or they may occur without much attention or awareness. One example of a social norm is the requirement for students to raise their hands before being called upon by the teacher in order to speak (Brooks & Dixon, 2013). Social norms that have been established in elementary mathematics classrooms include the following: explaining and justifying your reasoning and solution methods, listening and attempting to understand others, and teacher re-voicing (Kazemi & Stipek, 2001; McLain & Cobb, 2001).

Sociomathematical Norms

Mathematics reform efforts stress the importance of dialogue in the classroom. Students are no longer expected to sit quietly at their desks and be recipients of information provided solely by the teacher. Rather, it is an expectation that they discuss their thoughts and processes in regard to solution methods. Specifically, students are asked to participate within a dynamic classroom in which they explain, justify, and question solutions (Cobb, Yackel, & Wood, 1992).

When students participate in this type of environment, they build on their understanding as they engage with their peers. These interactions have the potential to highlight the development of more sophisticated sociomathematical norms than are typical in elementary classrooms.

Sociomathematical norms as defined in the broadest sense, are "Normative aspects of mathematical discussions that are specific to students' mathematical activity" (Yackel & Cobb, 1996, p. 458). Sociomathematical norms exist in all mathematics classrooms. Researchers have described productive sociomathematical norms (Van Zoest & Stockero, 2012). To be considered productive, expectations include fostering mathematical arguments and utilizing evidence to support these arguments. Students and teachers establish these norms over time.

Sociomathematical norms that are aligned with reform efforts and support SMP3 are built upon a structure that involves negotiation of meaning. The negotiation entails establishing what constitutes an acceptable mathematical explanation and a legitimate challenge. There is also a focus on determining if a solution method is 1) different from others and 2) a sophisticated mathematical solution. (Cobb, Hodge, & Gresalfi, 2011). These defining characteristics of discourse depict ideal sociomathematical norms for fostering meaningful discourse.

A first grade teacher engaged her students in building social and sociomathematical norms within a larger research study (McClain & Cobb, 2001). Normative and taken-as-shared discourse patterns were followed throughout the study. This study provides insight into the role of the teacher and the students as they shift with the new expectations that are closely aligned with reform methods in mathematics.

The research team noted an interesting development within the study. Although there was an established model of "teacher-student-teacher-student" discourse sequence, at times this was

modified. “This turn-taking pattern broke down when students indicated that they did not understand explanations and questioned and justified their reasoning to each other directly” (McClain & Cobb, 2001, p. 245). In those moments two additional norms were established which involved posing questions to the explaining student and providing their reasons for finding the work of another student invalid.

Student discourse was allowed and encouraged. This was allowed because the teacher deemed it important. When students spoke specifically to the work of other students, it was for the purpose of clarifying, which, in turn, provided a context for students to develop justifications for their solutions. This was a change from the usual student-teacher discourse pattern. The new pattern served the purpose of establishing norms that were intended to move the thinking of students forward. When students were encouraged to speak to the student from whom they needed clarification, the teacher was providing a meaningful context for dialogue exchanges. There was an element of students taking ownership of the mathematical conversation at times when it was logical for them to do so.

The fact that the teacher was comfortable in allowing this type of interaction was indicative of her desire to not be viewed as the sole authority over the conversation. She did not want to be the only one evaluating student thinking. Her disposition toward her role in the classroom allowed her to make instructional decisions that kept the work of the students in a central role. “She made it clear that judging the worth of students’ contributions violated basic tenets of her nonimpositional educational philosophy” (McClain & Cobb, 2001, p. 248).

This teacher embraced a different way of structuring classroom norms and exhibited the characteristics that she felt important for engaging students in the process of making sense of

their thinking and the thinking of their peers. Her role in the process became one of facilitating and valuing student dialogue. She was enacting a role that moved away from the traditional role of the teacher as one who judges the work of the students.

By allowing students to discuss their thinking, she provided an opportunity for them to have access to the reasoning and justification of their peers. She also established a setting in which students had a purpose to engage with other students and to justify and evaluate mathematical reasoning. Within this context, students were able to gravitate toward a natural tendency to address the person to whom they had a disagreement or question. "The two general values that characterize the microculture established in Ms. Smith's classroom are those of attempting to understand and of active participation at all times including when others were speaking" (McClain & Cobb, 2001, p. 246).

The teacher established several important aspects of meaningful mathematics. She highlighted the participation of her students while minimizing her control of the conversation. As a result, students demonstrated an autonomy that is not always seen in elementary classrooms. Generally speaking, when students participate in the negotiation of sociomathematical norms, one positive outcome is the establishment of "intellectual autonomy" (Cobb et al., 2011).

This kind of autonomy aligns with recommendations made by Vygotsky (1934). He believed that students could not simply assimilate the understanding of adults. His emphasis was on the need for students to learn through applied thinking and discourse within a social context. Without this, he warned, students would likely be merely parroting information without understanding.

> Educational experience, no less than theoretical research, teaches us that, in practice, a straightforward learning of concepts always proves impossible and

> educationally fruitless. Usually, any teacher setting out on this road achieves nothing except a meaningless acquisition of words, mere verbalization in children, which is nothing more than simulation and imitation of corresponding concepts which, in reality, are concealing a vacuum. In such cases, the child assimilates not concepts but words, and he fills his memory more than his thinking. As a result, he ends up helpless in the face of any sensible attempt to apply any of this acquired knowledge. (Vygotsky, 1934, p. 356)

Vygotsky (1934) characterized attempts at teaching children in this way as futile. His view was that a "… scholastic and verbal method of teaching, which is condemned by everybody and which advocates the replacement of acquisition of living knowledge by the assimilation of dead and empty verbal schemes, represents the most basic failing in the field of education" (p. 357).

In the book, Apprenticeship in Thinking, Rogoff (1990) explored the social context of cognitive development. She states,

> Although children are familiar with adult environments, they are likely to treat a situation differently if they are in charge of it rather than being given a task by adults. They are probably more playful and exploratory and less goal-oriented when involved in a purely peer activity. (Rogoff, 1990, p. 172)

Student playfulness and exploration would be welcome as they are likely signs that a student is at ease in the situation. This is indicative of the nature of learning promoted by Bruner (1966). As students become active participants with their peers, they are able to establish themselves as important co-constructors of understanding. When students are in charge of the discourse, there is a level of ownership involved that may not happen when teachers fill that role. As students become more independent in their learning and in their interactions, the role of the teacher is renegotiated.

Students are likely to relate to peers in different ways than they do to teachers. Creating a social context for students to respond directly to one another has the potential to place the mathematics within reach in a less-threatening way than always responding to the teacher, who has all the answers and is the established evaluator. As students take a more central role during mathematics instruction, the role of the teacher changes as well.

Teacher Practice

Cobb (2000) describes a process versus product theoretical orientation as follows. Process relates to student development of mathematical reasoning within a social context; product orientation relates to the understanding that a student develops on an individual basis. Teachers may exhibit a product orientation, with the belief of an objective truth, or they may have a construction orientation, which is more concerned with the process of constructing meaning. Teachers at the elementary level can provide opportunities for students to learn that there exist many mathematically legitimate ways to arrive at a desired outcome (Bauersfeld, 1992). Teachers with a product orientation towards mathematics communicate an agenda to their students. Rather than portraying mathematics as something in which to engage, it is delivered as a series of procedures to imitate.

An alternate view is that elementary students have the capability to engage in the process of constructing meaning prior to focusing solely on correct answers (Bauersfeld, 1992). It may be efficient to have a product orientation, but there is a price for efficiency. What is at stake is a construction of understanding. What if teachers were willing to trade efficiency for effectiveness? If effectiveness were described in terms of long-term understanding and flexibility of thinking, then students would likely need to have a different role in the classroom.

When students are participants in their learning, there is an element of involvement that does not occur in more traditional classroom settings. Students become more autonomous as they learn to relate to the mathematical concepts and connect in a meaningful way. Their personal connections help them to create meaning and then apply the concepts in novel situations (Lampert, 1990).

Unfortunately, it is not enough for a teacher merely to facilitate discourse. This practice requires more than simply turning over the conversation to students. There is a recent focus on developing the necessary skill set for teachers to effectively manage the dialogue of students. One study recommends five practices to accomplish this goal. Stein, Engle, Smith, and Hughes (2008) developed a strategy to help ensure the success of teachers and a more structured approach to facilitating dialogue. Their recommendation incorporates the following five procedures to establish a pedagogical model for student discourse.

> (1) anticipating likely student responses to cognitively demanding mathematical tasks, (2) monitoring students' responses to the tasks during the explore phase, (3) selecting particular students to present their mathematical responses during the discuss-and-summarize phase, (4) purposefully sequencing the student responses that will be displayed, and (5) helping the class make mathematical connections between different students' responses and between students' responses and the key ideas. (Stein, et al., 2008, p. 321)

When teachers utilize these strategies, they are more likely to be effective in helping students make meaningful connections to the mathematics. If teachers are unsure of the responses students might give, they are unlikely to use their discussion to make methodological decisions on the spot. Without proper preparation, teachers are likely to foster an ineffective "Show and Tell" mode of interaction (Ball, 2001; Stein et.al, 2008).

Task Selection

One of the important decisions that teachers must make is choosing tasks during mathematics lessons (Smith & Stein, 1998). The tasks that are included in instruction may provide varying levels of complexity and therefore have the capability to impact student learning. There is a difference between task selection and task implementation. Tasks may be purposefully or unintentionally modified during implementation and there is a caution to avoid turning meaningful tasks into rote computation.

While textbooks and district pacing guides often provide a structure and a plan to follow, it is the teacher that ultimately decides the focus and enactment of specific mathematical problems. The cognitive complexity of tasks may be affected by the enactment of tasks. Any given task may be made more or less challenging based on how the task is presented by the teacher (Charalambous, 2010).

Smith and Stein (1998) describe four categories of cognitive demand for tasks. They are 1) memorization, 2) procedures without connections to concepts or meaning, 3) procedures with connections to concepts and meaning, and 4) doing mathematics (p. 345). An important aspect when determining the cognitive complexity of a given task is to identify the type of thinking required of the students. If the task has more than one solution method, it is more likely to set the stage for students to engage in verbal exchanges to explain and defend their solutions. In contrast, when students are asked to merely follow a set of steps to solve a problem, their discourse becomes more focused on describing steps taken as opposed to their thought processes.

Teachers often experience discomfort when they challenge students and include problems that cause them to apply their understanding without prescribed methods being provided. The

end result is that teachers modify the tasks and diminish the complexity in order to assist the students and alleviate discomfort (Stein, Grover, & Henningsen, 1996). As teachers attempt to incorporate more challenging tasks and maintain the integrity of these tasks during mathematics instruction, they are likely to need support.

Re-evaluating the established roles of teachers and students, incorporating student talk into lessons, and implementing challenging tasks during instruction all have the potential to redefine what elementary students experience during mathematics. These changes have the potential to provide meaningful mathematical exchanges that shift the discourse from exclusively belonging to the teacher to building the capacity for students to gain ownership of conversations.

The Need for Increased Discourse

Standards for Mathematical Practice

By 2014, the Common Core State Standards (CCSSO) were adopted by 43 states and the District of Columbia in the United States. These standards were meant to ensure that students would graduate from high school prepared for college and the work force. These standards address what is taught during mathematics. They also include eight standards for mathematical practice. These standards for practice establish a set of expectations for how mathematical content is taught. The standard for mathematical practice three (SMP3) states that students will, "Construct viable arguments and critique the reasoning of others." There is an assumption that in order for students to participate in these tasks, then they must be able to accurately explain their reasoning to provide clarity for others.

NCTM also published "Principles to Action" (NCTM, 2014) which include eight teaching practices to support students as they engage in meaningful mathematical experiences.

One of these practices, “facilitate meaningful mathematical discourse”, is directly related to SMP3 and is defined as follows. “Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments” (p. 10). When students are provided opportunities to engage in meaningful mathematical discourse, they are more likely to develop the skills to be successful with SMP3.

Sociolinguistics

“The study of classroom discourse is thus a kind of applied linguistics-the study of situated language use in one social setting” (Cazden, 1988, p. 3). The intersection of social constructivism and sociolinguistics provides a framework for this study. The field of sociolinguistics is concerned with the role of language in social context. It is the study of, “how language serves and is shaped by the social nature of human beings. In its broadest conception, sociolinguistics analyzes the many and diverse ways in which language and society entwine” (Eble, 2005, p. 1).

In a narrow conception, sociolinguistics in elementary mathematics education has to do with developing shared meanings around mathematical topics. The context of mathematical discourse has the potential to make mathematics more accessible to students. If the expectation is for students to engage in dialogue to explain and justify their thinking, then there is a need to establish the context for these discussions.

One indicating measure of the social context of student discourse is where students look when they are speaking. Typically, students direct their talk to the teacher, even when they are addressing the work of another student.

> Peers, in turn, do not gaze at the speaker's face nearly as often as the teacher does. They look more often at the teacher listening than they look at the student who is speaking. As often as not, while one student is speaking, the other students do not look at anyone, but gaze off in the distance or downward. (Philips, 1983, p. 76)

The message being conveyed when the teacher controls the conversation is that it is the teacher and not the students that should be regulating the discussion. "A child's claim to the floor is validated by the teacher, both verbally and visually, or not at all, in the official structure of talk" (Philips, 1983, p. 76). Cazden (1988) provides two suggestions for fostering student-to-student dialogue. One suggestion is for the teacher to avoid making eye contact with the student speaker. This has the potential to open the discussion to another student and to cause students to look at their peers when they speak. Another suggestion is to have desks arranged in a circle. "It may be generally helpful, especially for young children, to have different physical arrangements for events where different discourse norms prevail" (Cazden, 1988, p. 59). She compares the acquisition of a second language with learning new patterns for discourse in that students benefit from having visual signals.

When teachers control the conversations during mathematics instruction, they have the potential to either positively or negatively influence what occurs during those discussions. An example of a negative influence occurred within a study of eighth grade classrooms (Atwah, Bleicher, & Cooper, 1998). The authors describe a comparison between two very different eighth grade teachers and their instructional practices as they interacted in classroom discourse with their students. One teacher worked with boys at an affluent school and the other worked with a group of girls in what was described as an average school. Atwah, et al. explain that the way in which these two teachers engaged their students varied due to their stereotypical views in regard

to expectations for their students' future careers. The teacher who taught a class of girls had lower expectations for their performance than the teacher who taught a class of boys. This was demonstrated in the discourse patterns as well as the way in which the teacher addressed the students. For example, "In one class, students were constructed in the mind of one teacher as tough and rebellious, whereas in the other, they were seen as fragile and obedient" (p. 74).

> Ivor expected his students to possess high abilities and motivation. He believed that his students could and should take responsibility for their own learning.… He expected that his students were intelligent enough to learn eventually without his needing to slow the lesson down and explain in more detail. In contrast, Jeff constructed an image of his students as being less able and needing more teacher assistance and reinforcement. He used a slower, more didactic approach to explanation in his classroom. (Atwah, Bleicher, & Cooper, 1998, p. 79)

As depicted in the actions of Ivor, who taught the class of boys, and Jeff, who taught the class of girls, the teacher's perceptions may provide an avenue for bias and self-fulfilling prophecy to seep into the classroom. In this study, the discourse patterns established by each of the teachers had the potential to affect the mathematical development of the students. It also could provide the students with a limited view of mathematics as portrayed by the teacher. "Thus classroom interactions, being consistent with teacher perceptions, tend to have a self-fulfilling role for teacher expectations" (Atweh, et al., 1998, p. 80).

Another related study highlighted the difference in verbal responses of boys and girls as they pertain to errors. Jungwirth (1991) found discrepancy in discourse patterns during a research study involving Austrian students in grades five to twelve. The boys in the study showed a pattern of glossing over their misunderstanding thus giving the impression of having a grasp of the mathematics, while girls appeared less competent to the teacher because they were more transparent about their inabilities. In this case, the sociolinguistic skills possessed by boys gave

them the upper hand over girls in regard to their participation and their perceived understanding during mathematics discussions. Generally speaking, the message sent by the teacher was that the purpose of responding during mathematics instruction was to reach a consensus with the teacher and to appear knowledgeable about the topic at hand. The teacher was portrayed as having a product orientation towards mathematics and this had ramifications as boys and girls in the classes established different discourse patterns.

While it is not my intention to address gender issues in mathematics education, these studies speak to the importance of examining discourse patterns within the social culture of the elementary mathematics classroom. Teachers have the potential to either unintentionally or intentionally negatively influence the experiences of students in mathematics. The instructional moves of the teacher communicate something about what it means to participate in mathematics. Students may perceive their role in the classroom in various ways based on the expectations set forth by the teacher.

While the two previous examples may seem extreme, they provide a glimpse into the implications of keeping discourse patterns out of reach of students. Another way of framing this is that, when students are discouraged for whatever reason from engaging in meaningful discourse, their path to making sense of the mathematics is essentially blocked. This can take the form of a teacher purposefully or unintentionally denying students access to the component of discussing ideas in mathematics.

On the other hand when discourse patterns become the work of the students, there are new possibilities for them to develop a depth of understanding that could be otherwise absent. Rogoff (1990) uses the analogy of naturally occurring family or work discussions that begin with

a problem and end with a solution. She reminds the reader that often in the end, because the participants in the discussion all contributed to the solution, it is difficult to determine the ownership of ideas. A participant may feel that the idea was theirs.

> Indeed, it was theirs, but not theirs alone. The insights of such coordinated discussion are theirs as participants in the process. The product of such social interaction, far from being a copy of what is already invented or available in the thinking of either partner, involves a creative process in which the effort to communicate propels the partners together to develop new solutions through social means, with the partners each bringing their own understanding of the values and tools of the culture to the interaction. (Rogoff, 1990, p. 196)

This is a stark contrast to the typically occurring discourse patterns that take place during elementary mathematics lessons. Placing the students and their discourse patterns in a position of prominence is in keeping with reform methods for mathematics education. These contrasting discourse patterns provide a context for my study.

Summary

This review of literature establishes the need for understanding the social context of mathematics learning and the development of social and sociomathematical norms. Research has been conducted in relation to how students develop meaning through interactions with others. There is also evidence of how teachers portray what it means to *do* mathematics through their instructional decisions.

Reform efforts in mathematics and the standards for mathematical practice, especially SMP3 (CCSO, 2010), call for students to discuss their reasoning with each other. When students ask clarifying questions in response to a student justification, the natural flow of discourse would include asking the question to the one who is speaking. In society, day-to-day discourse patterns do not include raising hands to speak. For this reason, in 2006 I conducted an action research

study with a group of second grade students in which I specifically addressed the hand-raising rule during mathematics instruction. I found that when students were allowed to talk to each other directly, without raising their hands first, there were many positive indications of them constructing their own knowledge. They interacted with their peers in meaningful ways and utilized discourse patterns that supported their efforts to make sense of the mathematics (Egendoerfer, 2006).

My personal experiences with establishing new social and sociomathematical norms were very positive. I would like to further explore this topic. It is important to gain a better understanding of how another teacher and his/her students negotiate these changes in practice. Because my goal is to develop a better understanding of the negotiation of social and sociomathematical norms, an ethnographic study will be conducted. Discourse patterns will be examined in an effort to better understand the depth and quality of discussions when students are allowed to speak directly to one another without raising their hands to speak.

CHAPTER THREE: METHODOLOGY

Introduction

This study built on an action research project I conducted in a second grade classroom (Egendoerfer, 2006). I found that my students could engage in dialogue directly with one another and in the process, build a conceptual understanding of the mathematics. As elementary mathematics teachers in the United States focus on ensuring that their students are ready for college and the workforce, there is need for teacher support as they redefine what it means for students to develop a deep understanding of mathematics (Stein, 2000; Walshaw & Anthony, 2008).

The current study added to research about reform efforts in mathematics education. The goal was to gain a greater understanding of the development of norms within a second grade mathematics classroom. There was an additional goal of understanding what happened when students were allowed to freely discuss mathematics with their peers. Within this context, I was able to learn more about how mathematical discourse patterns develop. The purpose of the study was to carefully examine the social context of learning in an elementary mathematics classroom as a teacher and a class of students negotiated discourse norms.

The process of how new social and sociomathematical norms are established was identified. The end goal was to describe the development of social and sociomathematical norms when students were not required to raise their hands to speak.

My research questions were:

1. How are new discourse patterns established during mathematics instruction?

2. What qualities of social and sociomathematical norms exist in a classroom in which a teacher allows the students to speak directly to one another without first raising their hands during whole group instruction?
3. How do the teacher and students react when traditional social norms are challenged?

Research Design

Student dialogue during mathematics lessons was explored and described in an effort to determine the qualities of students' verbal participation during instruction. This dialogue was shaped by the classroom culture as social and sociomathematical norms were established. For these reasons, I chose an ethnographic case study design.

Creswell (2007) depicts an ethnographic study in this way: "Ethnographers study the meaning of the behavior, the language, and the interaction among members of the culture-sharing group" (p.68). The "culture" in this case included the students and the teacher as they established new norms during mathematics lessons. This was appropriate methodology because it provided a structure to analyze themes that emerged as I closely examined the construction of these norms in an elementary mathematics classroom setting.

I utilized the guidelines for ethnographic study as outlined by Florio-Ruane (1987). She states that, "Good ethnographers of communication are careful and thorough in recording data, self-conscious about analytic categories, vigorous in seeking disconfirming evidence and discrepant cases, thoughtful about informants' participation, and artful in combining exposition with narrative and example" (p. 195). The data I recorded focused on the communication between the members of the class. I collected data before the teacher made any changes to his instruction or knew of the specific goals of my research. The purpose of collecting data before he

made any changes was to determine his typical instruction during mathematics. I collected data throughout the study as new social and sociomathematical norms were established.

Eisenhart (1988) provides rationale for including participant observation, ethnographic interviewing, artifacts, and researcher introspection. She also recommends that analysis should accompany the data collection process and "…subsequent analysis may raise new research questions or lead to insights that become incorporated into, or sometimes radically redirect, the study itself as well as later data collection and analysis procedures" (p. 107). These insights informed my decisions during the study. For example, after I observed the teacher during mathematics lessons, I analyzed occurrences for indications of the development of new social and sociomathematical norms. I was also able to adjust the professional development based on what occurred. I remained flexible in regard to the questions I would ask in the interview at the end of the study. Each of these data collection procedures will be discussed in detail throughout this chapter.

The order of data collection was as follows: 1) interview and choose a teacher for the study; 2) interview the students; 3) observe and collect video and audio recordings of business as usual instruction; 4) provide ongoing professional development, continue collecting video and audio recordings, and take detailed field notes; and 5) conduct ending interviews with the teacher and students.

The observations, interviews, and artifacts will be described later in this chapter. These types of data are common within the field of research study in elementary mathematics. According to Eisenhart (1988), however, what is not as common is researcher introspection. When engaging in researcher introspection:

> The ethnographer regularly records the kinds of things that are happening to her or to him in the research situation. In this manner, the ethnographer tries to account for sources of emergent interpretations, insights, feelings, and the reactive effects that occur as the work proceeds. (Eisenhart, 1998, p. 106)

I completed this introspective work each day within field notes, which will be described later in this chapter. These introspective insights influenced decisions I made during the study. They also provided indications of emerging themes in the data. Each of the data collection tools provided a wealth of information that assisted me in answering my research questions. The research tools and methods were important but also important was the opportunity to conduct my research in a local school district.

Setting

School and Class Demographics

Columbus Elementary School (pseudonym) is a public elementary school located in a small district in Central Florida. The school had an enrollment of 777 students in grades K-5. Sixty-eight percent of the students in the school were eligible for free lunch and an additional 12 percent of the students were eligible for reduced lunch.

The teacher I chose for the study, Mr. Sharp, (pseudonym) was a second grade teacher. He was relatively new to teaching. At the time of the study, he was in his third year of teaching. His only full time teaching experience was in second grade. Mr. Sharp had a background in music education and obtained his teaching certificate by taking the state certification exams. He had not taken any methods classes for mathematics in elementary education.

Mr. Sharp's second grade class consisted of 17 students. There were 9 girls and 8 boys in the class. Two of the students received services for gifted and were pulled from Mr. Sharp's

classroom on either Thursday or Friday each week. Students arrived to the classroom each morning at 8:30. They watched daily announcements and prepared for the day for the first 15 minutes of the day.

Mathematics was taught each day from 8:45am-10:00am. The schedule for mathematics was established by the administration. All of the second grade teachers followed this same schedule. The second grade team also planned their lessons from the textbook together. In regard to pacing, their goal was to stay within a lesson or two of each other.

Consent Process

Before I contacted the school district, I obtained Institutional Review Board approval from the University of Central Florida (Appendix A). Once the teacher was identified and agreed to participate in the research, the principal of the school was contacted and verbal consent was requested. I acquired consent from the district (Appendix B), then provided an official consent document to the teacher (Appendix C). I requested consent from the parents first and then from the students enrolled in the class. Parental consent consisted of a parent letter (Appendix D). Verbal consent was acquired from the students (Appendix E). My research was reliant on the commitment of a willing teacher. I worked closely with this teacher throughout the study.

Teacher Selection

Cobb (2000) highlighted the importance of the teacher in the process of establishing sociomathematical norms.

> With regard to the process of conducting a teaching experiment in collaboration with a teacher, the overriding concern should be that of establishing an effective basis for communication so that the teacher and the researchers constitute a pedagogical community united by a common purpose. The possibility of

> developing such a basis for communication should be considered very seriously when deciding whether or not to collaborate with particular teachers. In our experience, we have found it critical to identify initial common ground from which an adequate basis might evolve. (Cobb, 2000, p. 331)

One of the first steps to begin the study was determining my criteria for selecting the teacher. I made the determination based on the following criteria: taught either first or second grade, embraced reform methodology, was not participating in any other research, had the rule, "Raise your hand to speak," and was open to changing that rule.

I chose a teacher working with second grade. This was beneficial for several reasons. Although these students already had set patterns for expectations regarding discourse rules, I believed they would be more flexible due to the shorter amount of time in the school system. Another reason for choosing second grade was because of the testing that occurred in grades three through five. Second grade students did not participate in the state mandated achievement test and therefore, the teacher may have been more flexible with instructional time.

I determined if the teacher embraced reform methodology by utilizing an informal interview. This will be described in the data collection section. It was important that the teacher embraced the ideas espoused by the reform movement in mathematics education. If the teacher exhibited a very traditional disposition for his role in the classroom, the issue of relinquishing control would have more likely been problematic.

It was important that the teacher was not engaged in other research projects because I believed that changing established norms would likely prove challenging for the teacher. I wanted the focus of the teacher to be on my research project without the distraction of another study. The teacher was not involved in any additional research projects or any mathematics professional development at the time of the study.

I chose a second grade teacher that was implementing the rule, "Raise your hand to speak," because there was value in understanding how the new social norms were established when the rule was changed to allow direct student-to-student dialogue. It was also important to understand how the students participated in and negotiated the new social and sociomathematical norms. This allowed me to accurately describe the process of the development and implementation of these norms.

Although the focus of my study was on the students and the discourse of the classroom, the teacher was a critical component. Without a willing and open-minded teacher, it is unlikely that a setting in which to examine student interactions would have been established. What I asked of the teacher (allowing students to talk directly to each other) was beyond the normal scope of expectations for classroom behavior. The teacher had the qualities I was looking for in that he was 1) willing to modify the "raise your hand to speak" rule, 2) motivated to focus on students constructing their own knowledge, and 3) believed in student engagement during mathematics instruction. If the teacher did not see value in each of these changes, then it would be unlikely that he would have been interested in participating in research that involved changing the established hand-raising rule.

Professional Development

My initial work with the teacher was in preparation for changing norms during mathematics instruction. Throughout the study my focus was on supporting him as he changed the social and sociomathematical norms during whole group mathematics lessons. Previous studies have established teaching strategies that may be used to develop social and

sociomathematical norms. This body of research provided the structure for teacher training and informed my decisions related to professional development.

Carpenter, Fennema, and Franke (1996) found that teachers developed strategies in much the same way as students in regard to inquiry methods. "Consistent with our assumptions about children constructing knowledge of mathematics, we recognize that teachers construct their own understandings of students' thinking" (p. 5). When working with teachers, these understandings provided a framework in which they were able to apply a new understanding of how the professional development related to their particular circumstances. Rather than formally including topics for teachers to apply, Carpenter et al. presented ideas and the opportunity for teachers to make sense of the concepts in their own way.

Working from this model, I remained flexible and reactive to the teacher's needs. My initial professional development plan included a list of topics, video support, and professional reading for the teacher. I also planned to support the teacher in two distinct phases during the study. These planned phases will be described in the next section. Based on the needs of the teacher and what I was observing during mathematics lessons, I added to and adapted the professional development plan. One of these changes was in regard to having two distinct phases. I will discuss changes that were made including phased professional development in chapter four.

In this chapter, first I will describe the planned professional development. Next, I will describe the topics and resources that I shared and the general information about the professional development that was provided. Finally, in chapter 4, I will explain what actually occurred

during the professional development as well as the decision-making processes associated with the sessions.

Planned Professional Development

My initial plan included two distinct phases. The first phase of professional development, which was to last five school days, was built on the recommendations of Stein, et al. (2008). I would focus specifically on sharing strategies with the teacher such as "…monitoring students' responses, …selecting particular students to present, and …helping the class make mathematical connections" (p. 321). I viewed this as a stepping-stone. I anticipated that the teacher would be more comfortable in changing one professional practice at a time rather than being asked to change everything at once. In other words, I initially thought that it would be overwhelming to the teacher to be asked to make changes to his typical instruction while at the same time focus on establishing new social and sociomathematical norms.

The second phase of professional development was planned to last ten to fifteen school days. To develop this plan, I utilized the recommendations of Wood, Cobb, and Yackel (1991). They provided a structure for a lesson that included a beginning mathematical task and whole-class discussion, which would have already been established during the first phase of professional development. They also recommend a time devoted to paired-student discussion prior to the whole-class discussion.

The lesson structure described above was aligned with a form of Japanese lesson study used by Inoue (2011) with a group of elementary teachers in an effort to support their implementation of mathematics inquiry lessons with students in fourth and fifth grade. The four-step structure includes initial problem posing, individual or group problem solving, whole class

discussion, and summary (p. 6). The “neriage” stage, which occurs during the whole class discussion, includes encouraging students to listen carefully to one another and is considered the highlight of the lesson. It is during this whole class discussion time that students talk directly to one another without raising their hands first.

I anticipated that this structure would allow for the flexibility of the teacher to include topics as outlined in the district pacing guide, while still focusing on problem solving tasks so as to allow for students to have the opportunity to discuss their ideas.

The plan was that professional development would occur in two phases in an effort to help the teacher transition into his new role. During both phases, the teacher was going to be asked to: 1) Select a challenging mathematical task that requires problem solving by the students, and 2) Conduct whole group discussions that focus on student solution methods. These two requests were maintained in the actual professional development that occurred. Other aspects of the professional development plan were revised. These revisions will be discussed in chapter 4.

Topics and Resources for Professional Development

The guidelines I provided the teacher were established from research in mathematics education related to the social construction of understanding. Topics were chosen from this research in advance and were revisited throughout the study. Other professional development opportunities were intended to meet the particular needs of the teacher. I felt it was important to remain flexible in regard to what needed to be discussed either by me or by the teacher.

These professional development sessions were designed to address questions related to mathematics content, teaching strategies, or the practices related to the development of social and sociomathematical norms. These topics stemmed from the teacher, verbalizations of the

students, or what I observed during the mathematics lessons. These data will be presented in the next chapter.

The planned professional development topics were introduced beginning on my third day with the teacher. Prior to this work, I conducted the teacher and student interviews and collected data of typical classroom instruction during mathematics. Descriptions of each of the pre-planned professional development topics follow.

Journal Reading

One of the first tasks I asked of Mr. Sharp was for him to read the article, "Changing the Rules to Increase Discourse" from Teaching Children Mathematics (Brooks & Dixon, 2013). This provided a context for what would occur during the study and also allowed him an opportunity to think about the practical application of changing the rule for raising hands to speak. The article clearly outlined the steps that we were working towards together during the study. I asked him to write down questions, thoughts, and concerns that came to mind when he read the article. This would allow me the opportunity to gain a better understanding of his perspective and to address his questions or concerns.

Task Selection

Mr. Sharp and I discussed how to carefully consider the tasks he implemented during mathematics instruction. I explained that some tasks were better than others for sustaining discourse. I also cautioned against diminishing the complexity of tasks. I included the work of Smith and Stein (1989) as I addressed the tendency to attempt to help students by reducing the challenge.

I provided him with a chart that categorized mathematical tasks based on their level of cognitive demand (Stein, 2000, p.16). It was intended to help him understand the difference between low-level and high-level tasks. This chart was used as a focus of discussion during our professional development session. It was also revisited throughout the study.

Multiple Solution Methods

Another topic of discussion was highlighting a variety of different solution methods. For example, I spoke to him about asking students if anyone solved a problem in a different way. It was my intention to bring his attention to discourse opportunities when students share unusual or different ways to solve a problem (Carpenter, et. al., 1996). In allowing students to share their methods, there was an element of highlighting student talk during mathematics.

We also discussed how Mr. Sharp could support students in determining if shared methods were mathematically different, efficient, or sophisticated (Yackel & Cobb, 1996). I shared examples of these sociomathematical norms throughout the study.

Expectations for Whole-Group Discussions

We discussed the importance of stating expectations to students in regard to how to behave during whole-group discussions. A few related topics were that students would listen when others were speaking. They would also be expected to participate in the conversations (Brooks & Dixon, 2013).

Student Sharing

I asked Mr. Sharp to allow students to share their thoughts. I initially asked that he choose students to share based on the objective of his lesson. It was a stated expectation that

students be allowed to have time to think independently and/or in pairs before sharing their work whole group (Inoue, 2011; Wood, et. al., 1991).

Stating Disagreement

I shared that Mr. Sharp could have students initially show agreement or disagreement by showing a thumbs-up or thumbs-down signal (Warfield, et. al., 2005). We talked about how allowing disagreement would help students to think critically about what they were hearing. I also shared that students could be told that it is okay to disagree. I talked to him about how to share this with his students.

Terminology

I utilized terminology as depicted in research in mathematics to explain the underlying themes associated with my study. The terminology was intended to help Mr. Sharp have a clear understanding of expectations for student behavior during mathematics.

The social norms were defined as they related to student discourse. They were as follows: "Explain your reasoning. Begin a disagreement with specific questions or explanations based on what you heard. Question others when you do not understand what they are saying" (Brooks & Dixon, 2013, p. 86). Social norms for direct student-to-student exchanges included: "Address one another by name….Talk about your classmate's method before sharing your own thoughts….Take turns talking; speak one at a time….Speak clearly and loudly so others can hear" (p. 88).

I included the terminology of Yackel and Cobb (1996) as a goal for the ideal standard of sociomathematical norms. They were described as they related specifically to building a

mathematical understanding and included the following: "…normative understandings of what counts as mathematically different, mathematically sophisticated, mathematically efficient, and mathematically elegant…Similarly, what counts as an acceptable mathematical explanation and justification" (p. 461).

Video Sharing

Selected segments of video that accompanied the county adopted textbook series were shown to the teacher. These short video segments by an expert in the field teaching mathematics from the textbook series in classroom environments were available to the teacher for online support. The purpose in including these video segments was to highlight teacher practice that I wanted to reinforce. For example, I wanted the teacher to recognize teaching strategies that brought attention to a student's novel way of approaching a problem. I asked the teacher to notice what happened as a result of that teaching strategy. Mr. Sharp was given the opportunity to share insights, questions, and concerns that arose while watching the videos.

General Professional Development Information

The first professional development session occurred on my third day in Mr. Sharp's classroom. This was the last day of collecting data on business as usual instruction. I did not want to influence his instructional decisions as I tried to determine the typical occurrences during mathematics lessons.

Each professional development session lasted between 30 to 40 minutes during the teacher's planning time, which occurred directly after the mathematics block. We initially planned to meet once a week to make plans for the following week and to discuss any challenges

that occurred while changing the norms in the classroom. The scheduled meetings were changed at times due to unexpected meetings that prevented Mr. Sharp from attending a professional development session.

Additional professional development was planned in order to accommodate the teacher's schedule. Selected video clips of Mr. Sharp's instruction with related questions were made available online. This will be described in detail later in the chapter. The teacher had the opportunity to view actual occurrences within the classroom at a time that was convenient for him. The video provided a context and purpose for the professional development I offered. This allowed me to provide practical recommendations based on the particulars of the situation rather than just relying on theory and hypothetical information.

The hours of professional development totaled approximately 5 hours over 6 weeks. In addition to the more formal meetings, we also talked briefly either before or directly following lessons. During these times I was able to provide feedback, offer suggestions, and ask questions related to Mr. Sharp's feelings related to the study.

Data Collection

I began observing lessons and collecting audio and video data as soon as consent forms were collected. I purposely refrained from providing information specific to my study prior to these observations. My initial audio and video data were focused on determining the typical teaching practices and student discourse prior to any change in practice. I did not want to influence the teacher's instruction and therefore the only information that I gave the teacher was that I would be asking him to change a rule during mathematics instruction. The data from the business as usual lessons will be described in detail in the next chapter.

My data collection methods were influenced by research in sociomathematical norms, ethnography, and sociolinguistics. During the study I: conducted interviews with the teacher and students, video and audio recorded mathematics lessons and interviews, took field notes during mathematics instruction, and had the teacher provide "member checks" of the information I compiled. I also collected work samples from the students as they pertained to their construction of mathematics knowledge. Table 2 provides a rationale and description for each of these data collection choices.

Table 2 Data Collection Plan

Question	**Data**	**Description of how it addresses question**
How do the teacher and students react when traditional social norms are challenged?	Interview with Teacher	The teacher shared insights into reactions of role of the teacher, role of the students, how new norms were enacted, and how they interacted with the establishment of sociomathematical norms.
How do the teacher and students react when traditional social norms are challenged?	Interview with Students	The students described their impressions of instruction both before and after norms were changed and sociomathematical norms were established. They shared their reactions of what it meant to participate in mathematical discussions.
How are new discourse patterns established during mathematics instruction? What qualities of social and sociomathematical norms exist in a classroom in which a teacher allows the students to speak directly to one another without first raising their hands?	Video and Audio Recordings	Video and audio recordings provided evidence of the qualities of social and sociomathematical norms.
How are new discourse patterns established during mathematics instruction? What qualities of social and sociomathematical norms exist in a classroom in which a teacher allows the students to speak directly to one another without first raising their hands?	Field Notes	The notes helped me identify themes that immerged in regard to quality and depth of discussion. They allowed me to go back through the video to find evidence of quality and depth of discussion. They also provided a systematic method for recording introspective insights.

Question	Data	Description of how it addresses question
How do the teacher and students react when traditional social norms are challenged?	Online Surveys	The surveys provided a vehicle to share selected video clips with the teacher. He was able to share his reaction to classroom happenings.
How are new discourse patterns established during mathematics instruction? How do the teacher and students react when traditional social norms are challenged?	Debriefing Sessions	The teacher provided information during these sessions that helped me determine how new discourse patterns were established. These sessions were also an outlet for him to share his reactions to what occurred during instruction.

Teacher Interviews

An informal interview was used to determine if the teacher embraced reform efforts in mathematics education. This allowed me to make an informed decision in regard to teacher selection. The questions were as follows:

1. How important is it for your students to memorize during math instruction? (Bloom, 1978)
2. Are you familiar with the Standards for Mathematical Practice? (Provide information if necessary) What does it mean to you that students construct viable arguments and critique the reasoning of others? Do your students currently do this? In what ways? Do you see value in this? Why/Why not?
3. Is mathematics at your grade level more about a process or about an end product? Please explain. (Cobb, 2000)
4. What are your classroom rules? Would you consider changing one of these rules during mathematics instruction?

These four questions were used in conjunction with the criteria described previously in this chapter in the section on teacher selection. Because the teacher was selected to participate, I continued with the teacher to determine his/her views on student talk and the role of the teacher during instruction. These questions served the purpose of determining how to best help the teacher to initiate new norms in the classroom. Because I was working closely with the teacher throughout the time of the research, daily discussions were recorded and guided the support that was given during professional development sessions. During the interview, I asked the teacher to respond to the following:

1. How long have you been teaching?
2. Please describe a "typical" math lesson in your class.
3. What do you think about students' talk during mathematics?
4. What positive things do you notice with this particular group of students in regard to math instruction?
5. What challenges do you face with them in regard to math instruction?
6. What do you think about errors that occur during mathematics instruction?
7. Please describe the current patterns for talk in your classroom during mathematics instruction.
8. There is a pattern of talking between teachers and students described as initiate, respond, and evaluate. (Describe IRE in detail to the teacher) What are your thoughts about that structure?
9. How can I support you during mathematics instruction in your classroom?

I interviewed the teacher again at the end of the study. The purpose of this interview was to gain the perspective of the teacher in regard to the establishment of social and sociomathematical norms as well as the qualities of these norms during classroom exchanges. The ending interview questions are included in Table 3 along with the research questions to which they are associated.

Table 3 Teacher Ending Interview and Research Questions

Research Question	**Associated Teacher Interview Question**
How are new discourse patterns established during mathematics instruction?	1. What was especially helpful to you as you established new social norms in your classroom? Is there anything that would have helped that we did not do?
What qualities of social and sociomathematical norms exist in a classroom in which students speak directly to one another without first raising their hands during whole group mathematics instruction?	2. What do you think were the biggest changes you have made in regard to mathematics instruction since the beginning of this study?
How are new discourse patterns established during mathematics instruction?	3. What were the biggest challenges as new norms were established during math?
How are new discourse patterns established during mathematics instruction?	4. What do you think was most difficult for your students?
How are new discourse patterns established during mathematics instruction?	5. Was there anything that you felt was especially easy for the students?
How do the teacher and students react when traditional social norms are challenged?	6. How do you feel about changing the hand-raising rule during mathematics instruction?
How do the teacher and students react when traditional social norms are challenged?	7. How do you think your students felt about changing the hand-raising rule during mathematics instruction?
What qualities of social and sociomathematical norms exist in a classroom in which students speak directly to one another without first raising their hands during whole group mathematics instruction?	8. Thinking about how your students have learned to speak directly to one another, what do you think is working or worked especially well? What do you think has not worked or is not working well?
What qualities of social and sociomathematical norms exist in a classroom in which students speak directly to one another without first raising their hands during whole group mathematics instruction?	9. Do you think student talk is different since making changes during math instruction? In what ways?
How do the teacher and students react when traditional social norms are challenged?	10. Have your views changed in regard to student talk during mathematics?
	11. Anything else you would like to share?

The specific questions were developed at the end of the research study. They were not determined in advance because of the need for me to remain flexible in regard to the direction of the study and the possibility to change research questions during the study. I was also able to develop questions that allowed me to triangulate data acquired from other sources during the study.

Student Interviews

I engaged a select group of the students in a brief, semi-structured interview before the teacher implemented new social or sociomathematical norms. I interviewed four boys and three girls and included students that represented the diverse population of students in the class. Careful attention was given to the representation of academic achievement of the students. The teacher selected students that were low, medium, and high performers as demonstrated on mathematics assessments that correlated with the units of study in the classroom. I initially planned to interview three boys and three girls, but one of the boys was initially unavailable to be interviewed and was replaced. I included him in the interview process the next day when he arrived at school because he was originally chosen by the teacher. During the ending interview, one of the boys was not audibly loud enough to be heard. His responses were not included in the data.

I wanted to get the perspective from the children because this study was centered on the classroom community and it was important to get a sampling of perspectives from within this community. The interview was video-recorded. When students shared something that could be expanded upon, further questions were asked. During this interview, I asked the students to respond to the following:

1. Tell me about what your class usually does during math.
2. Do you talk a lot during math class? Why/Why not? Tell me about the kind of talking you do during math.
3. What do you think would happen if your teacher allowed you to talk directly to your friends during math class without having to raise your hand first?
4. Tell me about making mistakes during math class.
5. What do you think about explaining your work during math?
6. Is there anything else you think I should know?

Student interviews were conducted again at the end of the study. The purpose of these interviews was to provide the perspective of the students and to triangulate data obtained from observations and field notes. The interviews also provided depth of information and an opportunity for me to clarify points of confusion about patterns I observed during lessons. My goal was to remain flexible about the specific questions to be asked during the ending interview. Flexibility was important due to the possible changes that could occur in regard to the research questions during the study. The student interview questions that were used at the end of the study were as follows:

1. Tell me about what your class usually does during math.
2. Do you talk a lot during math class? Why/Why not? Tell me about the kind of talking you do during math.
3. Have you noticed your teacher doing anything different lately during math class?
4. What happened when Mr. Sharp allowed everyone to talk directly to each other during math class without having to raise their hands first?

5. How did you feel about talking directly to your friends without having to raise your hand first?
6. Tell me about making mistakes during math class.
7. What do you think about explaining your work during math?
8. Is there anything else you think I should know?

Each of these questions was designed to gain an understanding of the reaction of the students to what occurred during the study. The major change that occurred between the beginning and ending interview is the addition of two new questions. Question 3 was designed to determine the degree to which students could identify that a change had occurred during mathematics instruction. Question 6 addressed the topic of mistakes during mathematics.

Video and Audio Recordings

I began observing lessons and collecting audio and video data as soon as consent forms were collected. I purposely refrained from providing information specific to my study prior to these observations. My initial audio and video data were focused on determining the typical teaching practices and student discourse prior to any change in practice. I did not want to influence the teacher's instruction and therefore the only information that I gave the teacher was that I would be asking him to change a rule during mathematics instruction. The data from the business as usual lessons will be described in detail later in the chapter.

I began recording as soon as the teacher started the daily mathematics lessons at 8:45 each day. I recorded video and audio, took field notes, and observed Mr. Sharp for the entire mathematics block four days a week over the course of six weeks. It was my original intention to observe his class each day, but Mr. Sharp had a set schedule for his math lessons and my

schedule prohibited me from being there for one of the days each week. I was in his classroom for a total of 23 days and collected a total of 30 hours of mathematics instruction. The audio I collected was used mainly as a backup to the video recording. I also audio-recorded the professional development sessions so they could be transcribed.

I collected video and audio recordings of complete mathematics lessons. On the first day, I began to collect the recordings in an effort to establish what the teacher considered a typical mathematics lesson. This was used to establish baseline, "business as usual" instruction. Once that was established, lessons over five and a half weeks were observed and recorded. When I conducted action research on changing social norms in second grade (Egendoerfer, 2006) the development of norms was immediately evident. For this reason, I anticipated that I would be able to describe the establishment of social and sociomathematical norms within the second or third week of the changed hand-raising rule. I focused my analysis on the social culture of the classroom.

Select video and audio recordings provided data that were then transcribed and analyzed. I was looking for emerging themes within classroom discourse; I was interested in how these themes described the content of the discussions, establishment of social and sociomathematical norms, qualities of the norms, and error handling.

Hall (2000) conducted research that involved video recording a class of middle school students as they engaged in problem solving activities. He discussed the comparison of techniques used during videography of class events. For example, when focusing too closely on one aspect of classroom instruction, there may be important events or exchanges that are missed. The importance of making purposeful choices was made clear. It was beneficial to have multiple

recording devices so I could capture unexpected occurrences in the classroom such as conversations between students that indicated a misunderstanding about teacher expectations or their role in classroom discussions.

Hall also provided the metaphor of a "teaching diorama" and stated that, "…by combining a record of these teaching dioramas with focused records of group work like those described in the preceding section, it is possible to treat classroom videography as a sampling scheme that weaves together the multiple, local perspectives of teachers and students as they work together across settings" (2000, p. 654). The term diorama depicted the use of video to capture the dynamic classroom environment. The video included multiple perspectives, which helped to capture nuances that may have otherwise been overlooked.

Because my goal was to examine discourse patterns within the social context of the classroom, it was important to gain the perspective of the students while also understanding that I could not experience the mathematics through their lens. I obtained multiple points of data that provided rich descriptive evidence of dialogue as it was established in the elementary mathematics classroom.

I had a wide view of the whole class from two different points in the room. Each of these two cameras included as many students in the class as possible. At times the students sat at their desks for instruction and at other times they sat on the floor at the front of the room. Depending on the orientation of the classroom layout, the cameras were located either in the front on either side of the room, or one in the front and one in the back. I also had access to a camera with a zoom feature and video recording capability. I used it on occasion to capture individual student

work as well as aspects of classroom happenings that I interpreted to be critical in relation to student discourse.

An audio recorder was placed at the front of the classroom. This was used as a backup in case the video camera did not record the dialogue clearly enough. These audio recordings could have been used to create transcripts of dialogue that occurred during the lessons and served as a backup system to the video that was recorded.

Field Notes

I took daily field notes in which I described the social interactions in the classroom. The field note document included the following headings under which I took notes: Happenings, Time, Norms, Insights, and Interpretations. These notes helped me to keep track of occurrences that seemed to be important during instruction. The notes also assisted me in retrieving specific examples within the video recordings and noticing patterns and changes that occurred over time. This process is supported by Eisenhart (1988).

Debriefing

I incorporated some of Cobb's (2000) recommendations that, "Once the experiment is in progress, daily debriefing sessions and weekly meetings provide occasions in which to develop taken-as-shared interpretations of what is happening in the classroom" (p. 331). In an effort to be respectful of the teacher's time, I planned to meet with the teacher at least once a week face-to-face. The focus of these meetings was to discuss what occurred during the lessons and was intended to support the teacher as changes were made in the classroom. This was also a time to plan ahead to the lessons for the following week.

Much of the debriefing occurred within the professional development time. We had additional moments to speak before mathematics lessons while the students entered the room, unpacked their bags, or watched the morning announcements. We also had brief moments as students prepared to leave the room directly following the mathematics lessons. In addition to face-to-face meetings, I utilized email, phone calls, and an online survey tool maintained by Qualtrics (Qualtrics, Provo, UT, 2013).

Online Surveys

I uploaded selected video clips of Mr. Sharp teaching onto the Qualtrics site to share with him. Qualtrics provided an opportunity for me to easily share video with the teacher. It had the added benefit of allowing a variety of response options in the form of open dialogue boxes and an area for me to ask questions of the teacher. Sharing video with the teacher served two purposes. This allowed the teacher to be an active participant in the analysis of occurrences during instruction. It also served as a method to inform my targeted professional development.

The purpose of sharing video of teacher practice was to facilitate the teacher as new norms were established and to develop a shared understanding of what occurred in the classroom. The video provided a means to accurately depict what happened during instruction and held us both accountable to what was recorded (Hall, 2000). These video clips also informed my decisions in regard to the professional development I provided to the teacher. For example, I was able to notice common practices and include these clips to bring to the teacher's attention prior to his next lesson.

I originally planned to have Mr. Sharp watch video clips and answer questions at least once a week. The limit for video files uploaded to Qualtrics is 16MB, which equated to

approximately 1 minute in length. I did not want to send more than one Qualtrics survey at a time, so when he did not complete one survey, it created a backup and a missed opportunity for me to share video and collect feedback. Over the course of the study Mr. Sharp completed four surveys. The first survey was used to orient him to the site.

The teacher was provided with the opportunity to share impressions of what occurred. This allowed me to gain a better understanding of the teacher's perspective. In this way, I was not simply treating the teacher as a respondent. Rather he was invited to participate in the analysis of discourse patterns over time (Hall, 2000).

Summary

Each of the data collection decisions was informed by research in mathematics education. By utilizing interviews, video recordings, and field notes I was able to answer my three research questions. This ethnographic study provided the structure in which to examine the establishment of social and sociomathematical norms, the qualities of these norms during whole group discussions about mathematics, and the reactions of the teacher and students.

The data collection tools provided a plethora of information. In the next chapter I will provide detailed information about the actualized professional development as well as a thorough account of the answers to my three research questions.

CHAPTER FOUR: ANALYSIS

Introduction

Social and sociomathematical norms exist in all classrooms. Understanding these norms may provide an understanding of changes that have the potential to enhance students' experiences with mathematics. Within this chapter, I will provide a glimpse into one second grade classroom in which the teacher allowed students to speak to one another during whole group instruction without first raising their hands. My research questions were as follows:

1. How are new discourse patterns established during mathematics instruction?
2. What qualities of social and sociomathematical norms exist in a classroom in which a teacher allows the students to speak directly to one another without first raising their hands during whole group instruction?
3. How do the teacher and students react when traditional social norms are challenged?

To answer these questions, I will first describe qualities of social and sociomathematical norms in existence prior to the study. I will include the teacher and students' reactions and their interpretation of these norms. Next, I will provide detailed information about the professional development as I focus on how new norms were established; I will discuss the reactions of the teacher throughout the process. Finally, I will describe the qualities of social and sociomathematical norms at the conclusion of the study. Again, the reactions of the teacher and his students will be discussed as they relate to mathematics and the establishment of new norms in the classroom.

Professional development sessions supported changes in social and sociomathematical norms in Mr. Sharp's classroom. As new norms were established, they, along with the reactions of the teacher, guided and influenced subsequent professional development. Once the new norms stabilized I determined that they were established. It became apparent that Mr. Sharp and his students had settled into new social and sociomathematical norms.

Before answering my research questions, I will provide information about the teacher selection process. Choosing a teacher participant was an important decision. I began with an interview to ascertain the teacher's perception on mathematics instruction in his classroom. I followed that with classroom observations. The purpose of these observations was to determine if the interview responses were consistent with classroom practices. They also provided valuable information about existing social and sociomathematical norms prior to professional development.

Beginning Interviews

Teacher Beginning Interview

The initial interview with Mr. Sharp helped me to determine his suitability for this research. It also provided some insight into his reasoning in regard to his instructional decisions and his views on mathematics teaching and learning

Mr. Sharp sought to make the students in the class feel comfortable. He encouraged them to help each other and to get help from one another, especially as they tried to answer questions during mathematics lessons. One way he did this was to allow them to "phone a friend" if they could not come up with an answer on their own. Mr. Sharp used this phrase to describe when a

student who was struggling had the opportunity to ask a peer for help. This help was provided one-on-one outside of the group.

It was clear that he valued the idea of his classroom being a community. He shared that he called his students the "Sharpette's". He stated that they were a family. He also shared that he wanted them to always be comfortable asking for help when they needed it.

He described his instruction during mathematics as developing and pointed to the fact that he had never taken any mathematics methods classes. He felt that he was at a disadvantage when teaching his students. He was aware of the standards for mathematical practice and had just recently learned about SMP3. Mr. Sharp desired to have his students justify their answers and critique the reasoning of others. He stated that he was working toward having them develop the skill of justifying their thinking. He also shared that he valued the idea of his students critiquing the reasoning of others because that would be an indication that they really understood a concept.

It was interesting that Mr. Sharp struggled to provide me with a list of rules for his classroom. He shared that he did not have a chart on the wall stating the rules. He said that his students just knew what to do and that he had a very well behaved class. When pressed for his expectations for student behavior, he was able to provide some of the verbalized rules for his students.

Mr. Sharp expected his students to stay on task, complete work in a timely fashion, listen when others were speaking, and to always try their best. He implemented what he called a "one microphone rule", meaning that it was an expectation for students to speak one at a time and for everyone to listen to the student with the imagined microphone.

He described his process for calling on students. He stated that he called on students that raised their hands but that he also periodically called on students randomly. His goal was for students to pay attention because they could be called on at any moment. He also made it a habit to ask students to repeat what someone just said. When I asked Mr. Sharp if he would consider changing a rule during mathematics instruction, he answered an enthusiastic yes. He said that he was excited to learn more about teaching mathematics.

Mr. Sharp's answers to the interview questions helped me to determine that he was willing to modify the "raise your hand to speak" rule. He was motivated to focus on students constructing their own knowledge. He also seemed to believe in student engagement during mathematics instruction. The views he shared during the interview were aligned with making a change in the social norms during mathematics.

The beginning interview with Mr. Sharp helped me identify him as the participant in my study. It also, when combined with the student interviews and the initial classroom observations, gave some indications of the qualities of social and sociomathematical norms that were pre-existing in his classroom.

Student Beginning Interview

The beginning interviews with the students provided insight into their thinking in regard to the pre-existing social and sociomathematical norms in their classroom. The interviews were focused on how the students viewed mathematics and their role during instruction. When I asked the students about talking during mathematics, their responses provided their perspective on the value of silence during math lessons. The questions were as follows: Do you talk a lot during math class? Why/Why not? Tell me about the kind of talking you do during math. The student

responses are listed in Table 4. The names of the students have been changed to protect their identities.

Table 4 Student Beginning Interview Question About Talking

Student	**Response**
Marcus	No, because we only talk a lot in reading. Because we have to learn in math.
Sam	No, unless it's to answer a question because most the times I know the answer. Most of the times when I raise my hand, I really don't get picked sometimes. Basically, I think in my head. Sometimes I think about the questions.
Anthony	Yeah, when I raise my hand. I do it sometimes. When I know the answers and when I don't raise my hand, I try to think about the answers.
Charlese	Not really because I'm kind of shy. Sometimes I might get the wrong answer and I feel shy. I tell the teacher the answers like when he asks me, what is something like fifty times two, it's one hundred.
Emma	No, we don't talk a lot in math because we are learning. We usually talk to the person next to us about what could the answer to the question be.
Bay	Maybe a little. Maybe talking to my friends about I got my tooth pulled this weekend. When Mr. Sharp says phone a friend I phone a friend and then we talk together about math. I like it because you get to have a friend to phone with. We talk about like if Mr. Sharp told us to measure something then we measure it and we talk about how many inches it is.
Ken	No, because Mr. Sharp is talking. Like I answer the questions.

The students' responses to this question were an indication of one of the pre-existing sociomathematical norms in Mr. Sharp's classroom. The sociomathematical norm was that students were expected to be recipients of information during mathematical discussions. Student talk was limited to answering the questions provided by the teacher. It was interesting that the students equated listening with learning.

Marcus even made the comment about talking a lot in reading. It was his understanding that math class had a different set of expectations for talking. His impression was that talking occurred during reading class but not in math class.

Bay, on the other hand, equated the talking that she did during math class with getting in trouble. When asked if she talked a lot during math class, she assumed I meant the kind of talking that got her in trouble with the teacher.

Student answers in Table 4 indicate a focus on talking about answers to questions. Notably absent is a description of talking about engaging in mathematical discussions that are not focused on answers but on the process of doing the mathematical tasks.

The interviews provided participant insight, but it was also important to accurately portray enacted mathematics lessons. Observations, field notes, and video recording during three lessons provided data that enabled me to determine typical mathematics instruction. Mr. Sharp shared that these three lessons were indicative of the established norms and mathematical practices in his classroom.

Observations

Each of the lessons I observed at the beginning of the study followed the same format. Mr. Sharp would talk students through several questions that were shown on a T.V. monitor at the front of the classroom. Students were seated on the floor with individual white boards and markers that they used for solving equations. The teacher talked through problems by sequentially demonstrating each step and asking students questions throughout.

Table 5 details typical exchanges between the teacher and his students before any changes were made to the classroom norms. Some common elements of the discourse include the

use of choral response and a pattern of the teacher answering his own questions. Rather than have students share their thinking, the teacher often talked through *his* methods of solving problems. There was a strong emphasis on arriving at correct answers. The teacher focused heavily on the test taking skill of eliminating incorrect answers.

Table 5 Student Talk at Beginning of Study

Teacher Talk	Student Talk
So we know that there are 91 students in all and 53 of those students are girls. Any ideas? If you didn't have these choices, what kind of number sentences would you write? I want to see what you would do to figure it out. It's ok to talk to a neighbor. I see some of us have 91minus 53. Will that help us figure out the number of boys? Some have blank plus 53 equals 91. I see 91minus blank equals 53. Don't erase your boards. Let's check out your choices. Do you see any of your choices on here? You know, I like to use a process, the process of elimination. So I want to see which of these I want to eliminate. What does eliminate mean?	Allen: Take care of.
Take care of? Well, if you're in the mafia, if you eliminate someone that's taking care of them. But anyway, as I digress. What does it mean to eliminate?	(Students call out) Get rid of, take away, remove.
These are all synonyms. Blank minus 53 equals 91. What do we think about that one? Well, we know that 91is the total number, right? So, 91 is going to be the greater number. So I don't think I could take 53 away from something and get 91. That's not going to work. What am I going to do to A? (Indicating choice A. from the multiple choice answers)	(Choral) Eliminate
So, I want to eliminate letter A Alright, let me eliminate letter A. What about B? Hmm, blank plus 53 equals 91. I know that 91 is the total number, right? I think B might work, what do you think?	(Choral) No
Why not?	Silence.
Ok, let's try this, even though they are not asking us how many boys there are, lets figure out how many boys there are and then finish solving this. So if we know that there are 91 students total and 53 of them are girls, what kind of number sentence would we use to figure out how many are boys.	Trina: 91 minus 53
Let's stack the numbers up and figure this out. 91minus 53. Guys, I'm not seeing everyone show their work. Now guys, I'm seeing some of this from people, will that work? What's wrong with this? (Numbers written on the board and are not aligned). Should my ones line up? Are they lined up? This will not work. Straighten it up. Figure it out people. So, what do we have? I know how to do this. I got this. I'm the only one that knows this. One minus three, I can't take three away from one so naturally I just have to flip it around.	(Choral) No! Regroup.
So, I have to regroup? Let me go to my neighbor's house and borrow a ten of sugar. How many ten of sugar does my neighbor have?	(Choral) 9
My neighbor has ten, um nine tens of sugar. Nine tens of sugar. If I borrow one ten of sugar, now listen, when we regroup it's like again, rearranging your furniture. When you rearrange furniture, raise your hand if you've ever helped your parents rearrange the furniture. (Ten hands up) When you rearrange the furniture, do you move things around or do you take things away?	(Choral) Move things around
Moving around, but everything is still there, right? It's just in a different location, right?	(Two students call out) Yes
When we regroup, same thing, we're rearranging but everything is still there. That group of ten that we borrowed, I'm going to move it over here to the ones place. Hey, what is ten more than one? Kid with face? (Pointing to Tyler)	Tyler: 11

Teacher Talk	**Student Talk**
11? I am going to naturally start solving in the tens place….	(Choral) NO!
So, let me look in my ones place. What do I have in the ones place? Anthony?	Anthony: 11 minus three
11 minus three? Is it possible to take three away from 11?	(Choral) Yes
Zoey, what's 11 minus three?	Zoey: Eight
Eight. I've taken care of my ones, so now what am I going to do? Slide to the tens. Alright, what do I have in my tens place? (Points to Leah)	Leah: Eight minus five.
Eight minus five, is that possible?	(Choral) Yes
What's that? Five?	(Choral) Three!
Ok, Ken, what is the difference of 91 minus 53?	Ken: The difference of 91 minus 53 is 38.
So if I know that there are 38 boys, let's plug that in. 38 minus 53 would that get me 91? Will that work?	(Choral) No
No, so I have to eliminate it. Eyes this way. Let's plug this in here. Uh oh, 38 plus 53, that might work. Let me reverse this. 38 plus 53. What's eight plus three?	(Choral) 11
11, so I put 11 right here (in ones column)	(Choral) NO! Carry the one
Carry the one what? Carry the one group of ten. One plus three, four plus five. So, that will work, 38 plus 53, but even though I think I have my answer, will I stop there? I still have to check all my choices because I might miss something. I'll come back to that.	(Choral) No
53 minus 91, will that equal…? That doesn't even make sense, does it? What am I going to do with C?	(Choral) Eliminate
Alright, 91 plus 38 will that get us 53?	(Choral) No, eliminate.
The only thing left is what, Emma?	Emma: B

Throughout this exchange, Mr. Sharp called on students with their hands raised. He also randomly called on students and asked questions to the class which resulted in choral responses. Along with the strong focus on the process of elimination, the teacher asked questions based on the isolated steps of the mathematical procedure.

The sociomathematical norm exhibited by these practices is a focus on procedural understanding. Mr. Sharp was focused on communicating steps of a procedure rather than having students make sense of the problems. Opportunities to focus on student understanding were missing from these lessons. The talk of students in the class was focused mostly on one-word answers that reflected a shallow understanding of the problem that was presented.

Established Practice

Many of the details provided by Mr. Sharp and his students in the beginning interview were corroborated by what was seen during the initial observations. For example, Mr. Sharp shared that he utilized an "I do, we do, you do" model during his lessons. He explained that he first demonstrated and then had the students talk through problems with him before doing something on their own or with a partner. He stated that he followed the county adopted textbook as written. He also described utilizing an online testing tool with the students to practice math skills.

During the beginning interview, the students described their role during mathematics. They had an understanding of the importance of being silent listeners in order to learn. They also discussed the process of phoning a friend to get help. I observed each of these practices during the lessons.

Some of the practices I observed did not align with what Mr. Sharp said he valued. When answering the interview question about student talk, he stated that he preferred for his students to talk. He described student talk as preferable over teacher talk because lectures are boring. Mr. Sharp also stated that he was working toward having students explain and justify their answers and to critique the reasoning of others. Over the course of three days, I did not observe student talk that exceeded short phrases and answers to questions during whole group instruction. I concluded that although he desired these behaviors to occur in his classroom they were not evident in the lessons he identified as typical. Perhaps professional development would provide support that would facilitate Mr. Sharp's ability to establish new norms.

Professional Development

Table 6 provides an overview of the professional development sessions. The days are numbered sequentially including days that I was not in the classroom. Professional development began on day three and ended on day 28. Detailed descriptions of the professional development and the reactions of Mr. Sharp are provided in the sections following Table 6. The establishment of new social and sociomathematical norms is described alongside the professional development.

Table 6 Actualized Professional Development Sessions

Day	**Professional Development Topics**	**Reactive Topics to Support Norms**	**Norms Addressed**
Day 3	Provided article to read. Explained initial steps: • Selecting challenging tasks. • Focusing on student solution methods. • Guiding whole group discussions focused on student work. • Choosing students to share based on their solution methods. • Sharing unusual or different ways of solving problems. • Guiding students to recognize mathematically different solution methods. • Expecting students to share their thinking and listen to others as they explain. • Having students state disagreement or agreement by showing thumbs up or down.		Social: Sharing thinking and listening to others. Stating disagreement or agreement with thumbs up or down. Sociomathematical: Highlighting unusual or different ways of solving problems.

Day	Professional Development Topics	Reactive Topics to Support Norms	Norms Addressed
Day 8	Discussed the following: • Having student come up with unusual or different ways of solving problems. • Guiding students to recognize mathematically different solution methods. • Encouraging students to begin with their classmate's method before discussing their own. • Having students state why they agree or disagree with others. Focused on the following: 1. Examples of Mr. Sharp successfully implementing new norms. 2. Examples from textbook videos supporting discourse.		Social: Beginning with classmate's method before discussing own. Stating reason for agreement or disagreement. Sociomathematical: Highlighting unusual or different ways of solving problems.
Day 13	Made the following suggestions: • Placing students in a circle. • Having them use pencil and paper rather than white boards so they couldn't erase so easily. • Focusing on students explaining their process not just answer. • Allowing for struggle. • Allowing them to defend their answers whether they were correct or not. If they made a mistake they could correct each other. Made suggestions for planning that included the following: • Having students measure something longer than the ruler. • Asking students to measure something with iteration and then compare to larger item. • Utilizing the Higher Order Thinking (HOT) questions in the textbook.	Utilizing challenging tasks. Allowing productive struggle.	Social: Sharing thinking and listening to others. Sociomathematical: Focusing on explaining process rather than just answers. Defending answer whether correct or not.
Day 16	Discussed the following: • Refraining from stepping in too quickly when students struggle. • Providing opportunity for students to give guidance or tips to others that are struggling.	Allowing productive struggle.	Social: Highlighting student-to-student discourse.

Day	Professional Development Topics	Reactive Topics to Support Norms	Norms Addressed
Day 18	Discussed the following: • Planning with his goal for the lesson in mind. • Guiding and leading the lesson in the direction of the goal. • Highlighting the HOT questions from the textbook to provide challenge. • Using a recent assessment to inform instructional decisions. Helped him plan additional problems to implement the following week.	Carefully planning mathematics lessons. Maintaining academic integrity of lesson. Utilizing challenging tasks.	
Day 23	Provided another article (Dixon, Egendoerfer, & Clements, 2009) Discussed the following: • Encouraging students to come up with unusual or different ways of solving problems. • Guiding students to recognize mathematically different solution methods. • Encouraging students to challenge others using evidence. • Having students explain what fault they found in others' work. • Maintaining the complexity of problems. • Allowing times to call on students and *then* open the floor.	Maintaining complexity of problems.	Social: Sharing thinking and listening to others. Challenging others based on evidence. Sociomathematical: Highlighting unusual or different ways of solving problems.
Day 28	Discussed article Reviewed how to do the following: • Encouraging and highlighting unusual or different ways of solving problems. • Guiding students to recognize mathematically different solution methods. Provided professional development using manipulatives for geometry.		Sociomathematical: Highlighting unusual or different ways of solving problems.

The first day of professional development provided an opportunity for me to share the fundamental topics of the study. These topics were chosen from the literature and intended to support Mr. Sharp as he established new norms during mathematics instruction. The existing social and sociomathematical norms in the classroom were changed as new norms were established. Mr. Sharp initiated these changes. He and his students negotiated their roles during

mathematics lessons. The reactive nature of the ongoing professional development was designed to address areas of need specific to Mr. Sharp and to the end goal of developing sophisticated sociomathematical norms. What follows is a description of how new norms were established over time and corresponded with the professional development sessions.

Shared Video Clips

I was able to share video clips of Mr. Sharp and his students through an online survey portal. Mr. Sharp had the opportunity to view actual occurrences within the classroom at a time that was convenient for him. The video provided a context and purpose for the professional development I offered. I provided practical recommendations based on the particulars of the situation rather than just relying on theory and hypothetical information.

Each of the online surveys provided insight into the experience of the teacher. They also allowed Mr. Sharp to take the time to dissect what happened during his mathematics lessons. When we discussed the various aspects of what he saw, I was able to adjust the professional development and address the questions and concerns that arose throughout the study.

Initial Changes

On day three, Mr. Sharp was anxious to hear what the topic of the study would be. All he knew initially was that I would be asking him to change one of his classroom rules. I began the professional development session immediately following his math lesson. I explained that ultimately, I would be asking him to change his expectation that students raise their hands to speak during whole group instruction. He was excited to implement this change with his students. He enthusiastically embraced the idea of allowing students to speak openly and viewed

this as an opportunity for them to express their thinking. I explained that I would have him make gradual changes that would lead to students being allowed to speak directly to their peers without first raising their hands.

I described the first few changes as follows. I asked the teacher to allow students to offer solution methods and for other students to state agreement or disagreement during the mathematical connections. I encouraged the teacher to have students indicate this by using a "thumbs up" or "thumbs down" signal (Warfield, Wood, & Lehman, 2005). There was a focus on encouraging students to come up with solutions to problems that were unusual or different than other methods shared. I also asked him to help students determine if a solution method is mathematically different than another student's (McClain & Cobb, 2001).

I provided task selection guidelines to help Mr. Sharp to be intentional about selecting tasks with high cognitive demand and I spoke to him about carefully choosing students to share their work based on their solution methods. Each of these topics was meant to bring his attention to discourse during mathematics instruction.

I shared the first video clip of Mr. Sharp teaching on day four. My goal in sharing the first clip was to help him feel at ease with the process. Mr. Sharp shared that he hated the way he sounded when he had previously heard recordings of himself. He was also concerned with how he would look on video. Keeping his concerns in mind, the first video clip consisted of a lighthearted exchange between Mr. Sharp and the students.

The video showed only the students sitting on the floor in a circle in front of the teacher. He was trying to remind them of the term for the answer to a multiplication problem. He playfully said that he needed to buy some product for his hair. One of the students said that she

remembered him teaching them the term and she thought it began with the letter p. Then, another student got it, started laughing, and told Mr. Sharp that the term was product. The survey items and Mr. Sharp's responses are listed below.

> Me: Hi Warren (pseudonym). I will be utilizing this software to share video clips with you. I know you said that you don't like to see yourself on video, but I'm hoping that it will become easier as you get used to it. :) I'm including a video clip. Please watch the clip. This is a trial run to make sure that you can access the video and respond to the questions. I'm curious to hear what you think of this method for sharing about what happens in class.
> Me: Did you notice John's reaction? LOL!
> Mr. Sharp: Lol! His reaction changed my life forever!! (John's reaction on the video was that he burst out laughing as he said, "product")
> Me: Anything you would like to share:
> Mr. Sharp: Too bad I didn't think to have the class repeat John's answer.

Teacher Discomfort

On day six, Mr. Sharp shared that he felt he did a horrible job with the lesson. He was aware of where he wanted his students to be in regard to talking. He felt that he was not making progress quickly enough. He shared that he felt ill equipped to have students explain their thinking. Throughout the study there were other instances of Mr. Sharp sharing similar insights. The process of establishing new norms in the classroom proved to be difficult at times. In response to his initial discomfort, I decided to use the textbook videos to help provide some tangible examples of how to support student talk.

I also thought that it would be helpful for him to see a specific example from his own teaching. I thought a video clip of his instruction would provide an opportunity for him to

examine his practice in light of the recommendations during professional development. Perhaps he needed time to process what was occurring during instruction. The clip I chose and the survey questions were designed to bring his attention to what was occurring regularly during mathematics instruction. He was doing all of the talking and students were not engaged.

At this point, Mr. Sharp had read the article from Teaching Children Mathematics (Brooks & Dixon, 2013). We had also spoken about establishing new norms in the classroom, which consisted of having students share their thinking and beginning to state agreement or disagreement and to include justifications. The survey items and his responses follow.

Me: I'm including a video clip from Friday. Please watch the clip and then respond to the questions.

Me: What are some things you notice about the dialogue in this video?

Mr. Sharp: There was no dialogue.

Me: I'd like you to think about how you could have had students take ownership of the problem rather than you telling them what to think. For example, maybe you could have asked some leading questions or had students tell you what they know. What are your thoughts about that?

Mr. Sharp: Looking back, I wish I had helped to guide them and not just taken them...if that makes sense.

Me: What do you think about the idea of having students talk whole class and 1) explain their process for solving 2) justify their reasoning, and 3) challenge the thinking of others?

Mr. Sharp: I like the idea because it causes the students to have to think about their thinking. It also helps me to understand their thinking.

Me: How do you feel about trying this question again this week?

Mr. Sharp: I'm in.

Me: Anything else you would like to share: (He left this blank).

This exchange highlighted my attempt to carefully bring his attention to something he could work on. It was encouraging that he seemed aware of what he could have done differently and the effect it could have. It was also encouraging that he did not seem discouraged by the suggestions or the video.

It was interesting that he was already aware of the discrepancy between what he wished to achieve during lessons and what was actually occurring during lessons. It seemed as if the initial professional development brought practices to his attention. He was newly aware, yet unable to implement new norms during mathematics instruction.

Stating Expectations

Mr. Sharp explicitly taught the expectations that corresponded with the new norms to his class. Initially, he told the students that they were going to be rule breakers. He reminded them of the "raise your hand to speak" rule and explained that now they would be able to talk without raising their hands. Rather than only telling the new expectations at the beginning of the study, he provided daily reminders of what he was looking for in regard to dialogue in the classroom. On day seven, he provided modeling by taking the role of a student in the class.

> I want to tell you something. You know how you normally tell me your answers? Because we're a community do you think you can tell each other? I think it is five…I'm Wilbur. I think the answer is five because when Greg erased some of

> the chalk marks it was five centimeters long so my answer is five. Now if you don't agree, are you going to say, "NO!"? What's my name again? Wilbur. So you're going to say Wilbur, you said you thought the answer was five but I think, and then you tell me what your answer is. But then I want you to tell me why you think your answer is different from mine. I don't want you to just say you're wrong. I want you to tell me why you think your answer is different. You know how in reading we have to prove our answer? When you're taking that test, I always have on there provide evidence from the text, you have to support your answer, you have to prove that it is what it is, right?

The teacher helped the students have a clear vision of his expectations. He also made a connection to the familiar topic of providing evidence in reading. Students in the class were accustomed to utilizing evidence from text to support their answers. They were now being given the opportunity to apply that skill during mathematics. Mr. Sharp supported his students by taking on the role of Wilbur, an imagined student in the class. His purpose was to model and to have the students practice with him rather than to immediately attempt student-to-student discourse without support.

Indicators of New Social Norms

The establishment of new social norms was not a linear process. On day eight, I realized that Mr. Sharp was beginning to blur the lines between phases one and two of the study. I initially anticipated that he would establish underlying support for the new social norm of speaking without raising hands. This was to occur in phase one, when the focus was going to be entirely on having him monitor students' responses and share selected student work in an effort to support mathematical connections. Phase two was focused on creating and supporting opportunities for students to discuss mathematics openly during whole group instruction.

The expectation was that once phase one was in place, the structure for allowing students to speak without raising their hands would be established. However, it became obvious that as he focused more on student talk, it became natural for students to begin addressing each other. Mr. Sharp was calling on students randomly without having them raise their hands. As a result, the students were practicing the new social norm of speaking without raising their hands before Mr. Sharp explicitly changed the rule.

Table 7 highlights the discourse from the lesson this day. During the lesson, students had to find the difference between the lengths of two pencils. "Pencil a" was four inches long and "pencil b" was seven inches long. Mr. Sharp noticed that a few students wrote an incorrect answer.

Table 7 Student Discourse Involving Incorrect Answer

Teacher Talk	**Student Talk**
So, now here's the question, how much longer is the second pencil? How much longer is the second pencil than the 1st pencil? Or how much longer is pencil b than pencil a? Go ahead and figure out how much longer the second pencil is… Danielle, how much longer is the second pencil?	Danielle: The second pencil is seven inches longer than the first pencil.
What did she say, Trina?	Trina: The second pencil is three inches longer.
Danielle, what did you say?	Danielle: The second pencil is…
Say what you said before.	Danielle: Seven inches long and it's longer than the first.
What you said was the second pencil was 7 inches longer, right?	Danielle: Yeah…the second pencil is longer than the first pencil.

Teacher Talk	Student Talk
I see you're correcting yourself. What did you say the first time? …You don't want to say what you said the first time. Did you have a change of heart? So, initially, she told me that the second pencil was seven inches longer. Is the pencil seven inches longer or just seven inches long? So, we'll try that again Danielle. Danielle, how much longer is the second pencil?	Danielle: The second pencil is seven inches longer than the first pencil.
Ok, what did she say?	Trina: The second pencil is seven inches longer.
(Speaking to Trina) Now, I don't want you to give me your answer, Do you agree?	Trina: (shakes her head no)
Alright, so this is what we do guys when we don't agree. I want you to look at Danielle and then I want you to repeat, call her by her name, look at Danielle, and you'll say, Danielle, you said…and then you tell her what she said, ok?	Trina: Danielle, you said that um the …
Wait, I'm sorry, I should have said this the first time. When Trina is speaking, she has the floor. She has the Mic. We should be listening to her and we turn our attention to her. So when I see Allen still drawing on the board after I asked you not to, that makes me think that you're not paying attention, so make me think that you're paying attention. Ok, go ahead please.	Trina: Danielle, you said that the second pencil is seven inches longer than the first pencil.
But what do you think?	Trina: I think that the second pencil is three inches longer.
Why do you think that? She's talking to you, Danielle.	Trina: Because I counted from seven and counted back three.
Oh so you counted back from seven? You counted back how many from seven?	Trina: Three
What did she do, Emma?	Emma: She counted back from seven.
What did she get?	Emma: Three
So, how many did she count back?	Emma: Three
She counted back three? Ok.	
So, Emma, how much longer is the second pencil than the first pencil?	Emma: Three inches.
Aw man, I was hoping I could get a complete sentence.	Emma: I think the second pencil is seven,..three inches.

Teacher Talk	Student Talk
Three inches what?	Emma: Long, …longer.
Ok, say that again?	Emma: I think the second pencil is seven inches longer.
Ok, so this second pencil is seven inches longer than this pencil?	Emma: Three inches.
Oh, three inches longer? Will you give me your answer one more time in a complete sentence?	Emma: I think the second pencil is three inches longer than the first one.

Mr. Sharp held the students accountable to the conversation in a number of ways. He called on students to repeat what others shared. When Danielle attempted to change her answer in response to being challenged by Trina, Mr. Sharp held her accountable. He also oriented the students to the person talking and stated the expectation for listening. This was an example of the ways in which he consistently made his expectations for new social norms known to the students.

During professional development on day eight I offered Mr. Sharp a comparison of his instruction that day to what occurred before the study began. I shared my observations and what was becoming evident in my field notes and transcription of daily lessons. Students were talking through the problems as opposed to him doing all of the talking. Mr. Sharp reinforced expectations for the norms he was working to establish.

I highlighted the conversation between Trina and Danielle. I pointed to how Mr. Sharp held Danielle accountable for her incorrect response. I shared that what we were working toward was having them state why the other student was wrong. In this case, Trina should have been required to state the claim of her disagreement rather than just saying she disagreed. This would have been evidence of her interpretation of Danielle's thinking. Mr. Sharp reacted positively to the suggestion and said that he would be more mindful of having students support their disagreement by discussing the work of other students.

We discussed my initial plan for professional development to occur in two distinct phases. I told Mr. Sharp that I noticed he was straddling both phases and asked if he was comfortable with allowing students to speak to one another without first raising their hands. He agreed that he was already encouraging the students to speak to one another, so it felt comfortable to drop the expectation of raising hands.

I decided to focus the next video clip and survey on Mr. Sharp making progress toward the goal of establishing new expectations for student engagement during class discussions. In this video clip, Mr. Sharp was stating his expectations for social norms. He directed Trina to speak directly to May and corrected her when she addressed him instead. He also told May to look at Trina because Trina was talking to her. He followed up with a question for Mitch to tell what he heard, effectively bringing attention to the fact that he expected everyone in the class to be engaged even though two students were speaking to one another. Mr. Sharp was highlighting communication and the expectation for students to explain their thinking. The exchanges are as follows.

Me: General impressions?

Mr. Sharp: I don't like my voice.

Me: Which norms do you think you were working to establish?

Mr. Sharp: I was trying to get the students used to listening to one another and speaking directly to one another.

Me: Anything else you would like to share:

Mr. Sharp: I need to lose weight!

It was interesting that Mr. Sharp became critical of himself while watching this video. Rather than critiquing his facilitation of the new norms, he was critical of how he looked and how his voice sounded.

Teacher Support

Beginning with day nine, Mr. Sharp used phrases to describe his expectations from the students during whole group instruction. He explained that students should "Be Nosy" when student pairs were talking within the larger group. When he introduced being able to speak without raising hands, he explained the "Floor Is Open" meant they could speak to one another. It was necessary for him to provide these reminders because the students often forgot about the new expectations. It was also Mr. Sharp's way of identifying and meeting the needs of his students as they learned new ways to interact during mathematics.

During professional development, Mr. Sharp shared, "I feel a little better releasing the conversation over to them. I still need to work on the pacing because it takes more time. I don't know how long to let them talk." I advised him to always keep in mind his goal for the lesson and to not be afraid to guide the conversation and lead them where they needed to be. He said it was a learning process for him to know when to step in. He was feeling good about the conversations, especially in regard to Trina. She had always been a high achieving student but she'd never had the opportunity to question other students and dissect their thinking. It showed him that she understood and could articulate their thoughts.

Time Commitment

During professional development on day 13, I talked to Mr. Sharp about allowing students to struggle. We discussed allowing students to defend their answers even when they made errors. This would provide an opportunity for them to discuss their strategies. I also spoke to him about having his students explain their processes rather than just focusing on their answers.

In the next class session, Mr. Sharp told the students that there is more than one way to solve a problem. He also encouraged the students to keep their answers even if others didn't agree. He told his students the following: "Whatever you choose, I need for you to defend your answer, support your answer. What if you are the only one raising your hand for nineteen, should you change your answer? No." He was referring to a multi-step problem that required students to interpret information in a data table. The students had difficulty coming up with a solution and Mr. Sharp struggled to maintain momentum during the lesson.

That day during professional development, Mr. Sharp shared his insight into what he experienced during the lesson that day. He was becoming aware of how time consuming it can be to allow productive struggle and the opportunity for students to talk through their understanding (and misunderstanding) of the mathematics. He was also becoming aware that telling students how to approach a problem and talking them through it was essentially allowing them to avoid thinking for themselves.

> I, in the past, would have been done with that problem ten years ago but I would have guided them the way I would have wanted it done. And this allows me to see that they rely on *my* thinking instead of basically having to think for themselves. I didn't realize that I think for them. So I guess in the long run, I'm not helping them.

> I was really aware of it today because we would have been done with that one already had I guided them; had I told them what to add and subtract. And they would have, by all appearances they would have gotten it. But obviously that is not the case. Like I said, I've been thinking for them.
>
> I'm glad I'm aware, but then I feel bad because all this time, I thought they were getting it, but *I've* been getting it. I'm a better second grader now. Now I just need to figure out what steps I need to take now to help them take ownership of their thinking.
>
> In the past I did that same one for them. We worked it out. But they didn't remember. I went ahead on something and I showed them this very problem. When I did it with them they got it. But they don't got it.

Mr. Sharp pointed out that this was actually the second time that his students were asked to solve this particular problem. What seemed shocking to him was that they did not retain the skill to solve the problem even though he had previously shown them his method. He made the connection of this newfound awareness to the saying, "Give a man a fish, feed him for a day. Teach a man to fish, feed him for a lifetime." He explained that along with giving them a fish, he was fileting and serving them as well.

Reinforced Expectations

On day 17, Mr. Sharp started the lesson by reminding the students that they were rule breakers and that they were breaking the rule of raising hands to speak. He restated the expectations for having one microphone, which meant that they would speak one at a time. He also reminded students to listen when their peers were speaking. He said the following:

> I want you to try your best to understand why you've chosen the answers you have chosen. Maybe it's not right but at least tell us why you chose it. Maybe if I hear something that doesn't sound right or one of us hears something that doesn't sound right, we'll help you out.

Mr. Sharp oriented students to the new expectations. Each of his statements served as reminders for the students. These practices reinforced the new norms he was working to establish.

Later in this lesson students were using a graph they made earlier about their favorite ice cream flavors to solve problems that were similar to what they had done the day before. A student, Tyler, was asked to state a question for the class to answer. The dialogue that follows was indicative of the way students were learning to speak to one another. In this instance, the teacher provided expectations for listening, but repeatedly interrupted the speaker.

> Tyler: "How many ice cream votes are there in all?"
> Allen (responded directly to Tyler): "Tyler, there are sixteen ice cream votes in all."
> Leah: "Tyler, there are seventeen ice cream votes in all."
> Mr. Sharp: "So, when Allen gave an answer that you didn't like, instead of trying to one up him and give your answer, talk to Allen. Maybe try to figure out why he chose what he did."
> Leah (turned to face Allen): "Allen, you said…"
> Mr. Sharp (interrupted): "Bay, listen."
> Leah: "Allen, you said…"
> Mr. Sharp (interrupted): "Wait, I'm sorry. Not only do I need for Allen to pay attention to what Leah's saying, I need for everyone to pay attention to what Leah's saying. So, at this moment, Tia, you don't even need to write. I just want you to listen."
> Leah: "Allen, you said it's sixteen but I don't agree. I think it's seventeen."
> (Both children then looked to Mr. Sharp.)
> Mr. Sharp: (to Allen): "So, now do you stand by your answer?"
> (Allen nodded his head, yes.)
> Mr. Sharp: "Okay, why do you feel it's sixteen?"
> Allen: "I feel that it's sixteen because I got ten and then there was six more."
> Mr. Sharp: "Where did you get ten?"

Allen: “By adding up all the numbers.”

Mr. Sharp: “Explain. Help me out. Help a Sharp out. Help a brother out.”

(Allen sat silent.)

Mr. Sharp: “You added what and got ten? Where’s your chart? What did you add to get ten?”

Allen: “I got ten by adding five plus three, plus one, plus one.”

Mr. Sharp: “Okay, five plus three. Where’d you get three?”

(Allen then realized that he was using a number that had been changed and stopped talking.)

Mr. Sharp: (asked the class) “Did any of the ice cream flavors receive three votes?”

(The students gave a choral response of, “No.”)

Mr. Sharp’s interruptions disrupted the flow of the conversation. He was quick to regain control of the conversation. Leah and Allen both picked up on the shift, as Mr. Sharp became the one asking questions. These two practices became a theme during the establishment of new norms and were repeated on a daily basis.

I utilized an online survey to provide an opportunity for me to share an example of these setbacks. In the video clip, Leah and Allen were beginning to engage in a discussion. There was a brief pause between them when Mr. Sharp stepped in and took over. I was surprised when he took over and I wondered if he felt uncomfortable with the students being in charge of the conversation. The exchanges in the survey are below.

Me: Here is the clip of Allen and Leah from 2/20. Notice how Leah and Allen begin a conversation that starts with Leah disagreeing with Allen. What happens when you step in?

Mr. Sharp: When I stepped in, student dialogue ceased to be.

Me: Do you think the students could/would have corrected each other if you had not stepped in?

Mr. Sharp: I'm sure, at this point, that they could have. I was afraid of silence.

Me: Additional thoughts? (He left this blank).

It seemed that the video clip effectively brought his attention to the fact that his interruption caused the students to end their conversation. He noticed that he took over. It was interesting that he shared his fear of silence. This revelation provided an opportunity for me to address it in our next professional development session. I spoke to him about the importance of wait time. I suggested that he use the opportunity to remind students of the expectation for them to engage in the conversation. Despite the setbacks that occurred, group discussions began to look differently as new norms were established.

Qualities of Group Discussion

The qualities of discussions that occurred when students could speak without raising their hands were markedly different than the discussions that occurred at the beginning of the study. Rather than answering questions, the new expectation for students was that they would explain their reasoning and bring clarity to their justifications. Another quality was that of making sense of the thinking of others.

Initially, the teacher facilitated these expectations by modeling what he wanted the students to do. At times this meant that he took on the role of a student in the class. At other times, he purposefully made a mathematical mistake in order to provide the opportunity for students to correct him. Table 8 is an example of one of these exchanges. The students in the class were allowed to talk without raising their hands and the teacher provided the topic of

discussion by making a blatant mistake while interpreting a tally chart. This exchange occurred on day 18 of the study.

Table 8 Example of Open Sharing

Teacher Talk	**Student Talk**
Ok, I got this… Cody ate one ice cream cone, Paul ate three, Sam ate two, and John ate four.	(Choral response) "NO!"
Ok, what's wrong with my logic?	(Choral) It's wrong, it's tally marks.
I have a problem.	Trina: Mr. Sharp, what you did wrong was you said Cody had one, Paul had three, Sam had two and John had four, but I disagree. I think that four straight lines and a diagonal line is five. So, for Cody it would be five, Paul is fifteen, Sam is ten, and John is twenty.
But I think because I see this group here, it means one and three groups here that would be three. Bay, do you agree?	Bay: No
'Cause I see four groups here, that means four.	Bay: Twenty
I don't understand.	Leah: Mr. Sharp, we are counting by five because like what she said…Like what you did is you saw one and you counted it one, but we are counting by fives. Like, five, ten, fifteen. Like for John, it's like five, ten, fifteen, twenty.
Oh, so you are saying that each one of these groups represents five and not one?	Choral: Yes

Trina successfully began her response with a focus on Mr. Sharp's error. She addressed his mistake before sharing her own thoughts. This was something that Mr. Sharp and I discussed in professional development sessions starting on day eight.

Leah took it a step further when she analyzed Mr. Sharp's mistake. Leah demonstrated her understanding of Mr. Sharp's process for solving the problem. Leah also made her statement in a way that would teach Mr. Sharp.

This exchange is an example of sociomathematical norms that were established concurrently with the new social norms. As students were given the opportunity to speak openly and join the conversation, their comments were geared toward bringing accuracy and meaning to the incorrect utterances made by the teacher. In the case above, they successfully focused on the representation of groups of tally marks.

In regard to the classroom norms, it was notable that students were engaging in the conversation. It was also notable that the exchanges were still between the teacher and the students. This was however, a positive development because students were comfortable communicating with the teacher almost as a peer rather than as a teacher. It was good modeling and preparation for the desired norm of peer-to-peer discourse.

Peer-to-Peer Discourse

Although students had a tendency to revert back to addressing Mr. Sharp during mathematical discussions, they also began to talk directly to one another once the hand raising rule was dropped. At times, their utterances were superficial. Other exchanges were more productive. One example occurred on day 26 when the students were sharing their understanding of defining attributes of squares, rectangles, and triangles.

Tia: I picked that answer because we know that a triangle has three sides and three corners and the square or rectangle has four sides and four corners like the square does too. But the triangle is not a part of the family, of the rectangle family because the triangle has four sides and the triangle has three sides and the triangle has three corners. (She misspoke by inadvertently saying triangle instead of rectangle).

Trina: Tia, how many right angles are there? Right angles are like this (holding up her thumbs and pointer fingers to model right angles).

Danielle: Tia, (Trina pointed to Danielle for her to take over) Do you think that a triangle is the same as a square?

Tia: I don't think that.

Danielle: Tia, do you think that a triangle has different sides, edges, and faces are different from a square?

Tia: Because um like a triangle has three sides and four, three corners and a square's got, a rectangle and a square, has four sides and corners. So, I don't think that the triangle is part of the family.

Danielle: So, you think the triangle is different from a square?

Tia: Yes, because a triangle is like this (drawing a triangle in the air with her finger) and a square's like this (drawing a square in the air with her finger) and a rectangle is like this (drawing a rectangle in the air with her finger) and so that the triangle is not part of the family because if it was…if the triangle was part of the rectangle family it would have four sides. But a triangle is not part of the family so it has three sides.

It was obvious that Tia had difficulty expressing her understanding clearly. Trina was the one that allowed Danielle into the conversation by pointing to her. Danielle asked clarifying questions of Tia to make sure she understood what she was trying to communicate.

Planning

The process of planning lessons to create a climate conducive to class discussions was necessary but not always actualized. This was demonstrated several times throughout the study. One example is on day 13, when I asked Mr. Sharp to incorporate a series of challenging tasks during the next week of mathematics lessons. He did not implement any of them.

On day 18, I asked him to have his students complete a graph about the number of pockets in the class the following week. Figure 1 depicts the completed graph. His class had been learning about bar graphs, so the topic aligned with the curriculum.

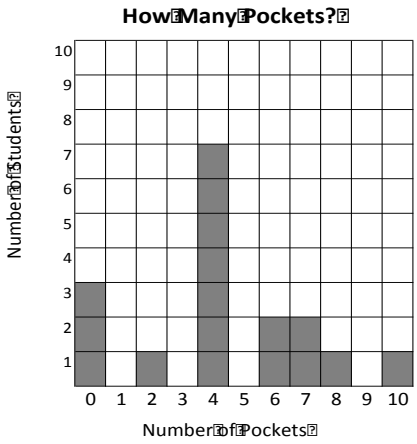

Figure 1 Pocket Graph

Mr. Sharp had his students complete the graph on day 22. They counted how many pockets they each had on their clothing and then stood to indicate each number of pockets. Each of the students had their own graph. On day 23 they analyzed the graph by asking questions to one another. One of the planned questions Mr. Sharp asked was, "How many pockets were there in all?" This question had the potential to provide an opportunity for meaningful discussion because the students would likely count shaded squares rather than make the connection of the shaded squares representing different quantities (Dixon, et. al., 2009).

Mr. Sharp did not allow time for the students to engage in productive struggle. Instead, he took over the lesson. During professional development after the lesson, he described his struggle with maintaining the complexity of the problem.

> I knew they were on the wrong track and didn't see a way out. I thought if I don't speed them along, we won't get there. I wanted them to go where I wanted them to go without telling them, go here.

He articulated two factors contributing to diminishing the complexity of the task. He felt it was taking too long for students to arrive at the answer. He also did not anticipate that students would have difficulty with the problem despite that being a topic of our professional development session leading up to the lesson. His perception conflicted with the reality of his pacing. Just the day before, he shared a concern that he only had one chapter left in the textbook and they still had a month left of school.

Gauging Student Understanding

On day 28, Mr. Sharp made a comment that demonstrated a new and profound awareness of the effect of having students talk directly to each other without having to first raise their hands. He noted that his goal during the lesson that day was to have the students complete a couple of workbook pages and he was happily surprised when the students were able to accurately supply all of the correct answers on the pages at a quick pace. Once they completed the pages, he intended to go over the correct answers but instead found himself asking them some questions with the goal of giving them an opportunity to have open discussion. I was very interested in the fact that he asked questions that were not included in the teacher's edition, that he was not just seeking answers, and that he made this decision on the spot. It was apparent that his goal was indicative of his desire to provide opportunities for students to engage with one

another and to have a challenge to address. What ensued was initially uncomfortable for the teacher but became what he called an, "Oprah aha moment". He stated the following:

> "They were able to fly through the book and provide the correct answers, but then, when it was time to explain their thinking, we got a little lost. I was able to see if I had not discussed anything and based my instruction on just what was in the book and write down the information, their thinking would not have been challenged. I guess it would have been completely lower level thinking. Now I'm seeing the importance of open communication because I told them what a rectangle is and a square, what it is. We talked about the rhombus. We talked about equilateral quadrilateral, and they looked to be agreeing with what I was saying and they could repeat what I said at the moment and you know, on the paper they were able to choose the right answer but it's just like, wow. So, when they take the test, I'm confident that I will get many As, but does it mean that they have a deep understanding of what's going on? I guess what they're showing me is just a superficial understanding of the material, especially when we talked about number six in the book. It's clearly, clearly not a rectangle and everyone in the beginning told me it was a rectangle. I wanted to say, are you kidding me? I was really shocked because certain students that I wouldn't expect to give that answer gave that answer, everybody. And some of them would justify their wrong answer."

Mr. Sharp recognized the change in the nature and tone of classroom exchanges when his focus was on open communication. He asked students to speak openly and their discussions often reflected more depth of understanding. This was in contrast to the short answer responses that were evident before the study began.

Teacher Reaction to New Norms

During the ending interview with Mr. Sharp, I asked this question: Do you think that there is something gained by having them not raise their hands specifically or do you think it has more to do with just letting them talk in general? In other words, if somebody were to say, does it make a difference if they are just talking out to each other or if they are raising their hand and talking, do you think there's a difference? This was his response.

> I think a lot of people equate raising their hands to great classroom management and structure but I think there's still great management with this method. I found that my students were thinking outside of the box. They were challenging themselves and challenging each other. I don't think that raising hands would have made this any better. As a matter of fact, raising their hands might have gotten in the way because they were just free to converse just like we're having a conversation. You're not raising your hand to wait for me to finish. You're *in* the conversation. You're part of this. You take ownership. I think that's what I'm thinking about. When you don't have to raise your hand and you're just a part of the conversation, it's like everyone is just taking ownership. When you're raising your hand, you're waiting for me to release the ownership to you. I'm in charge, and now I'm allowing you to be part of this conversation. Well, in that case, it's still my conversation and I just let you come along. But, with the open floor, everyone can take ownership. They can be a part of it.

Mr. Sharp made the connection of allowing students to speak openly with one another and them taking ownership of the conversation. He viewed the practice of raising hands to speak as contradictory to a naturally flowing discussion.

During the ending interview, I also asked Mr. Sharp, "Anything else you would like to share?" and received the following reply:

> Thank you very much. I'm grateful that I had the opportunity to do this because I feel that it has helped me as an educator. I feel like I was giving them just enough. But just enough is like living paycheck to paycheck. You're always struggling when you have just enough. So I guess I've allowed them with this method to spread their wings. I think that as a result they'll be better learners and better thinkers. And this is something that they can carry over. Just like it's carrying over into the other subject areas, they'll carry it over into different grade levels, carry it over into life. So, I'm grateful that I've had the opportunity and now I can, I'm still young in education. This is just my third year. I'm grateful that I've had this opportunity now, not in my 29th year. So now I'm thinking what kind of impact can I have *now*? I kind of feel like I'm impacting people now, but now I can do even greater because I can help them realize their ownership of situations.

Mr. Sharp made another connection of allowing students to speak openly with one another with spreading their wings. He was hopeful that students would carry the skills they acquired into other subject areas, grade levels, and ultimately into life. Student interviews at the

end of the study provided their reaction to being allowed to speak openly without first raising their hands.

Student Reactions to New Norms

When students provided answers to the ending interview, I was able to determine their reactions to the new social and sociomathematical norms. One of the interview items asked at the beginning and end of the study was, "Tell me about making mistakes during math class." I was interested in their perception of mistakes. Table 9 provides their interpretation of this aspect of mathematics.

Table 9 Student Perceptions of Mistakes During Mathematics Lessons

Student	**Beginning Interview Response**	**Ending Interview Response**
Sam	I really don't make them very often. Sometimes I am thinking of something else, and then I circle the wrong answer and I'm like, oh wait, and then I circle the right answer.	Sometimes when I make a mistake my friends help me. If I make a mistake they'll help me get the right answers. It's okay to make mistakes because sometimes people learn from mistakes.
Ken	When I make a mistake. I raise my hand and I tell him and he says I've made a mistake. Then I try to think about it some more. If you don't make mistakes then the class would be really fast and you could just get out, like get out of school.	When we make mistakes someone else tries to help us. That's when I think its good to make mistakes because someone helps us.
Charlese	When I make mistakes in math class I feel shy because sometimes when I say the wrong answer sometimes people laugh.	When I make mistakes I don't really feel very shy but I get shy and I think it is ok.
Emma	If I make a mistake, I would be embarrassed because I didn't know the answer. (Me: You think you should always know the answer?) Yes.	If we mess up we repeat the word and we kind of figure out the answer. It is okay because if we don't know the answer it is ok because we can figure it out while the other one is talking.

Student	Beginning Interview Response	Ending Interview Response
Bay	Maybe if I put the wrong number, Mr. Sharp would warn me that that's the wrong number. Sometimes you're not trying to do it but sometimes you are so maybe it's okay. Because you don't really mean to do mistakes but you could.	Usually people disagree with me sometimes. It makes me feel that since I said something wrong they help me figure it out. If other people make mistakes, I say I disagree with you and then I could help them. I feel happy helping someone.
Anthony	It's okay to tell the teacher that you made a mistake. He would say phone a friend. I like that because I can phone my friend John because he always knows the answers. He helps me out. I like that.	Mr. Sharp says its okay and then somebody would talk to that person and say that's okay that they disagree. It's okay because sometimes that person might be wrong.

There was a stark difference between the beginning and ending interview responses to making mistakes in math class. All of the students that were interviewed talked about mistakes being okay and opportunities to help one another. This was a change from their initial views.

Sam's initial response was indicative of his desire to minimize his mistakes. This is in keeping with the findings of Jungwirth (1991). He initially communicated that mistakes were to be avoided. His ending interview response indicated a more positive view of making mistakes.

Charlese and Emma seemed the most emotional in their initial response of equating making mistakes with being laughed at and embarrassed. Emma was very clear in her understanding that she should always know the correct answer. It was interesting that in the ending interview, both of them used the verbiage that it was "okay" to make mistakes. Emma seemed to focus more on the process of "figuring out" as opposed to always needing to know the answer.

Generally speaking, the tone of their responses during the ending interviews shifted from a view of mathematical mistakes being something to avoid to a view of them being something that provoked an opportunity to learn. Another shift was in their focus on answers versus a new focus on the process. Anthony even pointed out that sometimes a student might think someone has made a mistake when they are actually the one that is wrong.

Another question that was asked during the beginning and ending interview was in regard to students' views of talking during math class. Table 10 provides a contrast between their responses to the questions, "Do you talk a lot in math class? Why/Why not? Tell me about the kind of talking you do during math.

Table 10 Beginning and Ending Interview Responses on Talking

Student	**Beginning Interview Response**	**Ending Interview Response**
Sam	No, unless it's to answer a question because most the times I know the answer. Most of the times when I raise my hand, I really don't get picked sometimes. Basically, I think in my head. Sometimes I think about the questions.	Sometimes. When we talk about shapes and how much sides and vertices they have I might talk to tell how much sides and vertices and how they make the shapes.
Ken	Yeah, when I raise my hand. I do it sometimes. When I know the answers and when I don't raise my hand, I try to think about the answers.	Yes when he calls on me. Sometimes when he calls on people they talk for a long time and I can't remember all of it. I talk so I can tell them the answer. I tell Mr. Sharp the answer. Sometimes when someone needs help I try to help them. I talk how I got the answer and then they figure it out.
Charlese	Not really because I'm kind of shy. Sometimes I might get the wrong answer and I feel shy. I tell the teacher the answers like when he asks me, what is something like fifty times two, its one hundred.	Sometimes. I'm shy. Well, I talk about what we're focused on like being an active listener and trying to do that.
Emma	No, we don't talk a lot in math because we are learning. We usually talk to the person next to us about what could the answer to the question be.	Yes, because we have to discuss the answer. Like we disagree or agree and we repeat what they said and we tell our answer. We talk about what the answer might be.

Student	Beginning Interview Response	Ending Interview Response
Bay	Maybe a little. Maybe talking to my friends about I got my tooth pulled this weekend. When Mr. Sharp says phone a friend I phone a friend and then we talk together about math. I like it because you get to have a friend to phone with. We talk about like if Mr. Sharp told us to measure something then we measure it and we talk about how many inches it is.	No, because you can only talk to your friends about math.
Anthony	No, because Mr. Sharp is talking. Like I answer the questions.	Yes because when I was talking to Ken yesterday Mr. Sharp gave me a Poppins cause I was talking to Ken. He would usually ask us why is it not a rectangle or why is it a rectangle. I say, whenever people say they disagree, I say I agree because even if it has four sides that are slanted it can still be a quadrilateral. (If you disagree do you keep your answer?) Not really, I listen to them. (If you know they are correct?) I explain how I got my answer. I agree with their answer.

The students in the class developed a different mindset about talking during mathematics. They no longer viewed their role as silent recipients of information. They related to the idea of agreement or disagreement with classmates. Anthony's statement points to the process of mathematics as opposed to just sharing answers. He also shared about how he handled disagreement with classmates. He described how he listened to them to determine who was correct. It was evident through the interviews with the students and with Mr. Sharp that new sociomathematical norms were established.

In this chapter, I described how new sociomathematical norms developed as a teacher and students engaged in mathematical exchanges that helped them redefine what it meant to *do* mathematics. The practices that supported or diminished student discourse were discussed. I gained a greater understanding of what happened within an elementary mathematics classroom in which the social norm of raising hands to speak was removed. This understanding helped define

the social norms that were established in place of the traditional hand-raising norm and how they related to indications of new sociomathematical norms.

In chapter 5, I will summarize the findings from the study. I will also discuss implications, limitations, and conclusions.

CHAPTER FIVE: CONCLUSION

Introduction

This study provided insight into the establishment of social and sociomathematical norms in which a second grade teacher allowed his students to speak directly to each other without first raising their hands during whole-group mathematics lessons. Mr. Sharp effectively helped his students experience mathematics as something in which to engage. He changed the classroom norms and in doing so, established a classroom setting in which doing mathematics meant discussing, questioning, and challenging the work of others.

In this chapter, I will discuss the qualities of social and sociomathematical norms at the beginning and at the end of the study. Next, I will discuss how the norms were established. This will be followed by the reactions of the teacher and his students. Particular attention will be given to connections between the results of this study and the related literature. This chapter will also address the study limitations, implications, and considerations for future study.

Discussion

Qualities of Social and Sociomathematical Norms

I was able to determine Mr. Sharp's typical mathematics instruction when I observed him teach three different lessons. He confirmed that what I observed was indicative of what occurred during mathematics each day. Table 11 describes the qualities of social and sociomathematical norms at the beginning and at the conclusion of the study.

Table 11 Qualities of Social and Sociomathematical Norms

Norms	
Pre-existing Social Norms • Phone a friend • Students follow steps of teacher • Raise hands • Listen	Social Norms at Conclusion • Address one another by name • Listen and restate • State agreement/disagreement
Pre-existing Sociomathematical Norms • Procedural focus • Errors should be avoided • Students recipients of information	Sociomathematical Norms at Conclusion • Student thinking highlighted • Errors opportunities for growth • Conceptual focus

It was my goal to assist Mr. Sharp in developing productive sociomathematical norms. The sociomathematical norms I observed throughout the study changed but did not reach the level of sophistication as defined by experts in the field (Cobb, Yackel, & Wood, 1992). Nonetheless, the changes in social norms during mathematics lessons supported the development of sociomathematical norms that were more conducive to engaging students in meaningful mathematical discourse.

Pre-Existing Qualities of Social Norms

The beginning social norms that related to mathematics instruction were as follows. Mr. Sharp talked students through his processes for solving problems. He included a sequential progression of steps for students to follow. He invited students to answer simple questions by calling on students with their hands raised. At times he called on students that did not have their hands raised to see if they were paying attention. The social norms were indicative of traditional classroom practices.

Qualities of Social Norms at Conclusion of the Study

The qualities of the new social norms at the end of the study included the following practices. Students spoke out, often all at once when Mr. Sharp asked for explanations. Mr. Sharp was required to mediate until just one student spoke. There were expectations that students address one another by name, listen when others were speaking, and restate what others shared. Students also looked at one another when they spoke and stated agreement or disagreement to what they heard. The established social norms were a contrast to traditional classroom practices in that students were expected to address other students and challenge the thinking of others during whole-group discussions.

Pre-Existing Qualities of Sociomathematical Norms

At the beginning of the study Mr. Sharp shared that he valued student talk and felt that he could learn about his students' mathematical conceptions and misconceptions by listening to their thoughts. However, there was a mismatch between what he valued and what he enacted during his typical mathematics lessons. While he stated the importance of having students explain their reasoning, there was no evidence of him actually doing so during instruction. The discrepancy between his perception and enactment of lessons was similar to Peterson's findings (1990). Mr. Sharp, like the teacher in that study, was influenced by his interpretation of his practice as opposed to what actually occurred during instruction. His practices were not aligned to the tenets of what he espoused. Polly and Hannafin (2011) suggest that teachers have faulty assumptions related to their enactment of student-focused instruction.

Research has established that teachers often struggle to implement reform methods during mathematics instruction (Schifter & Fosnot, 1993; Windschitl, 2002). Mathematics

classrooms often portray traditional roles for teachers and students with teachers telling students how to complete procedures and the students passively focusing on what is being taught (Hiebert et. al., 2005). Mr. Sharp's initial patterns were consistent with this research. The pre-existing sociomathematical norms were focused on procedural rather than conceptual understanding.

When his students experienced mathematics under these circumstances they received messages about their role in the classroom, errors, and, the purpose of mathematics. As was evident in their beginning interviews, they considered their role during mathematics class to be listeners. They also were under the impression that they should know the answers. It was their understanding that errors should be avoided because being successful in mathematics was equated with being correct. When students hold this view of mathematics and mathematical errors, they miss the opportunity to experience mathematics that has the potential to move their thinking forward. It is difficult to find value and enjoyment in following arbitrary steps without connection to meaning.

These were three sociomathematical norms that were established prior to the study. Students were expected to be recipients of information, avoid errors, and focus on successfully following the teacher's procedures. Mr. Sharp and his students were enacting practices and views that were consistent with traditional methods as described by Stigler and Hiebert (2009). The initial observations depicted a setting contrary to the recommendations of Bruner (1966) in that students were not actively engaged. They were experiencing mathematics as isolated steps provided by Mr. Sharp. These sociomathematical norms changed during the study.

Qualities of Sociomathematical Norms at Conclusion of the Study

The new sociomathematical norms depicted a more active learning environment for students. It was evident that Mr. Sharp valued having his students take a more central role during mathematics. He highlighted student thinking as opposed to correct answers. These practices were evident in the way in which he framed questions as well as the opportunities he provided for students to consistently share their thinking. Mr. Sharp successfully brought his practice into a closer alignment with his values.

Students, through their direct discussions sought mathematical agreement and accuracy. Mathematics processes were examined through communication. As students were able to openly share their thinking, they contributed more to the conversation than one-word responses. Finally, mathematical misunderstandings were opportunities for conversation and growth. When students shared their mistakes, it helped others in the class determine the source of the mistake and in turn provided further opportunities for understanding.

Mr. Sharp explicitly told the students that it was acceptable to defend their answers, even when others disagreed. His verbalizations and actions in regard to errors created an environment that allowed students to discuss and gain a greater understanding of the mathematics. This is in keeping with recommendations of Stipek and Kazemi (2001) for practices that promote conceptual understanding.

Teacher questioning

Initially, Mr. Sharp asked questions that required short, one-word responses. The responses provided by the students consisted strictly of the answer to the question. Another common occurrence was for him to ask a question and all of the students to chorally respond at

one time with an answer. There was a marked shift in these exchanges once the new norms were established. Rather than the focus being placed on students providing an answer to a problem in the book, the focus became on the students making sense of the mathematics. In this way, the questions became a vehicle for students to express their understanding and for the students to have an opportunity to respond to one another. This was indicative of the teacher's change from IRE (Mehan, 1979) to IDE (Nathan, et al., 2007) patterns of discourse.

Establishment of New Discourse Patterns

Mr. Sharp found establishing new social and sociomathematical norms to be a challenge. He valued the process, but initially experienced frustration because he felt he could not change his practices quickly and easily. Stigler and Hiebert (2009) suggest that the cultural nature of schools causes a slow pace for change. Mr. Sharp only had three years of experience as a teacher, but had decades of experience being in the school system as a student. His progress towards change in his classroom did not follow an expected linear path toward open dialogue. Rather, there were successes and challenges along the way.

Changes

Mr. Sharp was motivated to make changes in his instruction during mathematics lessons. He was open-minded and flexible in regard to allowing students to speak out during class. He also valued student participation, positive interactions, and peer assistance. Each of these factors played a role in the establishment of new social and sociomathematical norms.

I initially planned to offer two distinct phases of professional development. The first phase was intended to assist in creating new expectations for students and providing a structure

for Mr. Sharp to build on during the second phase of the study. It was surprising that he began allowing students to speak to one another before the beginning of phase two.

Students were immediately able to engage in the new social norm of speaking without raising their hands during whole group mathematics lessons. It took more time, however for them to demonstrate their ability to adhere to all of the nuances required of this new expectation. For example, the students could go through the motions of speaking to one another without really having something to say to the other student. In these instances, the talk between the students was forced and unnatural. This was exemplified when on occasion students would speak to each other saying, "You said… but I disagree." It was as if they were trying to follow a script rather than truly engaging in meaningful conversations.

To further complicate the issue of transitioning to students talking directly to one another, Mr. Sharp was prone to take over the lead of conversations and at times oversimplify problems that could have the potential for more of a challenge and ultimately, rich dialogue. This was particularly evident when Mr. Sharp diminished the cognitive complexity of a data analysis problem in which the students were working to determine the number of pockets in the classroom. Mr. Sharp took away the opportunity for the students to struggle with the problem and discuss their reasoning. He shared his internal struggle between challenging his students and maintaining a preconceived pace of instruction.

Smith (1996) outlined several facets of teachers' attempts of meeting the challenges of reform methods in mathematics education. He states that teachers must redefine their sense of efficacy as it relates to their instruction. Mr. Sharp struggled with the temptation to rely solely on

providing information to his students, perhaps in part because of issues involving his self-efficacy related to telling.

Reform in mathematics often requires specific changes to be made by teachers. Often the enacted changes are superficial. “Small-group work, student projects, and manipulatives can be easily assimilated to views of content that emphasize the standard rules and algorithms, the teacher’s role of knowledge telling, and students’ roles of listening and practicing, leaving the pedagogy of telling fundamentally intact” (p. 396). Mr. Sharp shifted the focus of conversations when he allowed students to speak without raising their hands. In essence, he could not keep the pedagogy of telling intact. The act of allowing open communication became a pathway for Mr. Sharp to align his practice more closely to the tenets espoused by SMP3 (CCSSO, 2010).

Throughout the study, Mr. Sharp’s actions and verbalizations influenced the students and their engagement in social and sociomathematical norms. At times, he made instructional decisions that aligned with his stated values in the classroom. Other times, it was apparent that his implementation of different expectations from the students proved to be a challenge. Figure 2 summarizes which of Mr. Sharp’s actions and verbalizations supported or undermined the establishment of new norms during his mathematics lessons.

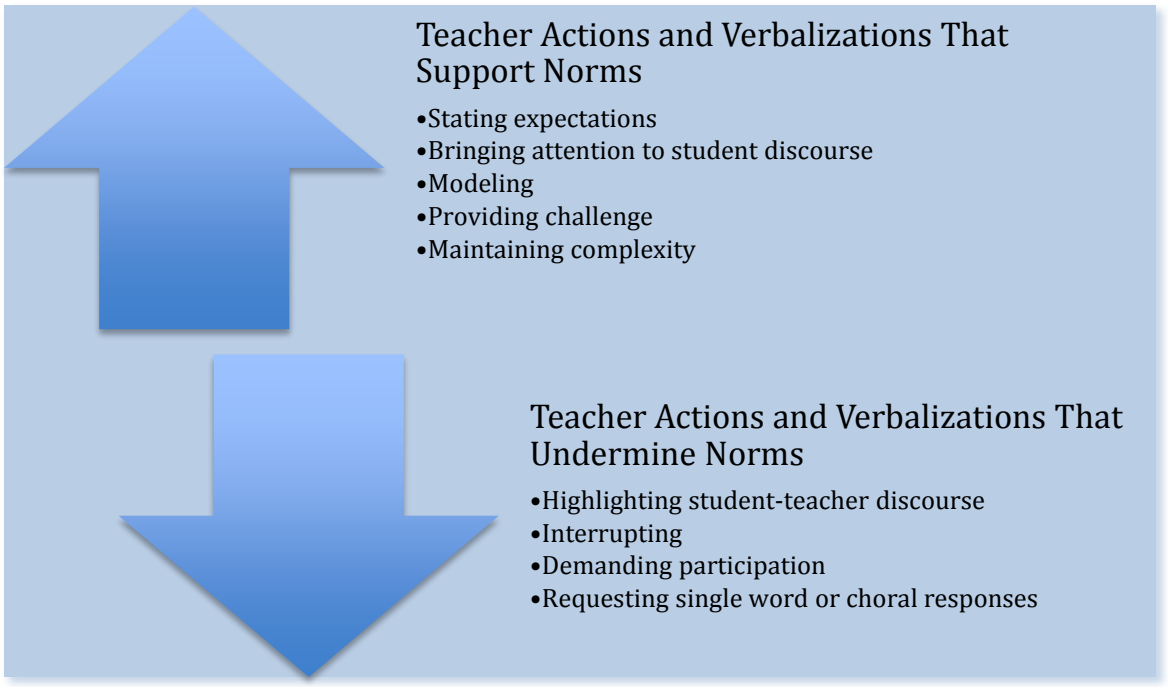

Figure 2 Actions and Verbalizations that Support or Undermine Norms

Making the change of allowing students to talk directly to each other without raising their hands proved to be a complicated task. It was often a matter of taking two steps forward and one step back. Mr. Sharp exhibited the struggle as new norms were negotiated. These struggles often stemmed from the conflicting pull to maintain the teaching role that was well established in his life. This supports the work of Windshitl (2002), especially in regard to the internal struggles that teachers face when attempting to change their practice. Negotiating sociomathematical norms is a lengthy process that is likely to look differently in different classroom settings. Windschitl described the complexity of changing established mathematical practices. Changing norms is associated with redefining the nature of mathematical learning and the social structure and expectations in the classroom.

Successes

Mr. Sharp was successful in engaging his students in new social and sociomathematical norms. His initial pre-existing norms were indicative of a product orientation towards mathematics as defined by Cobb (2000). Within a relatively short amount of time, he was moving towards establishing norms that highlighted student participation as described by Lampert (1990). He explicitly taught his students to explain their reasoning and discuss the reasoning of others. He modeled the expectations and helped the students to engage in meaningful ways. Overall, the tone in the classroom was very different than before he implemented changes. He became clearly focused on students sharing their methods. Some of the changes seemed easier than others. For example, Mr. Sharp seemed to easily shift his practice to accommodate the process of allowing students to talk. He successfully set new expectations for students to provide explanations of their thinking. Other changes proved to be more challenging.

Challenges

As the new norm of being allowed to speak without raising hands first was being established, students would often yell out, "Mr. Sharp" to gain access to the conversation. This indicated that students were responding to unspoken messages about their verbal interactions. Mr. Sharp was still maintaining ownership of the conversations. Students did not address each other in this way. In fact, the students were still directing their comments to the teacher instead of to one another. This signified that students had merely learned a new way to gain access to speak. Rather than raising their hands, they shouted the teacher's name and then he would choose one of the students who called out. When students called out, and when the teacher filled

the role of determining who would speak, the establishment of new social and sociomathematical norms was undermined. Students were told to speak to one another but received contradictory messages whenever they felt the need to have the teacher allow them into the conversation.

Another pattern that began to emerge was when the same three students initiated conversation. The teacher would interrupt them or tell them that he needed to hear from other students instead of them. The message that he sent was clearly that he was still the one who would decide who would speak and when. He did not want these three students to dominate the conversation and his goal was to get other students engaged in the discussion.

Mr. Sharp's concerns were valid. If only three students were to participate in mathematical discussions, it is unlikely that the others would benefit from the conversation. McClain and Cobb (2001) discussed a related teacher concern. The teacher in that study was under the impression that all students needed to share their methods, which led to the unintended consequence of a loss of momentum in the lesson and missed opportunities for students to analyze the merit of particular mathematical strategies.

Likewise, Mr. Sharp at times missed opportunities to guide the students toward a mathematical goal. He seemed to be under the impression that turning the conversation over to the students was an all or nothing endeavor. In interrupting the talkative students, he was attempting to keep the conversation open to all students. Unfortunately, this usually just ended the conversation and he inadvertently sent the message that he was still maintaining ownership. Mr. Sharp's intention of giving everyone an opportunity to speak was derailed by his insistence of students speaking when they may not have had something to share.

During the initial observations of Mr. Sharp's typical mathematics instruction only a few students spoke. There was a false illusion that students were participating, especially when they provided choral responses to questions. Mr. Sharp had an established routine of calling on students that did not have their hands raised. Supposedly, this would keep students from dominating the conversation and would make the discourse more equitable. This was not the case because students that did not wish to participate would simply not respond when called on.

It appeared that the students who typically stayed quiet did so whether the teacher was dominating the conversation, as evident during the pre-existing observations or when the vocal students were speaking once the norms changed. Mr. Sharp, in reinforcing his role during discussions also reinforced the role of the students as recipients of information. The difference was that they were getting information from their peers rather than Mr. Sharp.

On one hand, Mr. Sharp's attempt to include more students in the conversation was in keeping with the goal of increasing student opportunities to engage in mathematical discussions. On the other hand, leading students to participate in the discussion needs to be handled carefully. Too much control by the teacher has the potential to undermine the goal of students being able to speak freely.

There are several potential solutions for when students dominate conversations. These would likely vary depending on the circumstances. During the professional development sessions, we discussed having a time for him to choose students to speak, followed by a time for open discussion. I also encouraged him to allow students to provide tips to one another when they were struggling to solve a problem. Perhaps it would have been helpful for him to wait until the end of a lesson before asking the quiet students why they did not participate.

A challenge of establishing new social and sociomathematical norms in an elementary classroom is how to address domination of conversations. A related challenge is the conflicting expectations for roles in the classroom. Initially, Mr. Sharp had a well-established pattern of talking his students through steps of a problem. Mr. Sharp's students, as second graders, had already come to expect this from their teacher. They were also accustomed to having to raise their hands to speak. It was difficult for Mr. Sharp to deviate from his role and likewise, the students often looked to him to fulfill his traditional role. This made it easy for Mr. Sharp to revert back to his comfort zone. If the students were accustomed to experiencing different roles, perhaps it would have been easier for them to maintain whole-group conversations with their peers. This in turn, would have likely assisted Mr. Sharp to negotiate a new role for himself.

Reactions of Mr. Sharp and his Students

Teacher Discomfort

Mr. Sharp was uncomfortable with his implementation of the new norms. He felt that he should have been able to make the change quickly. He also communicated his discomfort with silence and with allowing his students to struggle. He realized that he talked a lot during instruction but he gave the impression that this provided a level of comfort in knowing he covered the mathematical content. It was unsettling for him to determine that when he was talking at his students and sharing his methods, they were not retaining the information. He appreciated the idea of productive struggle but felt that he needed to quickly provide strategies for them to follow. It was much harder for him to allow his students to grapple with a problem. He had difficulty with the amount of time that required.

Teacher Awareness

Mr. Sharp's experiences during this study influenced the way he viewed his role as the teacher and his expectations in regard to the role of the students in the class. During professional development and the ending interview, he shared his newfound awareness and the implications for mathematics instruction. Through these interactions, he was able to verbalize some key aspects of elementary mathematics.

His experience was that allowing students to talk to one another and to discuss their conceptions and misconceptions took time. It was much more efficient to simply tell students what he would like them to understand. But was it as effective?

Mr. Sharp shared that the process of telling the students how to solve problems did not produce the level of understanding that he originally expected. This was described in reference to a problem that he had students work on that he, sharing *his* methods, had previously taught them. He identified that he was in essence teaching his students that they did not need to think for themselves; he provided the information for them.

Another related area of awareness was that students could appear as if they understood something when in fact they did not. This was evident when he taught the exact same problem he previously taught. He was under the impression that the students understood the problem the first time around. They seemed to be able to follow along and nod their heads in agreement at the appropriate times.

Their false understanding was also evident to him on a different occasion when the students were able to quickly and correctly complete a page of workbook problems. Mr. Sharp chose to modify the lesson on the spot and probed in an attempt to foster communication. In the

process, he was able to identify that the students had misconceptions and only appeared to understand. The open dialogue that he implemented provided an opportunity for him to identify and address their misconceptions.

Under the original classroom norms, this could have easily been a missed opportunity if his students were not asked to share their thoughts about the problems on the page. Mr. Sharp recognized when his students failed to make deep connections to the mathematics when he allowed them to have open discussions. It is unlikely that he would have been able to determine the depth of their understanding, or lack thereof, had he not provided them the opportunity to share openly about the content they were learning.

Student Reactions

Each action, instructional decision, and problem posed during a mathematics lesson had the potential to influence the thoughts and behaviors of the students in the classroom. The students that participated in the interviews shared insightful information about their experiences during mathematics instruction. Through their interview responses, I was able to determine their reactions to their experiences during the study.

Before the study began, the message being received by the students was that they were to be quiet recipients of instruction during mathematics. Mathematics was something that did not involve them talking; that was reserved for reading lessons. When Mr. Sharp asked questions they could easily avoid answering or "phone a friend" and be provided information.

Their role and what was required of them changed throughout the study. By the time of the ending interview with the students, they verbalized a change in the message they were receiving about the role of talking during mathematics lessons. Talking was now seen as

something that had the potential to bring clarity and understanding. They reacted positively to the concept of helping one another.

The students also responded to the topic of errors during mathematics. It was their initial understanding that they were expected to know the answers to questions and that mistakes were to be avoided. Their reaction to making mistakes shifted from a source of embarrassment to an opportunity for growth and for helping others. They recognized that being challenged did not equate with being wrong. Their impression was that sometimes the person with a challenge was wrong and together they could work through the process to bring about understanding.

Limitations

Elementary mathematics classrooms are complex systems. It is difficult to pinpoint specific practices to study without considering the dynamic interplay of each part of the system. It is impossible to isolate other methods used by the teacher, the topic of study during mathematics, and other factors that could have influenced what I observed during my time in the classroom. For these reasons and some of the reasons to follow, the findings are shared cautiously.

This ethnography was pursued with the goal to gain a greater understanding of what occurs in a second grade classroom when students were encouraged to speak directly to one another without having to raise their hands first. This research was completed with one teacher in his particular classroom setting. While it is helpful to gain a thorough understanding of the occurrences under these circumstances, the results of this research are not generalizable to the larger community.

Considerations and Recommendations for Further Study

Mr. Sharp was provided with professional development throughout the study. The amount of professional development provided could be an area for further study. It is likely that more structured and devoted time to ongoing professional development would have made facilitation easier for the participating teacher.

The use of classroom video episodes of Mr. Sharp's instruction proved helpful. The online survey tool made it possible for Mr. Sharp to view the video clips at a time that was convenient for him. He found that the video helped him and it was beneficial for highlighting specific practices. Additional research should be conducted in regard to utilizing classroom video to assist in the establishment of new norms. It would be interesting to include examples of pre-existing patterns during mathematics. These video examples could be analyzed by the participating teacher in reference to views of his or her instruction and how they relate to their goals for mathematics instruction.

The timing of the study may have influenced the findings. The beginning of a school year marks the development of expectations for students. Teachers often spend much time devoted to setting the tone for the school year. This study began in February and therefore the patterns of discourse and expectations for roles in the classroom were well established. Mr. Sharp shared that he would continue with the new norms after my study concluded. He was especially interested in beginning the next school year by stating expectations for new norms with his students right away. Further research should be conducted in an effort to distinguish the establishment of social and sociomathematical norms at the beginning of the school year as opposed to these same norms being established at the end of the school year.

Another related area for future study is examining the establishment of these new social and sociomathematical at the beginning of students' academic careers. Mr. Sharp, a second grade teacher, responded to perceived pressures for pacing his mathematics instruction. Teachers in grades three through five have even more perceived pressure than teachers of primary grade students due to testing. This might cause a conflict with the flexibility necessary to change social and sociomathematical norms. Students in grades three through five are also likely to have more firmly established views on their role to be recipients during mathematics instruction. Different grade levels provide opportunities to study the establishment of new social and sociomathematical norms in a variety of settings.

Mr. Sharp had three years of teaching experience but did not complete a traditional teacher-training program. Some of the training he missed, such as classroom management and methods for teaching mathematics may have affected the establishment of new norms in his classroom. It would be beneficial to determine if teacher training is related to teacher comfort level in changing established norms.

It is difficult to determine if years of experience would make the process of setting new expectations during mathematics easier or more difficult. Perhaps being new affords a teacher more flexibility as habits are still being developed. On the other hand, classroom management and other skills related to experience could certainly play a part in the process. My research questions did not address the issue of experience but nonetheless it may have played a role in the research findings.

Likewise, I did not evaluate Mr. Sharp's mathematical content knowledge but it is possible that content knowledge played a part in the establishment of social and

sociomathematical norms. Mathematical knowledge for teaching has been established as a contributing factor in successful teaching practices (Ball, Thames, & Phelps, 2008). Future research could explore how a teacher's content knowledge is related to establishing new norms. A few possible connections are in regard to maintaining complexity and challenge of mathematical tasks, which are also related to mathematical knowledge for teaching (Charalambous, 2010). Further research should compare teachers with varying levels of content knowledge in an effort to evaluate the degree to which it influences instructional decisions that relate specifically to the development of social and sociomathematical norms.

Conclusion

My study was focused on how social and sociomathematical norms were established in a second grade classroom in which students were encouraged to speak directly to each other without first raising their hands. I was also interested in learning what qualities of social and sociomathematical norms were evident under these circumstances. Finally, of particular interest were the reactions of the teacher and his students throughout the study.

During the ending interview when Mr. Sharp shared that he felt he had been giving his students "just enough" before participating in the study. He likened this thought to living paycheck to paycheck. When our students have "just enough" mathematical understanding to mimic the steps of the teacher or to supply a correct answer, it is unlikely that they will be able to succeed in higher mathematics or to see value in mathematical tasks. When students have more than "just enough" understanding they are more likely to apply what they know in novel ways.

Our society needs a generation of students that have the capability to be independent thinkers. Our teaching strategies in elementary mathematics classrooms have the potential to

teach students to persevere and thrive when they encounter academic challenges. Elementary students have something to gain when they learn to take ownership of their ideas. Mr. Sharp's students were provided an opportunity to gain a new perspective for what it means to *do* mathematics.

APPENDIX A: IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Lisa Ann Brooks**

Date: **December 11, 2013**

Dear Researcher:

On 12/11/2013, the IRB approved the following human participant research until 12/10/2014 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	Replacing the Raise your hand to speak Rule With New Social and Sociomathematical Norms in an Elementary Mathematics Classroom
Investigator:	Lisa Ann Brooks
IRB Number:	SBE-13-09806
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 12/10/2014, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Joanne Muratori

IRB Coordinator

APPENDIX B: DISTRICT APPROVAL LETTER

[redacted]

[redacted]

[redacted]

February 20, 2014

Ms. Lisa Brooks
[redacted]

Dear Ms. Brooks,

I am in receipt of the proposal and supplemental information that you submitted for permission to conduct research in the [redacted] Schools. After review of these documents, it has been determined that you are granted permission to conduct the study described in these documents.

Upon receipt of district approval, the principal of the identified school has the authority to decide if he/she wishes to participate in your study. You have indicated via email that Dr[redacted]cc-eed below, has agreed to allow you to conduct your study on her campus. In addition, you have indicated that Mr. [redacted]n has agreed to participate in your study.

Please forward a summary of your project to my office upon completion.
Good Luck!

Sincerely,

[redacted]

[redacted]
Deputy Superintendent, Instructional Excellence and Equity

cc [redacted]
Dr[redacted]

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APPENDIX C: TEACHER CONSENT

Teacher Informed Consent

Principal Investigator(s): Lisa A. Brooks M.Ed.

Faculty Supervisor: Dr. Juli K. Dixon, PhD.

Investigational Site(s): [redacted]chool

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study because you teach first or second grade and you were recommended by a colleague. You must be 18 years of age or older to be included in the research study.

The person doing this research is Lisa A. Brooks of the University of Central Florida. Because the researcher is a graduate student, she is being guided by Dr. Juli K. Dixon, a UCF faculty supervisor in the College of Education.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to gain a better understanding of mathematical practices that lead to greater student engagement during lessons. My goal is to work with you by providing professional development and examining what happens in your classroom during mathematics lessons. I will be asking for you to change a rule in your classroom during mathematics lessons. I will observe a couple of typical lessons before sharing what the requested rule change entails.

What you will be asked to do in the study: You will be asked to complete a short beliefs survey that will take approximately 15 minutes to complete. You will also be asked to participate in an interview at the beginning and end of the study. The interview will be video or audio recorded and will take approximately 30 minutes. Throughout the study, I will be collecting video and audio of mathematics lessons. You will be asked to meet with me weekly for approximately 2 hours during planning time, or before or after school based on your preference. I will be asking you to view selected video clips of your mathematics lessons that will be sent to you using a web based tool. That will require approximately an hour each week in total. We will also be working together to develop math plans that involve tasks for the students.

Anticipated Timeline:

Week 1: complete beliefs scale; parental consent forms home with students; participate in interview

Week 2 & 3: collect parental consent forms; video and audio recording begins once consent forms are received

Week 4: professional development and student interviews

Week 5: professional development (to be disclosed by week 4)

Ongoing professional development and data collection process

2/28/14: (or earlier) ending interviews

Location: All research will be conducted at your school. You will also be asked to view video and respond to questions that will be accessed on a web-based tool at your convenience outside of school hours.

Time required: We expect that you will be in this research study for approximately 2 months. I anticipate the professional development to require approximately 3 hours of your time each week. This includes time spent during scheduled planning time as well as time outside of school hours when you can access the Internet to view and respond to video of your mathematics lessons.

Audio or video recording: You will be audio recorded during this study. If you do not want to be audio recorded, you will not be able to be in the study. Discuss this with the researcher or a research team member. If you are audio recorded, the audio will only be used for this research project. Audio from class lessons may be used in research presentations.

You will be video recorded during this study. If you do not want to be video recorded, you will *not* be able to be in the study. Discuss this with the researcher or a research team member. If you are video recorded, the video will only be used in connection with this research project and may be used in research presentations.

Benefits: If you choose to take part in this study, you will be receiving ongoing professional development without a cost to you or your school.

Compensation or payment: There is no compensation or other payment to you for taking part in this study.

Confidentiality: We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, talk to: Lisa A. Brooks, Graduate Student, School of Teaching, Learning, and Leadership, College of Education and Human Performance, (407) 823-0000 or Dr. Juli K. Dixon, Faculty Supervisor, School of Teaching, Learning, and Leadership, College of Education and Human Performance at (407) 823-4140 or by email at juli.dixon@ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Please let me know if you have any questions. Once you have decided whether you would like to participate in the study, please communicate that and save this document for your records. Thank you!

APPENDIX D: PARENTAL CONSENT

Replacing a Traditional Rule With New Social and Sociomathematical Norms in an Elementary Mathematics Classroom

Informed Consent

Principal Investigator(s): Lisa A. Brooks, M.ED.
Faculty Supervisor: Dr. Juli K. Dixon, PhD.
Investigational Site(s): [redacted]*hool*

I am providing two copies of this consent form. Please sign and return one of these consent forms to your child's teacher by ~~12/15/2013~~. Please retain the unsigned consent document for your records.

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being asked to allow your child to take part in a research study conducted by a student in the doctoral program at The University of Central Florida. Your child is being invited to take part in this research study because he or she is a student of a teacher who would like to participate in this research.

The person doing this research is Lisa A. Brooks of University of Central Florida, College of Education and Human Performance, School of Teaching, Learning, and Leadership. Because the researcher is a doctoral student, she is being guided by Dr. Juli K. Dixon, a UCF faculty supervisor in the School of Teaching, Learning, and Leadership.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should allow your child to take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you or your child.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The Common Core State Standards for Mathematics include 8 Standards for Mathematical Practice. These practices call for a change in usual practice as students are expected to take a more active role in the classroom. The purpose of this study is to examine the role of the student during mathematics instruction. I will be working closely with your child's teacher to plan and implement strategies that will help your student to successfully participate in mathematics lessons.

What your child will be asked to do in the study: This study will take place in January. Your child will be asked to participate in an interview at the beginning and at the end of the study. I will also be collecting video and audio recordings of the mathematics lessons and student work samples. Your child does not have to participate in every research task. You or your child will not lose any benefits if your child skips questions during the interview or would not like to participate in some of the research tasks. If you would not like your child to participate in the research, they will still participate in their classroom instruction but data collected will not be used. Your child's seat may be changed so that video will not include him or her. Alternatively, your child's image will be obscured from the video. Audio recording of your child's voice will not transcribed if you do not wish for him/her to be a participant.

Location: The research will take place in your child's classroom. The researcher will be attending daily mathematics lessons and may participate in the mathematics lessons.

Time required: The interview is anticipated to take approximately 15 minutes.

Audio and/or video recording: Your child will be audio recorded during this study. A recorder will be placed within each group of students. These recordings will be used to provide transcripts of classroom dialogue. If you do not want your child to be audio taped, your child will still be able to be in the study. Discuss this with the researcher or a research team member. The audio recordings will be used only for this research and for future research presentations. Student anonymity will be ensured. Student names will not be connected with the audio recordings. Your child will also be video recorded during this study. If you do not want your child to be video recorded, your child will still be able to be in the study. Discuss this with the researcher or a research team member. The video recordings will be used only for this research study and future research presentations.

Benefits: We cannot promise any benefits to you, your child, or others from your child taking part in this research. However, possible benefits include a greater understanding of what it means to participate during mathematics lessons.

Compensation or payment: There is no compensation, payment, or extra credit for your child's part in this study but students will receive a pencil when they return this permission slip to their teacher. They will receive a pencil whether consent is given or not.

Confidentiality: Pseudonyms will be used for all study participants. Personal information that links your child's responses and participation will be removed.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, you may contact Lisa A. Brooks, Graduate Student, College of Education, [redacted] or Dr. Juli K. Dixon, Faculty Advisor, School of Teaching, Learning, and Leadership, College of Education and Human Performance, (407) 823-4140.

IRB contact about you and your child's rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study:

You may decide not to have your child continue in the research study at any time without it being held against you or your child. If you decide to have your child leave the research, please contact the researcher directly at ([redacted]

Results of the research:

The results of this research will be included in a dissertation and future research articles.

Your signature below indicates your permission for the child named below to take part in this research.

DO NOT SIGN THIS FORM AFTER THE IRB EXPIRATION DATE BELOW

Name of participant	
Signature of parent or guardian	Date
	❑ Parent ❑ Guardian (See note below)
Printed name of parent or guardian	

Assent

❑ Obtained

Note on permission by guardians: An individual may provide permission for a child only if that individual can provide a written document indicating that he or she is legally authorized to consent to the child's general medical care. Attach the documentation to the signed document.

APPENDIX E: STUDENT ASSENT

Student Assent

Hi Students,

My name is Mrs. Brooks and I am a teacher and a student at the University of Central Florida. I am here to work with your teacher and to study what happens in your classroom. I would like to collect video and record your class during math for about a month. I also might be asking you some questions. You don't have to do this if you don't want to. Do you have any questions about what I would like to do with your class? Would you like to do this?

Thank you!

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