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Comparing Two Different Student Teaching Structures by Analyzing Conversations Between Student Teachers and Their Cooperating Teachers

Niccole Suzette Franc
Brigham Young University - Provo

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Niccole Franc

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Keith R. Leatham, Chair
Blake E. Peterson
Steven R. Williams

Department of Mathematics Education

Brigham Young University

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ABSTRACT

Comparing Two Different Student Teaching Structures by Analyzing Conversations Between Student Teachers and Their Cooperating Teachers

Niccole Franc
Department of Mathematics Education, BYU
Master of Arts

Research has shown that preservice teachers participating in traditional student teaching programs tend to focus on classroom management, with very little focus on student mathematical thinking. The student teaching program at BYU has been redesigned in the hopes of shifting the focus of student teachers away from classroom management toward student mathematical thinking. This study compared conversations between student teachers and cooperating teachers before and after the redesign of the program to work towards determining the effectiveness of the refocusing of the new student teaching program. The study found that STs and CTs in the different student teaching structures were talking about different things. Not only were the frequencies of conversations about pedagogy, students, and mathematics different, but the ways those individual topics were discussed was also different.

Keywords: Conversations-Teachers, Mathematics, Pedagogy, Students, Student Teaching Structure, Teacher Education-Pre-Service,

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CHAPTER ONE: RATIONALE

Both experienced and newly certified teachers see student teaching as powerful and often as the single most beneficial experience of teacher education programs(McIntyre, Byrd, & Foxx, 1996; Metcalf, Hammer, & Kahlich, 1996; Wilson, Floden, & Ferrini-Mundy, 2002; Zeichner, 2002).Student teaching has the potential to provide preservice teachers the opportunity to learn to become good mathematics teachers (Leatham & Peterson, 2010a).Unfortunately a substantial and growing body of research suggests that the typical student teaching experience may not result in the ends we desire (Cochran-Smith, 1991; Ebby, 2000; Hiebert, Morris, Berk, & Jansen, 2007; Hiebert, Morris, & Glass, 2003; Metcalf et al., 1996; Montecinos et al., 2011).

Good mathematics teaching focuses on students' mathematical thinking. *The Professional Standards for Teaching Mathematics* has as one of its six overarching standards for the professional development of teachers of mathematics *knowing students as learners of mathematics*. According to this standard, "teachers need opportunities to examine children's thinking about mathematics" (National Council of Teachers of Mathematics, 1991, p. 144). In mathematics classrooms it is critical that teachers promote mathematical discussion based on students' mathematical thinking to help students learn with understanding (National Council of Teachers of Mathematics, 2000). Orchestrating discussions centered on students' mathematical thinking, however, seems to be one of the most difficult aspects of this approach to teaching (Sherin, 2002)and so preservice teachers should be given opportunities to engage with the teaching practice of talking about students' mathematical thinking throughout their teacher education program, including their student teaching experience. If the practice of eliciting and using students' mathematical thinking is important, then one of the key purposes of student teaching programs should be to allow preservice teachers to gain insights into this practice so they can learn to incorporate student thinking into their own teaching, as NCTM encourages(National Council of Teachers of Mathematics, 2000). In order for this learning to occur, preservice teachers should have ample opportunity to discuss and reflect on the practice of eliciting and using students' mathematical thinking.

Unfortunately, the typical American student teacher (ST) does not spend a significant amount of time discussing or reflecting on students' mathematical thinking. Peterson and Williams (2001)conducted a study of the conversations that occur during student teaching between STs and their cooperating teachers (CTs). Their analysis found that certain STs spent a great deal of time (the extreme was 77%) discussing classroom management. Even more shocking, the amount of conversation spent talking about mathematics in general was very low (as low as 1% for some STs). Studies show that this pattern in conversation topics is typical across many student teaching programs (O'Neal & Edwards, 1983; Tabachnick, Popkewitz, & Zeichner, 1979)and has been such for decades (Rodgers & Keil, 2007).

Mathematics teacher educators are realizing that if good teaching involves the elicitation and use of students' mathematical thinking then student teaching programs should give preservice teachers opportunities to discuss and reflect on students' mathematical thinking as they learn to be a good teacher. For example, the Department of Mathematics Education at Brigham Young University (BYU) has implemented a new design for student teaching with the explicit goal of giving preservice teachers opportunities to gain insight into students' mathematical thinking. The program was purposefully redesigned in order to emphasize eliciting and using student mathematical thinking (Leatham & Peterson, 2010a). If the changes to the program have been successful then the everyday conversations between STs and CTs should reflect the strong focus on students and their mathematical thinking. This study has researched what STs in the BYU program are talking about in their casual, daily conversations with their CTs and investigated the effect of the changes to the traditional structure of student teaching on what the STs have the opportunity to learn.

CHAPTER TWO: THEORETICAL FRAMEWORK

As mentioned in the rationale, student teaching is consistently cited as being one of the most important parts of the process of learning to teaching, both by experienced and preservice teachers(Leatham & Peterson, 2010a; McIntyre et al., 1996; Metcalf et al., 1996; Wilson et al., 2002; Zeichner, 2002). This chapter makes the claim that the conversations STs have with CTs capture, at least in part, the focus of a student teaching program, whether the focus is intentional or not. The chapter will continue by making the claim that student teaching programs should focus on giving preservice teachers opportunities to learn to teach well. I end this chapter by explicitly stating my research questions about how the nature of conversations between STs and CTs might differ in differently structured student teaching programs.

Conversations as a Measure of the Focus of Student Teaching

The hope was that changing the structure of the student teaching program would positively influence preservice teachers by giving them the opportunity to focus on facilitating student learning. It is difficult to accurately capture the true focus of student teaching programs, but one important clue of what the STs have been focusing on is what they are talking about in everyday conversations with their CTs. In essence the conversations between CTs and STs encapsulate the learning content of student teaching. The conversations between STs and CTs will reflect the focus of the student teaching program.

I investigated how the nature of conversations between STs and their CTs differ in differently structured student teaching programs. This investigation will give insight into whether the structure of a student teaching program can positively influence the content of conversations between STs and their CTs. Teachers need opportunities to articulate and reflect on ideas and concerns about the practice of orchestrating meaningful classroom interactions if there is any hope of them learning to orchestrate classroom interactions in ways that contribute to the kinds of learning and teaching outlined by NCTM (2000). When teachers are given these opportunities, their reflections become deeper and more meaningful to them (Feiman-Nemser, 2001; Hollins, 2011; Richert, 1992; Rust, 1999).

My study was done on the mathematics education student teaching program at Brigham Young University. In order to carry out my study I compared two sets of conversations between STs and CTs; one set before the change in structure of the mathematics education student teaching program at BYU and one set after. These conversations were unscripted, took place during the day-to-day activities of student teaching, and did not involve university supervisors.

What Student Teachers Should Focus On

Despite its obvious importance, there are different views of what student teaching should focus on. For example, some believe the most important purpose of student teaching is to experience being in a real classroom, or to learn to manage a classroom, and others believe it is a time to determine if you are fit for teaching (Leatham & Peterson, 2010b). Leatham and Peterson (2010b)used the metaphor of the shoe store apprentice to portray their views of learning to teach and what a student teaching program should focus on. The shoe store apprentice must learn two things: (1) how to make shoes and (2) how to run the shoe store. Similarly, a teacher must learn two things: (1) how to facilitate student learning and (2) how to run a classroom. Through this metaphor we can see that learning to make shoes should take precedence to learning to run the shoe store. After all, what good is having a nicely run shoe store if the apprentice can't make the shoes? Similarly, learning to facilitate learning should take precedence to learning to run a classroom. I agree with Leatham and Peterson (2010b) and believe that the student teaching experience should focus on giving preservice teachers opportunities to learn to teach well, and I believe that good teaching entails a focus on eliciting and using students' mathematical thinking(National Council of Teachers of Mathematics, 2000).

Although student teaching is obviously a powerful experience, there is no guarantee that the student teaching experience will be one of high quality (Wilson et al., 2002). In fact, some studies show that the traditional field experiences often result in undesirable attitudes and ideas about teaching (Metcalf et al., 1996). All students learn what they are given the opportunity to learn (Hiebert, 2003), and this includes STs. In traditional student teaching programs STs are often thrown into classrooms with little or no supervision and as a result they are bombarded with classroom management issues. Because of this setup of student teaching programs, classroom management (or running the shoe store) is what STs are given the opportunity to learn and so it becomes the focus of the student teaching experience (rather than making good quality shoes). BYU's student teaching program has been purposefully re-designed and efforts have been made to reduce the bombardment of classroom management issues by giving CTs a more prominent role in the classroom (Leatham and Peterson, 2010a). As a result the STs are given the opportunity to focus on other aspects of teaching, like attending to student thinking. The student teaching program at BYU is set up so that STs bump up against student thinking more and classroom management less. The STs are then encouraged to articulate and reflect on the student thinking they are encountering as well as to focus on how to elicit and use desired student thinking. The goal behind this reflection is to give the STs the opportunity to learn about facilitating students' thinking, so that facilitating students' thinking becomes the focus of the student teaching experience.

I want to take a moment to stress that I do not believe that classroom management is an unimportant or trivial subject. Just as learning to run the shoe store is important, learning to manage a classroom is an important part of teaching, but I believe that it is something that can largely be experienced during the first year of teaching when novice teachers are given a classroom of their own. Typical teachers (preservice or not) are not given many opportunities to meaningfully discuss and reflect on students' mathematical thinking, and student teaching is an optimal time to do it (Leonard & Leonard, 2003). Often traditional student teaching programs are very similar to a novice teacher's first year teaching, but preservice teachers will never again have the same kind of opportunities that they could in a student teaching program that focuses on giving the ST ample time to reflect and collaborate with peers. So while classroom management is important, I believe there are more important things to be focusing on during the valuable student teaching time, like students mathematics.

The STs' conversations about pedagogy, students and mathematics should reflect the goal and focus of the student teaching program. The student teaching program has a focus on student-centered teaching with and specifically on eliciting and using student mathematical thinking. This type of teaching has been referred to as ambitious instruction (Kazemi, Franke, & Lampert, 2009). In this type of teaching teachers encourage students to think about mathematics in their own ways and build lessons and discussions around the student thinking. Teachers strive to make student thinking public and to build on that thinking to guide lessons and activities. Teachers with this perspective believe mathematics should focus on problem solving and making connections and that students are capable of engaging in these activities meaningfully. The literature has shown over and over that this type of teaching more effectively promotes students' conceptual learning than traditional, teacher-centered approaches to teaching(Fennema et al., 1996; Hiebert & Grouws, 2007; Saxe, Gearhart, & Seltzer, 1999; Staples, 2007; Stein, Engle, Smith, & Hughes, 2008; Stein, Grover, & Henningsen, 1996) and so this is the type of teaching the student teaching program encourages.

Conversations Reflect the Focus

We hope that student teaching programs give STS the opportunity to focus on ambitious teaching. My study will not address whether or not the STs being studied actually gained the necessary mathematical knowledge for teaching but will instead be looking for evidence in the conversations between STs and CTs that the STs were given the opportunity to gain mathematical knowledge for teaching. The conversations between STs and CTs will reflect the focus of the student teaching program, and so conversations about pedagogy, students and mathematics and how these topics relate to each other will demonstrate that the focus of the student teaching program gave STs opportunities to gain important knowledge and teaching mathematics. If student teaching programs could get teachers to talk about pedagogy, students and mathematics, their quality of instruction would likely improve (Hill et al., 2008).

Pedagogy, Students and Mathematics

A study similar to my proposed study was conducted on the conversations between STs and their CTs during reflection meetings in BYU's student teaching program (Leatham & Peterson, in press). This study gives insight into the nature of the conversations that STs have with their CTs and will provide me the framework through which I hope to approach my data. Three main conversation topics were focused on in this study: 1) pedagogy, which relates to the circumstances of the classroom or specific pedagogical moves;2) students, which refers to student thinking or actions, either as an entire class or individual students; and 3) mathematics, whether in student thinking, the thinking of the STs, or other classroom activities.

Pedagogy

The study found that statements about pedagogy dealt primarily with the planning and execution of the lessons, with statements about specific teacher moves as well as statements about the thinking or reasoning behind teacher moves. Sometimes STs would talk about why they made certain pedagogical decisions (e.g., "We decided to talk about homework number four because it led into what we were talking about today. So that's why we did that."). Sometimes the pedagogical conversations dealt with teaching philosophies or the process of learning to be a better teacher. For example, a CT gave his viewpoint on teaching: "And this is probably going to be your hardest thing as a teacher, to figure out how to push the kids that totally understand and not leave behind the kids that don't understand." It is important to note that the conversations that were considered exclusively about pedagogy had to be conversations about the lesson as it was removed from the mathematics in the lesson. The statements were often general statements that perhaps could have been made in any type of classroom, mathematics or otherwise.

Students

Statements strictly about students dealt with what students were doing or thinking, as well as how engaged with the material the students were. An example of this type of statement would be "There was a group of two up here…the boy, he actually understood more than the girl, which is not what I actually anticipated there either." In this statement one of the STs is describing the actions and thinking of the students she observed.

Mathematics

Statements about mathematics tended to focus on working through math problems together or making sense of the mathematics. For example, one conversation about mathematics began with the statement "What is the difference—this is a very sincere question—what is the difference between trend line and a perfect guess line?"

Pedagogy and Mathematics

Clearly not all conversations were about pedagogy, students or mathematics exclusively; the three main topics also combined to create new types of statements. For example, statements about pedagogy and mathematics together also dealt with the planning and execution of the lessons but, unlike in conversations exclusively about pedagogy, these incorporated the mathematics into the planning and execution. For example, when discussing the execution of the lesson one of the STs noted "I think a lot of the ideas came out. We didn't get to talk about perpendicular lines at all, and we didn't actually get to discuss what the intersections mean algebraically and then how you can calculate those." The statement incorporates the pedagogical and mathematical components of what happened in the lesson that day. The topic of pedagogy is discussed as the teacher discusses how the lesson went and how the anticipated ideas were not talked about. The mathematics discussed deals with graphing linear equations.

Students and Mathematics

Statements that dealt with students and mathematics simultaneously were often very similar to the conversations strictly about students but also included conversations about students' past knowledge or experiences in mathematics as well as conversations about mathematical concepts or ideas that were confusing to students. For example, when talking about her students one ST said "…because they believe multiplication makes bigger, division makes smaller, that's what they go by and then they get their operations all out of whack." The teacher is discussing a specific mathematical concept (multiplication and division) and how her students think about it (incorrectly).

Pedagogy, Students and Mathematics

Some statements incorporated both pedagogy and students and others incorporated all three topics, pedagogy, students and mathematics. These types of conversations were very similar, with minor differences based on whether the statement included specific references to mathematics. These statements typically focused on the interactions between students and teachers as teachers responded to students or students responded to teachers during classroom conversations. For example, when commenting on the observed lesson one ST said,

> It really looks like they understand how to use the number line, like the method that ST Jane introduced in her class today I had introduced a week ago, and so just seeing them be able to use that to try to make sense of what's happening here was nice to know that they understood that strategy.

We see here that the conversation focuses on pedagogy as a topic when the ST explains what happened in class that day; ST Jane introduced something in a different order than the ST speaking. The topic of students is also discussed in the mention of how students reacted to what was being taught. The students were able to make sense of what was happening. Finally, mathematics, specifically the number line, is a clear topic as well.

Other Topics

Of course not all of the statements in these reflection meetings could be considered to be about pedagogy, students or mathematics. There were a small number of statements related to the reflection meeting set up (e.g., "If we are done with comments we'll turn the time over to you, Mr. Johnson."),statements about administrivia (e.g., "I keep my late work in this folder.") or just comments in general (e.g., "I have a question" or "Can I make a comment?").

Another code in this study was the behavior code. Statements coded as behavior were statements that dealt with classroom management. Conversations and statements were given this code when they dealt with or commented on establishing or maintaining the necessary conditions in order for instruction and learning to occur (Emmer & Stough, 2001). These types of statements could occur when teachers are dealing with disruptive students (e.g., "I had to move him because he wouldn't stop talking to his friend.") or when teachers are dealing with students' lack of engagement in the class (e.g., "She just stares off into space and I'm not sure she's ever turned anything in."). Any statement that was about managing the classroom in a way to keep instruction and learning possible was given this code.

The topics just discussed (pedagogy, students, mathematics, pedagogy and mathematics, students and mathematics, pedagogy and students, pedagogy, students and mathematics, administrivia and behavior) will be referred to as the PSM codes for the remainder of this document.

It is important to note that the behavior code was given as a sub-code in addition to codes given for pedagogy, students and mathematics. For example, in the statement shared above ("She just stares off into space and I'm not sure she's ever turned anything in.") we can see that the statement describes how the teacher responded to a student so it is coded as pedagogy and student, but it also receives the additional code of behavior because it deals with discipline and off-task student.

Recall that typical student teaching programs have a strong focus on running the classroom and so as a result I expected conversations between STs and CTs in typical student teaching programs to reflect that focus. Those conversations would typically involve pedagogy, students, a combination of pedagogy, students, and behavior. There would most likely be very little discussion about mathematics including how the mathematics influences the pedagogy or students.

If the re-structuring of the student teaching program at BYU had done what it was designed to do then I expected the conversations between STs and CTs to reflect the new focus on facilitating student learning. The conversations should have statements about pedagogy, students and mathematics. There would be deep conversations, not only about pedagogy, students and mathematics individually, but also about how each of those topics affects the others, so there would be statements about pedagogy and mathematics, students and mathematics, and pedagogy, students and mathematics as well. Viewing the data through the lens of this framework helped me to focus on the pedagogy, students, and mathematics in the statement and make important conclusions about the differences in how these important subjects were talked about, and thus focused on, in each student teaching structure individually.

Research Questions

The purpose of my research study was to explore possible differences in the nature of conversations between STs and CTs in different student teaching structures. By "nature" of the conversations I refer to the frequency of the PSM codes topics discussed as well as how those topics are discussed. Analyzing these sets of conversations helped me to answer my research questions: 1) When STs and CTs talk about pedagogy, students and mathematics, what are they talking about in traditionally structured student teaching programs versus in the reformed student teaching program, and 2) How does the nature of these conversations differ in each student teaching structure? These two questions guided my comparison of the two structures. Answering these questions will also be useful in working towards answering the bigger question of whether we can influence STs by changing the structure of their student teaching program because the answers to these questions reflect what kinds of things the student teaching program focused on, which is what the STs were given the opportunity to learn.

CHAPTER THREE: LITERATURE REVIEW

My literature review has three main areas of focus. First I will discuss what the literature has shown about the focus of student teaching programs. Next, because I studied conversations to capture the focus of student teaching programs, I will discuss what the literature has shown about conversations between STs and CTs. Finally, because I studied conversations through the lens of pedagogy, students, mathematics, and behavior, I will briefly explore what the literature has shown about how teachers talk about each of these main topics.

Focus of Student Teaching Programs

Traditionally the student teaching structures in the US have been similar: one ST is assigned to a CT in an apprentice-type program (McIntyre et al., 1996). The amount of control the CT and the ST have in the classroom varies among different programs, because typically programs leave this decision up to the CT. In some cases the CT and university supervisor scaffold student teaching experiences, giving STs guidance and support throughout the experience, but often the ST is given complete control of the classroom with little or no supervision from the CT or university supervisors.

Often the goals for student teaching programs in the US are poorly defined and it is not uncommon for those involved in the student teaching experience to have contradicting perspectives about what is important. Because of the lack of explicit goals, the experience of the pre-service teachers usually depends largely upon the CT they are placed with. What is important to the CT becomes the focus of the student teaching experience (McIntyre et al., 1996; Thompson, 1984).

With the influence of CTs in mind, it is important to consider what CTs view as important in student teaching programs and how STs perceive that focus. Research has shown that CTs have many different opinions on what is important in student teaching. Leatham and Peterson (2010b)asked CTs what they perceived some of the purposes of student teaching to be and got many different responses that were grouped into seven main categories:1)a time to interact with a real live experienced and practicing teacher;2)a time to experience real classrooms and see everything that goes into teaching; 3) a time to learn about classroom management; 4) a time to interact with real students;5) a "proving ground" to determine if the ST is fit for teaching; 6)a time to develop critical affective characteristics, such as enthusiasm for the career; and7) an enculturation period, where preservice teachers can learn what it's like to be part of a department, school, district, etc.

Generalizing across these results, Leatham and Peterson (2010b) concluded that CTs tend to view student teaching as an opportunity for STs to interact with teachers in real classroom as they learn to successfully manage classrooms. One CT from another study explained,

> Teaching strategies and different lessons and different ways of teaching things are easy to learn and you can pick a lot of that up from watching other teachers or workshops. That type of stuff is very easy to learn and pick up, but managing 36 little junior high kids at the same time is not an easy thing to do.(Peterson, Williams, & Durrant, 2005)

Similarly, STs tend to base their evaluations of their CT and student teaching experience on how organized and well managed the classroom is, rather than how well the CT teaches (Osunde, 1996). Managing the classroom is seen as the necessary focus. One ST used a metaphor to give insight into his way of thinking:

> I think that classroom management is the 'lay-ups' and when we can get that down, we can move out to the three pointers. But it really takes a skilled teacher to be able to manage thirty kids, manipulatives, and activities. I think where we make mistakes are when we want to jump and shoot three pointers right away.(Peterson et al., 2005)

This focus of managing and surviving in the classroom is very common and has become the main focus of student teaching in most US program (Wilson et al., 2002).The heavy focus on classroom management is seen clearly in past research on conversations STs and their CTs. The Peterson and Williams (2001)study cited in chapter one is an example. Recall that their analysis found that STs spent the majority of the time discussing classroom management and, in some cases, as little as 1% of the time talking about mathematics. Other studies show these results are typical(O'Neal & Edwards, 1983; Tabachnick et al., 1979).

Student teaching experiences are structured differently in other countries. For example, the structure of student teaching in Japan is very different from the traditional student teaching structure in the US. Peterson (2005)described the traditional Japanese student teaching structure. Japanese STs are placed into schools with several STs working with one CT. STs do not teach a full load of classes to allow time for a heavy focus on planning and reflecting as well as teaching. All STs and CTs are very involved in the planning, teaching and reflecting of each lesson and each lesson is planned and reflected on with a great emphasis on students' mathematical thinking. STs spend a great deal of time collaborating with other STs and expert teachers discussing what student thinking could or should be elicited in the lesson. During the lesson several STs and other expert teachers observe the lesson and are able to focus on important aspects of the lesson because of their background in helping to plan it. After the lesson the ST meets with other STs and expert teachers to discuss the lesson that was observed. They reflect on the lesson, on the student thinking that was elicited, what went well and what could have gone differently. There is a clear and common focus among all involved that learning to elicit and use student thinking is the primary goal of student teaching.

In the past two decades teacher educators across the US have been working to improve the structure of student teaching programs (Cochran-Smith, 1991; McIntyre et al., 1996; Zeichner, 2002).One example of this re-structuring has taken place at Brigham Young University, where the student teaching program was redesigned in the hopes of redirecting the focus of student teaching to student mathematical thinking (Leatham & Peterson, 2010a). The structure has been modeled, at least in part, after the Japanese student teaching structure with the goal of eliciting student thinking clearly demonstrated throughout the structure.

In the new student teaching structure, STs work with a partner and are paired with a CT. Teams of STs and CTs are grouped together to create clusters that work together to plan, teach and reflect on lessons. The STs are given quality learning-to-teach activities such as daily journals, focused observations and student interviews. During the course of the student teaching program the STs gradually gain more and more control of the classroom in an effort to reduce the feeling of fighting for survival in the classroom. There is a teach/observe/reflect cycle, much like the Japanese structure, that allows STs to work together to plan and teach lessons, and observe each other's lessons along with other STs in the cluster, and then meet together to reflect on the lessons taught through the lens of student thinking. This new, different structure of student teaching allowed for dramatic changes to take place as STs began to focus more on students' mathematical thinking and less on survival in the classroom (Leatham & Peterson, 2010a).

The research that has been done to show that the student teaching structure at BYU is effective in changing the focus of student teaching came from analysis of the formal reflection meetings held with STs, university supervisors and CTs. The conversations in these meetings were evaluated to see if classroom management was a main focus of conversation. The results were dramatic: classroom management was discussed less than 4% of the time in these reflection meetings. The focus on student mathematics, which was the dominant subject of the reflection meeting conversations, did not leave room for a focus on classroom management (Leatham & Peterson, in press).

This encouraging research leaves a question of whether these results apply to conversations outside of the formal reflection meetings. The influence of the student teaching structure on formal conversations is clear, but does the influence remain as strong when STs and CTs are not in formal reflection meeting atmospheres? Clearly it is hoped so. There is little good in a student teaching structure that does not extend desired perspectives beyond facilitated conversations. The STs studied in the research on BYU's student teaching structure also recorded all conversations with their CT that lasted longer than five minutes. My research will look at these conversations to determine whether the focus on students' mathematical thinking is extended beyond the formal setting of conversations facilitated by a university supervisor. The analysis will focus on how STs talk about pedagogy, students and mathematics in their informal conversations and will also compare the conversations had by STs and CTs in a traditional student teaching structure to those had by STs and CTs in the reformed structure.

Conversations between Student Teachers and Cooperating Teachers

Not a lot of research has been done on the conversations between STs and CTs in differently structured student teaching programs. Perhaps this is due to the fact that the efforts to improve student teaching programs, which often include a focus on the conversations STs are having, are relatively new and the results have not yet been fully explored. My research on the conversations between STs and CTs will help to fill this hole and be a benefit to the field.

Studying conversations between STs and CTs is important because the literature shows that when STs are asked about the primary influences of their student teaching programs they point to their CTs (Frykholm, 1996). These conversations that have been studied all show the same over-arching patterns: when CTs and STs converse, their conversations tend to be superficial and focus on immediate classroom practices and routines(Chalies, Ria, Bertone, Trohel, & Durand, 2004; Ward & McCotter, 2004). Chalies et al. (2004)found that often the conversations remain shallow because the ST and CT make an effort to avoid offending each other. Goodfellow (2000)discussed the difficult and complex relationship between a CT and his ST. The CT must juggle the needs of his students with the needs of the ST and somehow give constructive feedback without creating tension or discouragement. The ST must recognize the teachings of their university and the beliefs of the CT and somehow reconcile both of these while still respecting that the classroom belongs to the CT. Perhaps because of possible contradicting viewpoints or wanting to reduce embarrassment, ST and CTs rarely talk about standards or research-related principles (Frykholm, 1996; Schlagal, Trathen, & Blanton, 1996) and conversations about mathematics are infrequent (Peterson & Williams, 2008).

Perhaps these conversation trends come as a result of the CTs' perceptions of the purpose of student teaching programs. As previously discussed (Leatham & Peterson, 2010b), CTs tend to view the purpose of student teaching as a time to give STs the opportunity to manage a classroom. It is alarming that there was no general agreement that the purpose of ST should be to give preservice teachers the opportunity to learn to facilitate student mathematical learning. The student teaching program that I will be studying has been restructured with a strong focus on facilitating student mathematical learning through eliciting and using student thinking. My research will focus on the type of conversations that can occur in this environment.

How Teachers Talk About Mathematics, Pedagogy and Students

Conversations among Teachers

In the past there has been very little research done on how teachers talk about mathematics, pedagogy or students in general. Perhaps this is because of the way the teaching profession is typically organized. Teachers in the US have been very isolated from others with little time to reflect or collaborate. Teachers often complain about their large loads of work and little preparation time, pointing out that in order to collaborate with other teachers they would all have to stay after school even later than they already do (Leonard & Leonard, 2003). As a result the only opportunities teachers have to talk with each other is often in the faculty room at lunch and those conversations more often focus on gossip than useful reflections on teaching (Pitt & Kirkwood, 2009). This lack of useful conversation between practicing teachers is distressing because research shows that good conversations (or conversations that allow teachers to reflect on the mathematics of the students and how to teach it) between teachers is a predictor for success in school reform (Rust, 1999).

In the last decade there has been a push for change in this lack of collaboration and communication between practicing teachers. Teachers are coming together to participate in professional learning communities (PLCs) that strive to develop collaborative cultures within the profession(DuFour, 2004; Vescio, Ross, & Adams, 2008). PLCs give teachers the time and resources to work with their peers and have important conversations about student thinking and learning. The encouraging research has shown that, when done well, these PLCs are helping teachers be better able to facilitate student learning(Vescio et al., 2008). Teachers (both practicing and preservice) need the time to reflect and converse about student thinking and learning in order to be successful teachers (Vescio et al., 2008).

Mathematics Conversations

Peterson and Williams (2008)studied mathematical discussions among CTs and STs and found that they were surprisingly rare. They noted that there was a strong belief among the CTs and STs that classroom management was more important. The CTs believed that the mathematics was straightforward and that the STs, who were about to graduate with degrees in mathematics education, must surely have adequate understanding of the mathematics concepts. Ball (1991)showed evidence refuting these commonly held beliefs. We learn from her work that it is problematic to assume that math teachers know math. Teachers need opportunities to talk about mathematics, and not just to talk about it, but to talk about it in meaningful ways. STs should be talking about and questioning mathematics frequently in order to understand the complexities and nuances that are often overlooked and also to have the opportunities they need in order to deepen their own mathematical understanding.

Pedagogy and Students Conversations

There is very little research done on how teachers talk about students or pedagogy in general at all, but what is there is discouraging. One study found that when teachers talk about students and pedagogy they are usually pointing out children who frequently misbehave or giving advice on how to successfully manage problem students(Pitt & Kirkwood, 2009). Research about these teacher conversations, particularly in the staffroom, shows that teachers use this time to vent about problems in the classroom (Ben-Peretz & Schonmann, 2000)or to make unrelated small talk and escape from the realities of teaching (Pitt & Kirkwood, 2009).

Although conversations about pedagogy, students and mathematics appear to be more the exception than the norm, research has shown that when they do occur they can be quite beneficial. Horn (2005) reported on a study of the effectiveness of a professional development workshop designed to encourage calculator use in the classroom. The study showed that the workshop alone was not nearly as useful in getting teachers to implement the changes in their classroom as letting the teachers who attended the workshop discuss and reflect together about how this might work in their specific classrooms.

Perhaps the lack of deep conversations involving pedagogy, students and mathematics is due to the fact that these conversations do not happen spontaneously. It is difficult and unnatural for teachers to reach levels of deep reflection, and without a conscience effort, their conversations will stay on a superficial level (Ward &McCotter, 2004).

In conclusion, we would hope that the literature could tell us that teachers (novice and practicing) are talking about and expanding their mathematical knowledge for teaching by making efforts to have meaningful conversations about the pedagogy, students and mathematics in their classrooms all of the time, but so far this is not the case. The literature has shown that student teaching programs are not focusing on the things we would want them to focus on, and that conversations about pedagogy, students, and mathematics are not happening the way we would want them to happen in student teaching programs or in the teaching profession in general. Teachers, including STs, need to be aware of the need and given the opportunity to talk about students, pedagogy and mathematics and how they relate in order to be good teachers with strong backgrounds in how to facilitate the learning of mathematical concepts for students effectively.

CHAPTER FOUR: METHODS

This section of my proposal describes the methods of my research study. I will begin by describing the context of the study, what type of data I used, and how they were useful in answering my research questions. I will then describe how these data were analyzed.

Context

This study analyzed conversations of STs and their CTs as they participated in the student teaching program as part of their studies in mathematics education at Brigham Young University. Because my study focused on comparing how the nature of conversations differs in different student teaching structures, two data sets were studied.

The first data set is of conversations between BYU STs and CTs from the year 1998, before the structure of the BYU student teaching program was re-conceptualized. The student teaching structure very much resembled a typical American student teaching program, which was described in my literature review. The first data set comes from a study that focused on studying the conversations held between 8 CTs and their STs(Peterson & Williams, 2001). The researchers administered a questionnaire to all CTs who had agreed to accept a ST during Fall Semester, 1998. Twenty five responded and from that 25 the researchers chose 8, attempting to balance the sample on level of school (high school vs. middle school). Each pair of participants was given a hand-held cassette recorder and a supply of tapes. They were asked to record any conversations they held that they expected to be over 5 minutes in duration. A total of 42 conversations, ranging from 1 per pair to 9 per pair, were recorded. These conversations were transcribed for analysis(Peterson & Williams, 2008).

The second data set is of conversations between STs and CTs from the years 2006 and 2007, the first two years after the structure of the BYU student teaching program was adjusted.

The changes to the structure were discussed in detail in my literature review, but generally the program was redesigned with a strong focus on the teacher practice of eliciting and using student thinking. The second data set contains conversations between 7 pairs of STs (3 pairs from 2006 and 4 pairs from 2007) and their 7 CTs. As in the 1998 study, the participants were given a hand-held cassette recorder and a supply of tapes and asked to record all potentially substantive conversations (5 minutes or more in length) among STs and between the STs and the CT. A total of 35 conversations, ranging from 1 per group to 6 per group, were recorded. These conversations had not previously been transcribed or analyzed.

As noted previously, the conversations that make up the data set for this study were spontaneous conversations between STs and CTs. University supervisors were not present for the conversations and STs and CTs were not instructed to talk about anything in particular. This study thus analyzed the casual, undirected conversations of the STs and CTs.

Data Analysis

I transcribed the conversations between STs and CTs and coded each statement according to the topic of that statement (using the PSM codes described in my theoretical framework). The unit of analysis for the conversations was one statement, or roughly one sentence. If a sentence did not make sense standing alone and could be clarified by being grouped with one or two other sentences, that group of sentences was considered as a single statement. The 1998 data had a total of 4,178 statements coded and the 2006-2007 data had a total of 4,907 statements coded.

Coding for What Teachers Talked About

Before diving in to coding I tested my coding scheme on one conversation from each year in a small pilot study. I found that the existing codes were able to accurately capture the types of statements in the conversations being coded. I then carried out the coding in a random order, assigning numbers to each ST and CT pair (in the 1998 data) or STs and CT cluster (in the 2006-2007 data) and then using a random number generator to decide the order, which switched randomly between the old and new data sets. I coded the entire set of conversations from one ST and CT pair or STs and CT group before moving on to the next one.

In addition to the initial level of PSM codes, another level of coding was conducted in an effort to more accurately capture what was being talked about in each statement. The ideas for possible sub-codes originally came from the coding scheme developed in the Leatham and Peterson (in press) study on reflection meeting conversations between STs ,CTs and university supervisors that was mentioned in my literature review. As I was initially coding the statements for the PSM codes I also considered if statements of a certain category (i.e. "Students and Mathematics" or "Pedagogy") fit into any of the sub-codes previously developed. If a statement did seem to fit with a previously developed sub-code then it was given that sub-code in addition to its PSM code. If a statement did not seem to fit with an existing sub-code then I developed a new sub-code for that statement to receive along with its PSM code. I made a conscious effort to keep an open mind while coding and be ready to develop a new sub-code if needed. For example, after coding a few transcripts, I realized that I needed a way to capture conversations that STs and CTs were having about how to operate a calculator. Talking about how to work a calculator is talking about a certain kind of mathematics, so the statement receives an M-code. My only mathematics sub-codes dealt with math facts, sense making, or how the teachers thought about mathematics. None of those sub-codes seemed to fit in this case so I developed a new sub-code that was used to capture statements of this type. When a new sub-code was developed I would go back through statements of the same PSM code that had been given a different sub-code to be sure that the new sub-code was not a more accurate fit. I was constantly coding and re-coding statements until all statements were coded with both a PSM code and an additional sub-code further describing the PSM code.

Once all of the statements were coded with a PSM code and an additional sub-code I looked across all statements of each sub-code individually to be sure the sub-codes were necessary (the same thing was not being said in another sub-code) and accurate (if two statements were given a particular sub-code then the statements were similar statements and should be grouped together).

Coding For How Teachers Talk About Pedagogy, Students, and Mathematics

The PSM codes and their sub-codes helped me to carry out my first layer of analysis, which answered questions of what and how often certain topics are talked about in each structure, but did not answer questions of *how* these topics are addressed. For example, both sets of data had statements that were PSM-coded and sub-coded as Teacher Response to Students. It was interesting that the 2006-2007 data had a significantly higher percentage of these statements than the 1998 data did. I could make the statement that after the student teaching structure was changed STs and CTs talked more about pedagogy, students and mathematics, specifically about how teachers respond to students' moves, but, while coding the data, I had noticed that often statements with the same PSM code and the same sub-code still *felt* very different. The way each statement talked about pedagogy, students and mathematics and the messages those statements sent about the STs or CTs views on mathematics teaching and learning varied greatly. *What* the STs and CTs were talking about was captured by the PSM codes and the additional sub-codes, but I had not captured *how* the STs and CTs were talking about those topics. It felt to me that the STs and CTs from the different structures were talking about these topics in different ways that were not captured in the initial levels of coding. The STs from each student teaching structure were getting opportunities to learn very different things based on *how* the topics of pedagogy, students, and mathematics were being discussed in each structure.

I needed a deeper level of analysis that could answer questions of how certain topics are talked about. I realized that carrying out this deeper level of analysis on all 9,000+ statements was beyond the scope of this project and made the decision to focus instead on a subset of the data. Because the focus of my research was on how STs and CTs talk about pedagogy, students and mathematics I chose to look more closely at all statements coded as "pedagogy, students and mathematics" (PSM-coded statements) in both sets of data, because looking at only those statements would still allow me to make claims about how the STs and CTs were talking about pedagogy, students, and mathematics individually.

There were 269 PSM-coded statements in the 1998 data and 1,004 PSM-coded statements in the 2006-2007 data. Looking at all 1,273 of these PSM-coded statements was still beyond the scope of the study, so I took a subset of about half (666 statements) of the PSM-coded statements to analyze more closely. This subset was chosen by organizing all of the PSM-coded statements first by speaker and then by the additional given sub-code, and then alphabetically. I then chose every other statement from each speaker, ensuring that each speaker and each sub-code and each conversation was proportionally represented in my sample. The subset of PSM-coded statements analyzed is slightly more than half because when a particular speaker's set of PSM-coded statements with a particular sub-code had an odd number of statements and exactly half of them couldn't be chosen I took an extra statement into my subset, rather than being one short.

Once the set of PSM-coded statements was gathered I began my deeper level of analysis. The way I accomplished my deeper level of analysis was by analyzing what each PSM-coded statement said about the speaker's view of pedagogy, students, and mathematics. I captured the views by recording one-sentence descriptions for each topic. For example, in one PSM-coded statement a ST said "And we could even ask them, if they just estimate we could say 'Well how else do you think you could check to see if that is right?'" This statement was assigned one sentence describing its views on pedagogy ("Teachers should encourage students to make sense of the mathematics."), one sentence describing its views on students ("Students are capable of sense making."), and one sentence describing its views on mathematics ("Mathematics is about sense making.").

After each statement from my PSM subset had associated sentences describing its' views on pedagogy, students and mathematics I looked across the whole list of sentences for pedagogy individually (and then students and mathematics) to make sure the sentences were necessary (the same thing was not being said in another sentence) and accurate (if two statements were described with a particular sentence, then the statements were similar statements and should be grouped together).

Once I had recorded a sentence to describe what each statement said about pedagogy, students, and mathematics individually I compiled the list of sentences for each topic (pedagogy, students , and mathematics) and grouped them into three groups: (1) sentences whose message about pedagogy, students, or mathematics were aligned with the ideas of ambitious teaching (as described in the theoretical framework), (2)sentences whose message about pedagogy, students, or mathematics aligned with traditional mathematical teaching, and (3)sentences whose message about pedagogy, students, or mathematics could support either traditional or ambitious teaching. I will give a few examples to illustrate the grouping process. The sentence describing a view about students, "Students can contribute meaningfully in class", was given to statements that emphasized the need for student thinking to be valued and used in the classroom. This sentence was included in the list of statements whose messages about students primarily aligned with the ideas of ambitious teaching because ambitious teaching promotes student-centered classrooms that build on and respond to student thinking. In contrast, the sentence describing a different view about students, “Students need clear examples and explanations to learn”, was given to statements that promoted the ideas that students can only understand mathematics if they are given clear, step-by-step instructions. This sentence was included in the list of statements whose messages about students primarily aligned with the ideas of traditional teaching because traditional teaching promotes teacher-centered classrooms that use lectures and examples to teach mathematics. Finally, the sentence about students “Students can’t learn on their own” was given to statements that emphasized the idea that students need support in order to be successful in mathematics classrooms. This sentence was included in the list of statements whose messages about students could support both ambitious and traditional mathematics teaching because the way that the teacher gave the student the support they needed would affect whether or not this view of students supported ambitious or traditional mathematics teaching. For example, if the speaker implied that students cannot learn on their own and should be working with other students around them giving and sharing mathematical ideas and sharing authority in the classroom then the speaker’s views on students would support the ideals of ambitious teaching. In contrast, if the speaker implied that students cannot learn on their own and must have support from the teacher, the sole authority in the classroom, then the speaker’s views on students would support traditional views of teaching mathematics. Because the sentence could be interpreted both ways the statement is considered neutral.

Once the sentences were sorted into the three categories of ambitious teaching, traditional teaching, and neutral, I was able to sort them into bigger categories that related to each other and come up with a succinct list of attitudes and ideas about pedagogy, students, and mathematics that supported each type of teaching (see Figure 1).After sorting the sentences into these categories I was able to analyze how STs and CTs were talking about each subject of pedagogy, students and mathematics by capturing what their PSM-coded statements tended to say about pedagogy, students, and mathematics individually.

Topic	Traditional Mathematics Teaching	Ambitious Mathematics Teaching	Neutral
Pedagogy	Teachers must give clear explanations and examples.	Teachers should understand and use student mathematical thinking.	Teachers should do their best and expect the same from their students.
	Teachers should expect students to memorize and reproduce learned definitions and procedures.	Teachers should expect students to actually think on their own about mathematics.	Teachers should help students gain correct knowledge.
		Teachers should push students to think about more than just correct answers.	Teachers must not make students struggle unnecessarily.
			Teachers need students to encourage students to cooperate in order for learning to occur.
Students	Students need clear examples and explanations that they can easily follow in order to learn.	Students are capable of thinking about and making sense of mathematics.	Students are capable of learning mathematics.
	Students often simply forget mathematics concepts and need to be reminded.	Students do not all think about mathematics in the same ways.	Students need to know that they are cared for and a lot is expected of them.
	Students should rarely do "hands on" mathematics activities because they are difficult to manage.	Students and their thinking should influence what happens in the classroom.	Students sometimes have a difficult time learning mathematics.
			Students can have issues being motivated to do mathematics.
Mathematics	Mathematics can be told.	Mathematics can be thought about in many different ways.	Mathematics sometimes uses calculators.
	Mathematics is a set of rules to be copied.	Mathematics should be made sense of.	Mathematics sometimes is exciting.
	Mathematics is meant to be memorized and reviewed.		Mathematics is not always easy to understand.

Figure 1. Categories of how PSM-coded statements talked about pedagogy, students, and mathematics.

In addition to capturing how STs and CTs talked about pedagogy, students, and mathematics, I was also interested in the strength and specificity of the mathematics of each statement because I noticed that, although all statements that contained some sort of mathematics were M-coded, I had not captured whether or not the statements were actually about mathematics or just using mathematics as a context. In order to capture this strength I gave each PSM-coded statement in my subset a code to identify whether the mathematics in the statement was talking about a specific piece of mathematics (e.g., "Ask them what the 1 stands for and if they say it's a 1 they don't understand carrying because it's not a 1, it's a 10."), a general mathematical topic or concept (e.g., "Then in response we could ask them to write a table for their equation."), or just using the mathematics as a context (e.g., "If I wanted students to put their graphs on the board for everyone to see how could I do that?"). This coding helped me get at how STs and CTs talked about mathematics by identifying the specificity of the mathematics in the statements.

Both levels of analysis (coding for "what" and coding for "how") were necessary to answer my research questions of how conversations in each student teaching structure vary in terms of what the STs and CTs are talking about (PSM codes and additional sub-codes), and how those topics are discussed (strength of the M-code and what the PSM-coded statements say about their views on pedagogy, students, and mathematics). Once I had the statements coded I was able to use the code counts to characterize and describe the conversations from each student teaching structure.

In my analysis I found that none of the percentages of statements given a specific code were the exact same in both data sets. When comparing the conversations in each data set I had to decide which differences in the percentages of codes between the 1998 data and the 2006-2007 data were important and which were trivial, so I developed the following method: When comparing the proportions of statements given a specific code, I divided the larger proportion by the smaller. If this percentage was greater than 150% then the changes were considered sufficiently compelling (one being at least half again as big as the other) and they were discussed in the results chapter. If the changes were not greater than 150%then I determined that the increase or decrease in the proportion of statements given that specific code was minor and assumed the proportions for each year could be considered similar.

An example of this method of comparing proportions of codes from the 1998 data to proportions of codes in the 2006-2007 data can be found in Figure 3. In this figure columns D and F show the proportion of statements given an M, P, or S code in the 1998 data and the 2006-2007 data. Column G shows what percent column F is of column D. The first row of values, statements given an M code, show that the proportion of statements given an M code more than doubled from the 1998 data to the 2006-2007 data and the proportion of the 2006-2007 data was 227% the size of the statements given an M code in the 1998 data. Because this proportion falls outside of the 75-150% range this difference should be noted. By contrast, the second and third row of values show the different proportions of statements given a P and S code in both data sets. Again, column G shows that the proportion of statements given a P or S in the 2006-2007 is just about 95% of the proportions given a P or S in the 1998 data. Given that these proportions fail to fall outside of the required 75-150% range, the proportions are considered to be similar. This means that in my discussion of the results I made the decision to consider the proportion of statements given a P or S code in the 1998 data comparable to the proportion of statements given the same codes in the 2006-2007 data. The results of all levels of coding that met the described conditions will be discussed in the next chapter.

A	B	C	D	E	F	G
		1998		2006-7		
		Count	Proportion	Count	Proportion	
P, S, M	M	1160	0.2776448	3096	0.6309354	227.25%
	P	3618	0.8659646	4025	0.8202568	94.72%
	S	2020	0.4834849	2259	0.4603627	95.22%
	Total	**4178**		**4907**		

Figure 2. Determining the importance in the difference of proportions between data sets.

CHAPTER FIVE: RESULTS

The results section has three main areas of focus. The first section focuses on the results I found pertaining to my first research question, which asked *what* the STs and CTs talked about in each student teaching structure. The results discussed here will be strictly about how often the topics pedagogy, students, and mathematics were talked about in each student teaching structure. This section concludes with a comparison of the statements made by CTs to statements made by STs within each student teaching structure. The second section of this chapter focuses on the second part of my research question, which asked *how* the topics of pedagogy, students, and mathematics were discussed. Similarly, I end this section with a comparison of the statements made by CTs to statements made by STs. Finally, I finish the chapter by discussing how differences in the nature of conversations related to conversations about classroom management.

What They Talked About

A total of 4,178 statements across the 1998 conversations and 4,907 statements across the 2006-2007 data were coded with some combination of the PSM codes. Overall the percentage of conversations involving pedagogy (P, PS, PM, and PSM-coded statements) and students (S, SM, PS, and PSM-coded statements) in both data sets were comparable, but the percentage of conversations about mathematics (M, SM, PM, and PSM-coded statements) increased drastically in the 2006-2007 data (see Table 1).

Table 1

Percent of Statements With Some Pedagogy, Students, or Mathematics

	Student Teaching Structure	
Topic	1998	2006-2007
Pedagogy	87%	82%
Students	48%	46%
Mathematics	28%	63%

In both the 1998 data and the 2006-2007 data the vast majority of the statements were about pedagogy in some way. Both data sets tended to talk about students in some way about half of the time. At this level of coding, the differences in the conversations between the 1998 data and the 2006-2007 data show up in the frequency of statements about mathematics. In the 1998 conversations less than a third of all statements were about mathematics in some way, but in the 2006-2007 data that percentage almost two thirds of all statements were about mathematics in some way.

These similarities and differences in the frequencies of the broad topics of pedagogy, students, and mathematics are interesting and can be further explained by analyzing the distributions of the PSM-codes. Table 2 and Figure 3 show the breakdown of the statements by these codes.

Table 2

Percentages of PSM Codes by Student Teaching Structure

	Student Teaching Structure	
Topic	1998	2006-2007
Pedagogy	34%	19%
Students	7%	3%
Mathematics	3%	8%
Pedagogy Students	32%	16%
Pedagogy Mathematics	15%	27%
Students Mathematics	3%	7%
Pedagogy Students Mathematics	6%	20%

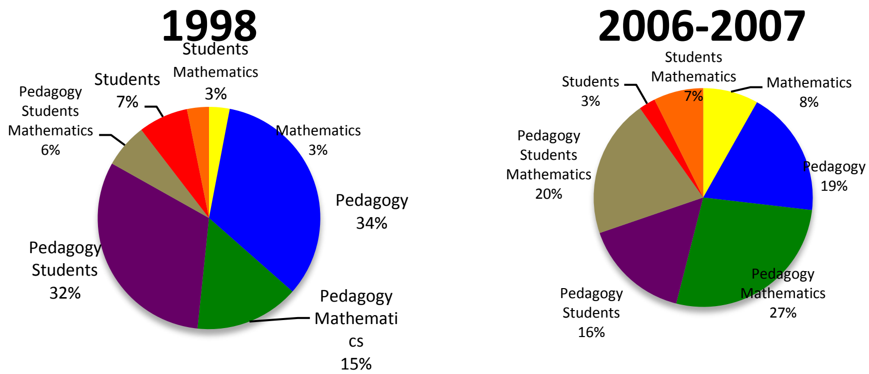

Figure 3. A comparison of the PSM codes of all statements in both data sets.

The distributions of the PSM codes show that STs and CTs in the traditional student teaching structure were talking about combinations of pedagogy, students, and mathematics at very different frequencies than the STs and CTs in the reformed student teaching structure. In the traditional student teaching structure statements were most commonly (over 60% of the time) given the P-code or the PS-code. STs and CTs tended to talk most often about pedagogy and students, without talking about mathematics. STs and CTs in the reformed student teaching structure made P-coded and PS-coded statements too, but not nearly as often (about 35% of all comments).

The most common codes in the reformed student teaching structure were PM and PSM (making up about 50% of all statements). These STs and CTs were talking about pedagogy while also talking about how it interacted with mathematics and students. The traditional student teaching structure had statements about the interactions of pedagogy with students and mathematics, but only about 20% of the time.

Statements about students or how students interacted with mathematics made up 10-11% of all statements in both student teaching structures, but with an important difference. In the traditional student teaching structure this 10% was made with about 7% of the statements strictly about students and the other 3% about students' interactions with mathematics. In the reformed student teaching structure those percentages were reversed, with only 3% of the statements strictly about students and 8% of the statements being about student and mathematics.

In the 1998 student teaching structure statements strictly about mathematics were the least common (only about 3%). This percent almost tripled in the 2006-2007 data with about 8% of all statements strictly about mathematics.

These differences in the frequencies of the PSM codes show that the CTs and STs of the reformed student teaching structure were much more likely not only to have more conversations about mathematics, but also to have conversations about the interactions mathematics with pedagogy and students. Thus far, the data has shown that CTs and STs in the traditional student teaching structure are talking about the broad categories of pedagogy, students, and mathematics at different frequencies, but the question of whether or not the conversation within each PSM code look the same for each student teaching structure still remains. The sub-codes given to each of the PSM codes can give a better characterization of the similarities and differences between the two student teaching structures.

Pedagogy

Pedagogy was the most common code given in the 1998 data, with 33.51% of all statements (1,400 statements) P-coded. Only 18.67% of the statements (916 statements) were P-coded in the 2006-2007 data.

Eight sub-codes were developed in an effort to better capture what STs and CTs were talking about when they talked about pedagogy (see Figure 4). The eight sub-codes were then grouped into categories of codes about lesson organization, codes about teacher actions, and codes about teaching ideas in general. It is important to note that because these statements were given a "pedagogy" code without a "students" or "mathematics" code, each of the statements describe lessons organization, teacher actions, or general teaching perspectives without any reference to students or mathematics. P-coded statements about lesson organization tended to be about ordering and executing lessons for logistical reasons like time or convenience, not because of students or mathematics. The moves, responses and emotions of the teachers discussed in statements coded as some type of teacher action were solely about the teacher, without any implied interaction with the students and the mathematics. Statements about teaching in general only commented on the teachers' roles, not on how a teacher may interact with the students or the mathematics.

Category	Code	Definition	Example
Lesson Organization	**Lesson (L)**	These statements were about past or future lessons.	"I only want to spend 10 minutes on questions and grading the homework."
	Curriculum (CUR)	These statements were about the ordering and sequence of units and lessons.	"If we spend a day on 3.2 we could test on a Friday."
	Planning (PL)	These statements talked about the need to plan a lesson or scheduling of when to plan a particular lesson together.	"Can we talk about 4.2 tomorrow before school?"
Teacher Actions	**Teacher Move (TM)**	These statements were about a move or decision that teachers made.	"I gave each Table their own worksheet."
	Thinking Associated with Teacher Move (TAT)	These statements are when the teachers went beyond merely stating their move as teachers and began talking about the reasoning behind their moves	"We could put the [homework] on the overhead so we don't have to waste time [reciting them out loud]."
	Teacher Affect (TA)	These statements talked about the feelings and emotions of the teachers and described the teachers as excited, nervous, frustrated, stressed, pleased, etc.	"I feel so flustered when I try to [take roll] at the beginning when everything is happening, but then I forget to later."
General Teaching	**Teacher Philosophy (TP)**	These statements talked about a general philosophy or attitude that a particular teacher takes towards teaching. These statements are more general than a teacher move and tend to give a generalized opinion of how to handle a category of situations.	"The teacher doesn't always have to be at the front of the classroom. You can move around and even stand in the back!"
	Learning to Teach (LT)	These statements were about an attitude or move that the STs would learn or become better at over time.	"You'll get better [at watching the clock]; it's something you'll pick up when you're not feeling so flustered."

Note: A similar sub-code of planning was developed in the Leatham and Peterson (2012) data, but the planning sub-code in that data referred to any statement that was about thinking or planning that happened before the lesson. Because so many of my conversations were entire conversations happening before the lesson was taught it did not make sense to include that definition. Initially I took the PL sub-code out entirely, but then found that it was necessary to capture a different type of statement about planning, which is when STs and CTs are talking about a need to plan particular aspects of their lessons.

Figure 4. Definitions and examples of P-coded statements.

The distributions of the sub-codes for P-coded statements in both the 1998 data and the 2006-2007 data are very similar (see Figure 5 and Table 3). Overall, when STs and CTs in both student teaching structures talked about the topic of pedagogy, they talked about essentially the same things.

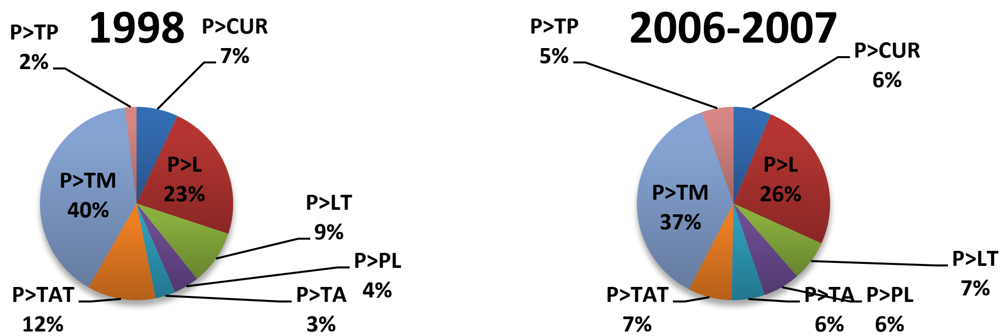

Figure 5. Distributions of the sub-codes of P-coded statements.

Table 3

Distributions of Sub-Codes of Pedagogy

		Student Teaching Structure	
Category	Code	1998	2006-2007
Lesson Organization		34%	38%
	Lesson	23%	25%
	Curriculum	7%	6%
	Planning	4%	6%
Teacher Actions		55%	50%
	Teacher Move	40%	37%
	Thinking Associated with Teacher Move	11%	7%
	Teacher Affect	3%	6%
General Teaching		11%	12%
	Teacher Philosophy	2%	5%
	Learning to Teach	9%	7%

None of the differences in frequencies of the P-coded topics between the two student teaching structures were significant according to the rule outlined in the methods chapter. Remember, this is not to say that the way the STs and CTs talked about pedagogy in both years was necessarily the same, just that when STs and CTs from each structure talked about pedagogy, the pedagogical topics were discussed with basically the same frequencies.

Students

7.23% of all the 1998 statements (302) were coded as strictly about students (S-coded) whereas only 2.47% of statements (121 statements) were given this code in the 2006-2007 data.

Three sub-codes were given to statements coded as "students" (see Figure 6). The statements being discussed here were coded strictly as "students", with no "pedagogy" or "mathematics" code, so it is important to note that the actions, engagement, and affect of the students had no influence from the mathematical and pedagogical aspects of the classroom.

Code	Definition	Example
Description of Action (DA)	These statements described a student move or action.	"Michael used pen on his homework."
Engagement (E)	These statements went beyond describing the action of the student to commenting on how engaged a student was in the daily activities of the classroom.	"Half the class was packed up and standing at the door when they should have been working on their homework."
Affect (A)	These statements were about the emotions or feelings of the students in the classroom.	"She was so nervous to come to the board."

Figure 6. Definitions and examples of S-coded statements.

The distribution of the sub-codes in the 1998 and 2006-2007 data have some similarities (see Figure 7). Both data sets have the same percentage of statements describing the (non-mathematical) actions of students and such statements make up about two thirds of the S-coded statements.

Figure 7. Distributions of the sub-codes of S-coded statements.

There are some interesting differences as well in the conversations about students. One major difference is the decrease in statements about students' engagement (and corresponding increase in statements about students' affect) in the 2006-2007 data. The 2006-2007 data had only 26% of the amount of S-coded statements given the engagement sub-code that the 1998 data did. This decrease is an interesting difference when considering the nature of the engagement sub-code. Because this code was given to statements coded strictly as "students" with no "pedagogy" or "mathematics" code, these statements only commented on the general engagement of the students, with no reference to the pedagogical moves or mathematics that the student should be engaged in. As a result, these statements were most often about the poor behavior of students, with occasional contrast of students behaving well. The reformed student teaching structure encouraged STs to focus on students and mathematics—to have conversations about students' engagement in the classroom that focused on mathematics. This type of statement would not be captured here, and so the decrease in the percent of statements about student engagement provides evidence that the structure was accomplishing its purpose.

In conclusion, the STs and CTs in the 1998 student teaching program talked about students (without talking about pedagogy and mathematics) about three times as much (about 7.2% of all statements) as STs and CTs in the 2006-2007 student teaching program did (about

2.5%). When STs and CTs from both data sets were talking about students their conversations topics were usually the same (description of action), with slight differences in the frequencies of some of the less-talked-about topics (engagement and student affect).

Mathematics

Only 2.99% (125 statements) of the statements made in the 1998 data were strictly statements about mathematics (M-coded). The M-coded statements in the 2006-2007 data more than doubled that with 8.1% (about 401) of all statements given this code.

Four sub-codes were developed to describe the M-coded statements (see Figure 8).

Code	Definition	Example
Math Fact (MF)	These statements gave a basic math fact or true statement in mathematics.	"Linear equations with the same slope are always parallel."
Sense Making (SM)	These statements went beyond stating a math fact to giving reasoning behind a math concept or explaining how to make sense of a specific concept.	"Well [asymptotes in the denominator] happen because you can't divide by 0 so think about the denominator in a fraction, it's how many pieces [are in the whole]. You can't have 0 pieces."
Teacher Math (TM)	These statements were given when STs or CTs shared the way they thought or think about mathematics. In these statements it was almost as if the teacher became the student, explaining the way they experienced learning math.	"I had never seen the fish thing, that's not how I solved proportions at all. I always just solved for x using algebra."
Calculator (CALC)	These statements described how to use a calculator or what functions are available on a calculator.	"Then the trace function will let you walk up and down the graphed curve and show you the values along the way."

Figure 8. Definitions and examples of sub-codes for M-coded statements.

The distributions of the sub-codes in both sets of data have similarities (see Figure 9). The frequencies of M-coded statements about math facts in both student teaching structures are exactly the same (57% of all mathematics statements). The frequencies of mathematics statements about sense making are also the same in both data sets (7% of all mathematics statements).

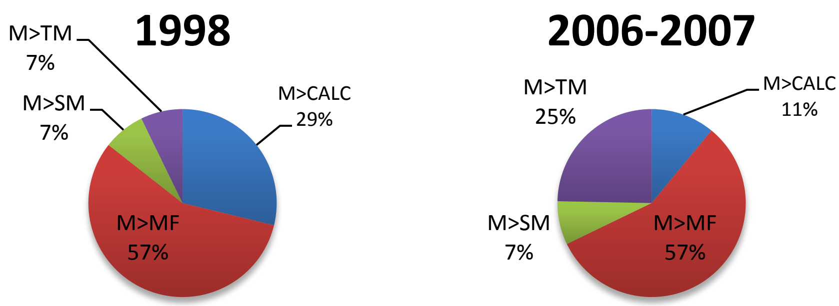

Figure 9. Distributions of the sub-codes of M-coded statements.

One interesting difference between the two data sets is that the 1998 data talked about calculators and their functions and uses almost three times as often as the 2006-2007 data. One explanation for this decrease in M-coded statements about calculators is that using graphing calculators in the schools was a new thing while the 1998 data was being collected. Often one of the people in the conversation had never used the calculator to do a specific operation and so the statements were given the calculator code as one speaker would explain how to use the calculator to the other speaker. It may be that conversations of this type did not occur as frequently in the 2006-2007 data because by this time both the CTs and the STs had worked with graphing calculators and were more familiar with their operations and uses.

Another interesting difference between the two data sets' conversations about mathematics is the increase in conversations about the teachers' mathematics (about 18%) in the 2006-2007 data compared to the 1998 data. This is an interesting difference because the reformed student teaching program encouraged a focus on students and mathematics, and the literature has shown that teachers talking to each other about how they know and think about mathematics is an important step in teachers getting students to think and know about mathematics in similar ways (Horn, 2005, Rust, 1999). These conversations about teachers' math are valuable.

In conclusion, not only did the frequency of conversations about mathematics increase drastically from the 1998 student teaching structure to the 2006-2007 student teaching structure (less than 3% to over 8%), but the conversation topics improved slightly as well. Most of the time the STs and CTs from each structure talked about the same things when talking about mathematics (math facts and sense making), but the 2006-2007 STs and CTs spent more time talking about the teachers' understanding of mathematics while the 1998 STs and CTs spent that time talking about how to use a calculator.

Pedagogy and Students

The 1998 data had almost as many statements coded as "pedagogy and students" (PS-coded) as it did P-coded, with 31.5% of all statements (1316 statements) given this code. The 2006-2007 data only had about half as many PS-coded statements, with 15.77% of all statements (774 statements) given this code.

Five sub-codes were developed to better describe what was being talked about in PS-coded statements (see Figure 10). The five sub-codes were then grouped into categories of codes about specific student and teacher interactions and codes about general student and teacher interactions. It is important to remember that the student and teacher interactions in these statements (whether specific or general) always happened outside of the mathematics, because none of these statements received mathematics codes.

Category	Code	Definition	Example
Specific Student/Teacher Interactions	**Student Response to Teacher (SRT)**	These statements described actual or potential interactions between students and teachers, specifically how a student responded to a teacher's move.	"Well after I told him to sit down he didn't get up again the rest of class, it was great."
	Teacher Response to Student (TRS)	These statements described actual or potential interactions between students and teachers, specifically how a teacher responded to a student's move.	"I didn't understand what she said so I guessed. I probably should have kept asking questions though."
General Student/Teacher Interactions	**About Teacher Move (ATM)**	These statements described the reasoning behind teacher moves when that reasoning was because of the students in some way. This code was different than TRS because instead of responding to a specific student action it is making decisions based off of what students in general needed.	"They need time to think. That's why I always tell them to not say anything out loud for a few seconds."
	About Student Thinking (AST)	These statements involved the teacher evaluating or analyzing student thinking.	"I didn't expect them to work so hard and be so excited about [working in groups]."
	Learning to Teach (LT)	These statements were about an attitude or move that the teachers would learn or become better at over time.	"You get better at having that eye in the back of your head and knowing what [the students] are doing at all times, it will come with practice."

Note: The difference between the SRT and TRS code was sometimes trivial. Some statements would contain long strings of teacher/student actions and reactions and the decision to code the statement as SRT or TRS would be made by which action (student or teacher) came last in the statement.

Figure 10. Examples and definitions of sub-codes for PS-coded statements.

The distributions of the sub-codes for both the 1998 data and the 2006-2007 data are almost identical (see Table 4 and Figure 11). When STs and CTs from both data sets made PS-coded statements, they were most often talking about specific interactions between students and teachers (91% of all pedagogy and students statements). STs and CTs from both data sets talked about general student and teacher interactions in only 10% of all statements about pedagogy and students. The differences in the sub-codes that fall under general student and teacher interactions are negligible.

Table 4

Distributions of Sub-Codes of Pedagogy and Students

		Student Teaching Structure	
Category	Code	1998	2006-2007
Specific Student/Teacher Interactions		91%	91%
	Student Response to Teacher (SRT)	42%	42%
	Teacher Response to Student (TRS)	49%	49%
General Student/Teacher Interactions		9%	9%
	About Teacher Move (ATM)	5%	6%
	About Student Thinking (AST)	3%	2%
	Learning to Teach (LT)	1%	1%

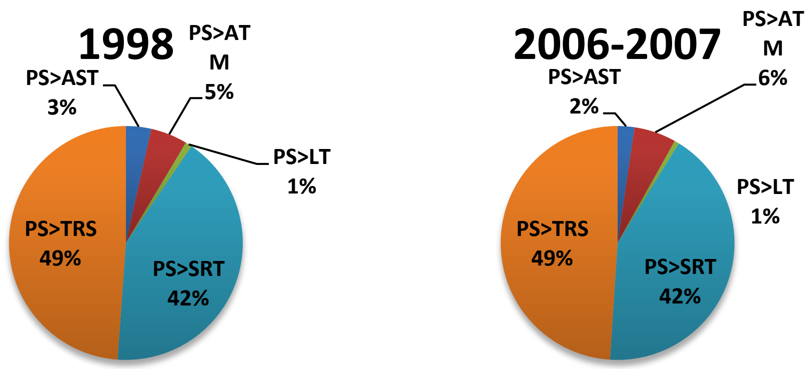

Figure 11. Distributions of the sub-codes for PS-coded statements.

In conclusion, when STs and CTs were talking about pedagogy and students (and not mathematics) in both student teaching structures they were talking about the same topics, and most often they were talking about the specific interactions between students and teachers. The frequency of such statements, however, occurred half as often in the conversations among the 2006-2007 STs and CTs (about 15% of all statements) compared to the conversations among the 1998 STs and CTs (about 30% of all statements).

Pedagogy and Mathematics

15.15% of all statements (633 statements) in the 1998 data were about both pedagogy and mathematics (PM-coded), making it the third most common type of statement in the 1998 data. By contrast, this was the most common code for the 2006-2007 data, almost doubling the amount of PM-coded statements in the 1998 data, with 27.12% (1331 statements) of all statements PM-coded.

The seven sub-codes developed for statements given the PM-code were very similar to the sub-codes developed for the P-coded statements except, obviously, they now included ideas about and interactions with the mathematics (see Figure 12). An interesting difference between the two sets of sub-codes is that the Learning to Teach (LT) code, which made up about 8% of the statements strictly about pedagogy in each year, was not a useful code for PM-coded statements. STs and CTs did not tend to make statements about the progression of teaching ability over time when they were talking about teaching mathematics rather than just teaching in general.

Category	Code	Definition	Example
Lesson Organization	**Lesson (L)**	These statements were about past or future lessons.	"The lesson starts off with a review of fractions, which will help later on in the lesson."
	Curriculum (CUR)	These statements were about the ordering and sequence of units and lessons.	"We don't talk about slope in this class; it's not in the curriculum."
	Planning (PL)	These statements talked about the need to plan a lesson or scheduling of when to plan something together.	"We need to make a worksheet for linear equations; can we work on that tomorrow morning?"
Teacher Actions	**Teacher Move (TM)**	These statements were about a move or decision that teachers made.	"I wrote both equations on the board next to each other and left them there through all of class."
	Thinking Associated with Teacher Move (TAT)	These statements are when the teachers went beyond merely stating their move as teachers and began talking about the reasoning behind their moves	"We wanted to not make the adding and subtracting the hard part [so we decided to set out calculators]."
	Teacher Affect (TA)	These statements talked about the feelings and emotions of the teachers and described the teachers as excited, nervous, frustrated, stressed, pleased, etc.	"I am scared to teach [a specific method for adding large numbers] because I don't think I'm exactly as confident as I should be with it."
General Teaching	**Teacher Philosophy (TP)**	These statements talked about a general philosophy or attitude that a particular teacher takes towards teaching. These statements are more general than a teacher move and tend to give a generalize opinion of how to handle a category of situations.	"Teaching math is much harder than people think if you do it right. You really shouldn't be just ignoring everything and giving a lecture."

Figure 12. Definitions and examples of the sub-codes for PM-coded statements.

The distributions of the sub-codes of PM-coded statements had some similarities (see Table 5 and Figure 13). In both data sets PM-coded statements talked most frequently about lesson organization (over 60% of all pedagogy and mathematics statements in each data set). About half of all PM-coded statements were given the sub-code of lesson, meaning that when STs and CTs from both student teaching structures talked about pedagogy and mathematics they talked about what happened or would happen in their daily lessons.

Table 5

Distributions of Sub-Codes of Pedagogy and Mathematics

		Student Teaching Structure	
Category	Code	1998	2006-2007
Lesson Organization		69%	60%
	Lesson	56%	53%
	Curriculum	9%	5%
	Planning	3%	1%
Teacher Actions		29%	39%
	Teacher Move	20%	29%
	Thinking Associated with Teacher Move	9%	9%
	Teacher Affect	1%	1%
General Teaching		2%	1%
	Teacher Philosophy	2%	1%

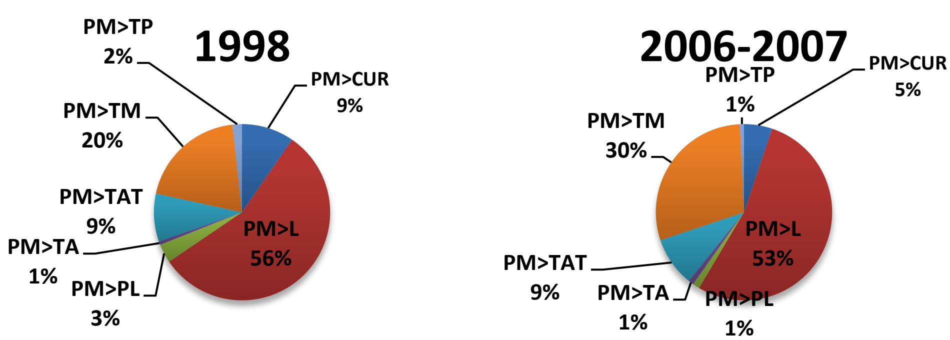

Figure 13. Distributions of the sub-codes for PM-coded statements.

One interesting difference in the PM-coded statements between the two years is the shift in percentages from lesson organization to teacher actions. In the 1998 data about 70% of all PM-coded statements were about lesson organization and about 30% of all PM-coded statements were about teacher actions. In the 2006-2007 data those percentages shifted a bit so about 60%

of all PM-coded statements were about lesson organization and about 40% of all PM-coded statements were about teacher actions. This difference is interesting because it shows that STs and CTs in the reformed student teaching program were more likely to talk about their moves and the reasons behind their moves than just talking about lesson organizations. This is especially encouraging considering that these statements received a mathematics code as well as a pedagogy code and so the teachers in the 2006-2007 data were more likely to be talking about the mathematical reasoning behind their moves than to just comment on pieces of the lesson, which is a change that would have been hoped for in the reformed student teaching program.

In conclusion, the 2006-2007 STs and CTs nearly double the amount of statements about pedagogy and mathematics compared to the 1998 STs and CTs (15% compared to 27%), and when STs and CTs were talking about pedagogy and mathematics in both years they were usually talking about the same types of things and both tended to be making statements about past or future lessons. The differences in conversation topics from the 1998 STs and CTs to the 2006-2007 STs and CTs showed that teachers in the 2006-2007 student teaching structure were more likely to be talking about their mathematical moves and reasoning, which was a desired consequence of the reformation of the student teaching program.

Students and Mathematics

In the 1998 data only 3.18% (133 statements) of the statements were about both students and mathematics (SM-coded). The 2006-2007 data more than doubled that with 7.34% (360 statements) of all statements SM-coded.

Three sub-codes were developed to describe how STs and CTs talked about the statements given the SM-code (see Figure 14).

Code	Definition	Example
Previous Knowledge and Experience (PKE)	These statements describe what students know or should know about mathematics from past lessons, either in class with the current teacher or in previous grades.	"They've done a lot with slope, that word shouldn't be new to them."
Range of Responses (R)	These statements describe the way students think about mathematics.	"They got it fast. They didn't have any trouble at all with solving [the proportion]."
Point of Confusion (PC)	These statements went beyond describing the way students think about mathematics to describing a specific misconception or obstacle in understanding that students may have.	"He thought division should always make [the answer] smaller so he thought he was wrong."

Figure 14. Definitions and examples the sub-codes for SM-coded statements.

The distributions of these sub-codes in both years show some interesting differences (see Figure 15). For example, in the 1998 data the amount of students and mathematics statements coded as range of response and as point of confusion are about the same (just over 40%), but in the 2006-2007 data the percentage of statements about the students' responses increased about 15% and the percentage of statements about student misconceptions dropped about 20%. It seems that the STs and CTs in the 1998 data felt that when talking about students and mathematics it was equally important to talk about interesting student responses as it was to talk about the misconceptions of students. In the 2006-2007 data it seems that STs and CTs talked about how students are thinking and understanding the math more often than how they were misunderstanding the math. In the reformed student teaching structure the STs and CTs were more interested in talking about how their students were interpreting the mathematics correctly.

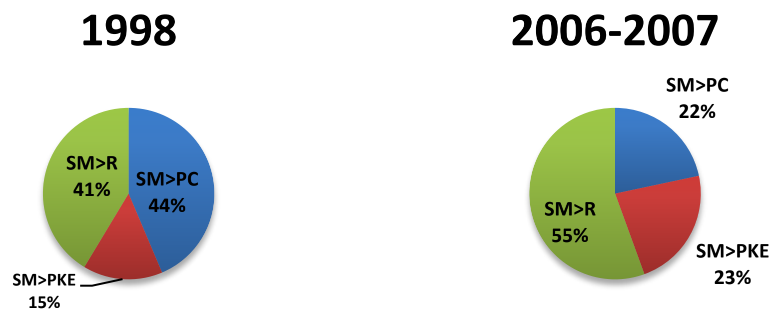

Figure 15. Distributions of the sub-codes for SM-coded statements.

Another interesting difference in SM-coded statements between the two data sets is the increase in statements about the students' previous knowledge and experiences from the 1998 data to the 2006-2007 data (about 151% increase from 1998 to 2006-2007). This increase in statements coded as PKE is interesting because an important aspect of the reformed student teaching program was to get STs to consider students' mathematics when teaching and in order to do this STs would need to know and build on the students' existing knowledge. The increase in conversations about students' previous knowledge and experience is encouraging.

In conclusion, the frequency of statements about students and mathematics more than doubled from the 1998 STs and CTs (about 3% of all statements) to the 2006-2007 STs and CTs (more than 7% of all statements). Not only were there more conversations about students and mathematics in the 2006-2007 student teaching program, but also the statements that were made tended to show more of an effort to understand and discuss students' background mathematical knowledge in the reformed student teaching structure.

Pedagogy, Students and Mathematics

The statement type that differed the most in terms of frequency between the two student teaching structures was statements coded as pedagogy, students and mathematics (PSM-coded). The1998 data only had 6.44% of all statements (269 statements) PSM-coded. The 2006-2007 data, however, had about three times that amount with 20.46% (1004 statements) of all statements given this code. To further illustrate the difference in frequencies it interesting to note that when ordering the types of statements (the PSM codes) in the 1998 data by percent of all statements, PSM-coded statements fall into the bottom three categories (with the only categories with lower percentages being M-coded statements and SM-coded statements, each at about 3% of all statements). In contrast, when ordering the 2006-2007 data in the same way, PSM-coded statements are the second biggest percentage of all statements, following closely behind PM-coded statements (which make up 27% of all statements). This means that PSM-coded statements were not very common in the traditional student teaching structure, but became a main conversation topic in the reformed student teaching structure.

The four sub-codes developed for PSM-coded statements are similar to the sub-codes developed for PS-coded statements, but have the added interaction with mathematics (see figure 16).

Category	Code	Definition	Example
Specific Student/Teacher Interactions	**Student Response to Teacher (SRT)**	These statements described actual or potential interactions between students and teachers, specifically how a student responded to a teacher's move in the presence of mathematics.	"They really liked the example I showed them about the slope, it really helped them to see one more example of that."
	Teacher Response to Student (TRS)	These statements described actual or potential interactions between students and teachers, specifically how a teacher responded to a student's move in the presence of mathematics.	"He didn't seem to know what was going on so I asked him 'Do you know why we can't divide by 0?'"
General Student/Teacher Interactions	**About Teacher Move (ATM)**	These statements described the reasoning behind teacher moves when that reasoning was because of the students and mathematics in some way. This was different than TRS because instead of responding to a specific student action it is making decisions based off of what students in general needed in the presence of mathematics.	"We're doing it on the overhead calculator because students sometimes need to see the graphs and the tables changing together to understand what's going on."
	About Student Thinking (AST)	These statements involved the teacher evaluating or analyzing student mathematical thinking.	"I thought the one using similar triangles to measure the distance to the moon would be too hard for them."

Figure 16. Definitions and examples of the sub-codes for PSM-coded statements.

Again, learning to teach (LT), which was included as a sub-code for PS-coded statements was not a useful sub-code in statements that also talked about mathematics. STs and CTs did not tend to make statements about the progression of teaching ability over time when they were talking about teaching students mathematics rather than just teaching students in general. A handful of PSM-coded statements were given the sub-code of LT, but the number of such statements was so small that LT was not considered a useful sub-code for PSM-coded statements and those LT statements were given another sub-code instead, depending on what part of teaching the statement was talking about learning.

The distribution of sub-codes among the PSM-coded statements is interesting (see Table 6 and Figure 17).

Table 6

Distributions of Sub-Codes of Pedagogy and Students

		Student Teaching Structure	
Category	Code	1998	2006-2007
Specific Student/Teacher Interactions		51%	77%
	Student Response to Teacher (SRT)	33%	51%
	Teacher Response to Student (TRS)	18%	26%
General Student/Teacher Interactions		49%	23%
	About Teacher Move (ATM)	17%	7%
	About Student Thinking (AST)	32%	16%

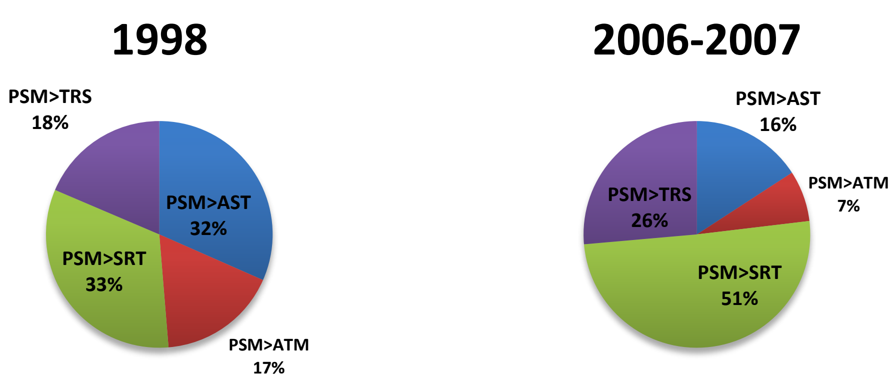

Figure 17. Distributions of the sub-codes of PSM-coded statements.

The fact that the distributions of sub-codes in PSM-coded statements were so vastly different from the traditional to reformed student teaching structure was surprising considering the sub-codes of all other PSM codes were generally similar, with only occasional differences. The main difference between the distributions of PSM-coded sub-codes between the two data sets is that in the 1998 data the STs and CTs only talked about specific interactions between students and teachers about half the time, but in the 2006-2007 data that frequency increased to more than ¾ of the all PSM-coded statements being about these specific interactions. STs and CTs in the reformed student teaching program spent significantly more time talking about actual specific interactions with students and teachers in the latter data than talking about general influences of students and mathematics on their pedagogy.

In conclusion, the frequency of statements simultaneously about pedagogy, students and mathematics showed a drastic increase from the conversations of STs and CTs in the traditional student teaching structure from the 1998 data (about 6% of all statements) to the STs and CTs in the reformed student teaching structure in the 2006-2007 data (about 20% of all statements). Not only did the frequency of these statements increase, but the data also shows that when STs and CTs in the reformed student teaching structure talked about pedagogy, students and mathematics simultaneously they were more likely to talk about specific actions and interactions between students and teachers with the mathematics rather than general comments about these topics.

Comparing ST and CT Conversation Contributions

My analysis focused on comparing the conversations of STs and CTs in a traditional student teaching structure to the conversations of STs and CTs in a reformed student teaching structure. Throughout the discussion of my results I characterized conversations from each student teaching structure without distinguishing between statements by STs and statements by

CTs. One might ask whether such a grouping masks differences between ST and CT contributions within a given structure. In order to address this concern I divided the statements made by STs from the statements made by CTs so I could analyze the differences in the distributions of the PSM-codes (See Figure 18).

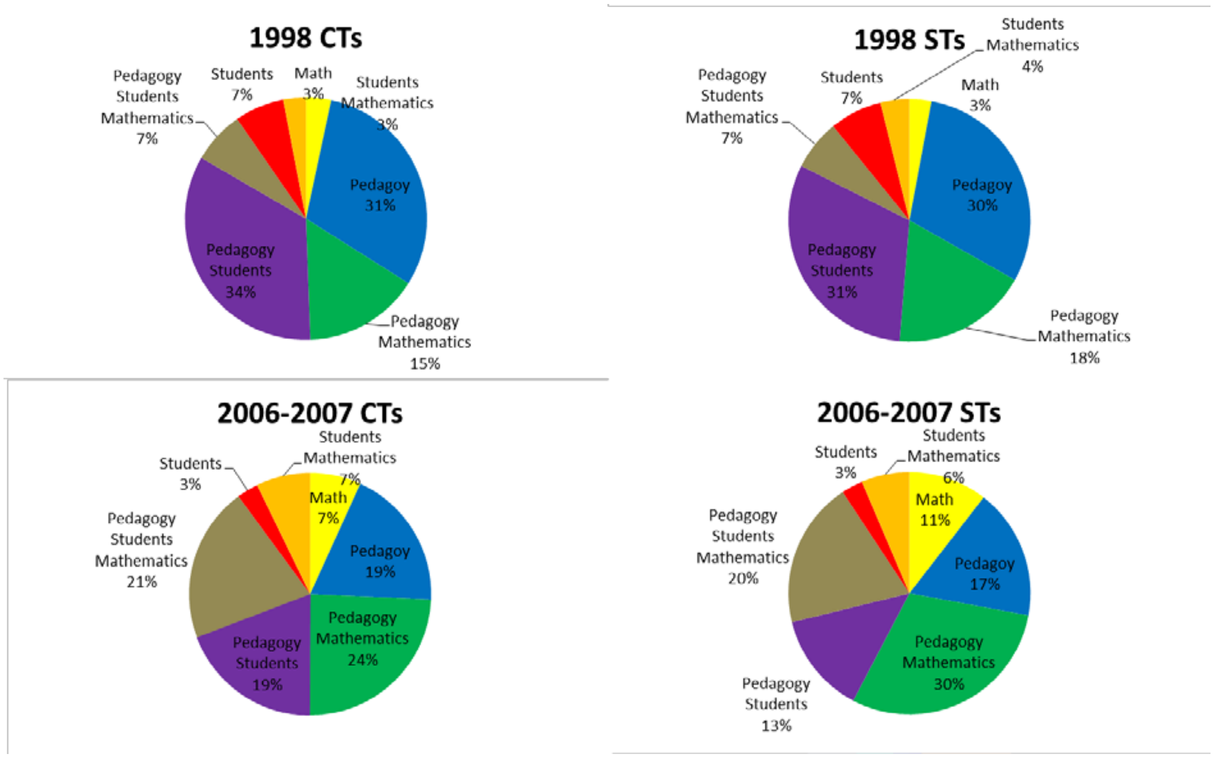

Figure 18. A comparison of the distributions of PSM codes for CTs and STs.

When comparing the proportions of specific PSM topics the CTs made to the proportion of statements the STs made there were no significant differences (found as discussed in the methods chapter) between statements made by the STs and statements made by the CTs in the 1998 data, but there was one significant difference between the proportions of PSM topics among the 2006-2007 STs and CTs. The 2006-2007 data showed that the STs had more M-coded statements (about 167% of the proportion of the CTs ' M-coded statements). This difference in M-coded statements makes clear that the increase in M-coded statements from the 1998 data to the 2006-2007 data was even more extreme among the STs than among the STs and CTs combined(as previously reported). The CTs in the 2006-2007 data had twice the proportion of M-coded statements as compared to the CTs in the 1998 data (just over 200% of the 1998 CTs proportion of M-coded statements), but the STs in the 2006-2007 data more than tripled the proportion of M-coded statements that the 1998 STs had (about 360% of the 1998 CTs proportion of M-coded statements).This increase in the proportion of statements given the M-code is encouraging because the student teaching structure encouraged a focus on mathematics and the increase shows that STs in the reformed student teaching structure were having significantly more conversations that were strictly about mathematics than the STs in the traditional student teaching structure were.

If there had been significant differences between the statements made by the STs and the statements made by the CTs then this study would have been majorly flawed. All analysis would have to be repeated after sorting statements made by CTs from statements made by STs. In addition, a significant difference in statements made by STs and statements made by CTs would have decreased the evidence that reforming student teaching programs can change what STs have the opportunity to learn. One of the points of reforming the student teaching program was to ensure that STs had a specific type of experience and the opportunity to learn specific things in the student teaching program, regardless of their CT. If the statements made by STs and the statements made by CTs were hugely different, then the different STs would have had the opportunity to learn different things depending on who their CT was, which lessens the credibility of the student teaching program.

Because the distributions of the PSM codes are so similar between STs and CTs within each student teaching structure (except for the increase in M-coded statements from the STs in the 2006-2007 data), this study assumes that the statements made by the CTs are comparable to the statements made by the STs, and no distinction between speakers was necessary when analyzing what STs and CTs talked about in each student teaching program.

Summary

The data analysis thus far has shown that STs and CTs from the traditional and reformed student teaching structure were talking about the same basic topics, but often at quite different frequencies. STs and CTs from the traditional student teaching structure spent most of the time talking about students and pedagogy, with few conversations about mathematics at all. Almost 80% of the statements from this data were P-coded, S-coded, or PS-coded. In contrast, STs and CTs from the reformed student teaching structure tended to talk about teaching math and students' interactions with the mathematics. Almost 60% of the statements from this data were PM-coded, SM-coded, or PSM-coded. This shows STs and CTs in the reformed student teaching structure were more likely to talk about the important subjects of students' mathematics and how that mathematics related to pedagogy than were STs and CTs from the traditional student teaching structure.

The differences in the types of conversations within the topics of pedagogy, students, and mathematics were also encouraging. The data has shown that when the conversations within the PSM coded statements differed between the two data sets, they differed in encouraging ways. STs and CTs in the reformed student teaching structure consistently talked about pedagogy, students, and mathematics in ways that seemed to promote a purposeful focus on students' mathematical thinking.

The results of what STs and CTs talked about in the different student teaching structures were encouraging, but the next part of this chapter will go beyond looking at frequencies of the

PSM codes and their sub-codes to analyze *how* pedagogy, students, and mathematics were discussed in each student teaching structure.

How They Talked About Pedagogy, Students, and Mathematics

The data has shown that the frequencies of topics about pedagogy, students, and mathematics have differed between the two student teaching structures, but so far the data has not answered questions about how STs and CTs talk about pedagogy, students, and mathematics in each student teaching structure. Remember that in order to answer this question I focused on only PSM-coded statements. I knew that the 2006-2007 data had significantly more PSM-coded statements than the 1998 data did (20% of all statements compared to 6% of all statements), but I wanted to know if the ways the STs and CTs were talking about pedagogy, students, and mathematics in those statements were the same. Looking at PSM-coded statements allowed me to analyze the ways pedagogy, students, and mathematics were talked about when all three topics were present in one statement. Looking at statements with pedagogy, students and mathematics simultaneously present helped me to make inferences about how pedagogy, students, and mathematics were talked about in general in each student teaching structure.

One of the guiding questions in my attempts to capture how the topics of pedagogy, students and mathematics were being discussed in each statement were "What does this statement say about pedagogy?" "What does this statement say about students?" and "What does this statement say about mathematics?" I was looking for what messages were being sent by the speaker about how a teacher should think about pedagogy, students, and mathematics in each statement. These questions helped me to answer the questions of how the STs and CTs talked about pedagogy, students and mathematics.

In this section I will first discuss how the PSM-coded statements in each student teaching structure talked about pedagogy by talking about the messages the statements sent about pedagogy. I will then follow with similar discussions about how the PSM-coded statements in each student teaching structure talked about students and mathematics and also with a discussion on the strength of the mathematics in the PSM-coded statements. I end this section with a comparison between how the statements made by the STs in each student teaching structure compared to the statements made by the CTs in the same student teaching structure in terms of how the STs and CTs talked about pedagogy, students, and mathematics.

Pedagogy

The answers to the question "What does this statement say about pedagogy?" were sorted into three categories that aligned with three perspectives of pedagogy: a traditional teaching perspective, an ambitious teaching perspective, and a neutral perspective. The resulting definitions and examples of the categories for the statements for each year's conversations about pedagogy can be found in Figure 19.

Perspective Towards Mathematics Teaching	Category	Definition	Example
Traditional Mathematics Teaching	Teachers must give clear explanations and examples.	Statements in this category implied that good pedagogy requires teachers to lead the class through a lecture with many clear explanations and examples for students to watch.	"I felt like I got my message across better in 5th period because, did you see I did two examples for them?"
	Teachers should expect students to memorize and reproduce learned definitions and procedures.	Statements in this category implied that good teachers should help students to remember and reproduce the memorized definitions and procedures.	"You'll really want to stress the [exponent] rules again without going into too much detail because the details just confuse them."
Ambitious Mathematics Teaching	Teachers should understand and use student mathematical thinking.	Statements in this category implied that good pedagogy requires teachers to anticipate, understand, and use student mathematical thinking as a central part of all lessons.	"Something that I struggle with is recognizing that they don't understand when they don't ask questions; that's important."
	Teachers should expect students to actually think on their own about mathematics.	Statements in this category implied that good pedagogy requires teachers to help students to be engaged in sense making, problem solving, making connections, modeling, and understanding conceptually throughout the lesson.	"Have them discuss their thoughts [on why rules of exponents work] with their partner before you have a class discussion so they've had someone validate their ideas."
	Teachers should push students to think about more than just correct answers.	Statements in this category implied that good pedagogy requires teachers to focus the classroom on helping the students feel comfortable participating in the classroom, not on only getting correct answers.	"[When a student asked whether an answer was right or wrong] I just responded and said 'Thanks for asking, I don't know what the right answer is, let's discuss it and follow up and see'."
Neutral	Teachers should do their best and expect the same from their students.	Statements in this category implied that teachers and students both make mistakes and good pedagogy requires that the teachers and students are expected to do their best in the classroom.	"I got sidetracked and taught them the wrong thing, but I think they did okay once I figured out the permutations and combinatorics."
	Teachers should help students gain correct knowledge.	Statements in this category implied that good pedagogy requires that teachers build on students' existing knowledge and give them the time and tools necessary to learn.	"Don't move on until their questions are answered because they're going to have a lot of questions on [classifying functions]."
	Teachers must not make students struggle unnecessarily.	Statements in this category implied that it is not beneficial pedagogically to try to force students to learn things that are out of their reach or unrelated to the current lesson.	"I realized as soon as they started working on it that I should change it because it had a lot of distribution and pre-algebra stuff that they haven't gotten to yet."
	Teachers need to encourage students to cooperate in order for learning to occur.	Statements in this category implied that good pedagogy requires that teachers keep control of the classroom and expect students to make efforts to cooperate in lessons.	"She didn't do her homework so she had no idea what I was talking about when I tried to ask her about the factors."

Figure 19. Definitions and examples of statements about pedagogy that are supporting the different perspectives of mathematics teaching.

Statements that promoted a traditional pedagogical perspective sent messages that teachers must give clear lectures and examples about mathematical definitions and procedures that students can then memorize and reproduce. For example, the following is an example of a statement that is considered to promote a traditional pedagogical perspective: "I felt like I got my message across better in 5th period because, did you see I did two examples for them?" This statement implies that it is the teacher's job to show the procedures and give examples for students to follow and learn from.

Statements that promoted pedagogical perspectives that aligned with ambitious teaching sent messages that teachers should understand and use student thinking to encourage students to use their own reasoning to conceptually understand mathematics topics. An example of this type of statement is "Have them discuss their thoughts [on why rules of exponents work] with their partner before you have a class discussion so they've had someone validate their ideas." This statement promotes the idea that teachers should encourage students to work together to become confident in their own mathematical reasoning and let students be their own authority in the mathematics classroom.

In general, statements that promoted neutral pedagogical perspectives sent messages that teachers should do their best to keep high expectations for the students while helping them to obtain correct mathematical knowledge without making them struggle unnecessarily. This perspective of pedagogy could potentially be valued by teachers who practice ambitious teaching as well as teachers who tend to have traditional views of teaching, so it is considered a neutral pedagogical stance. An example of a statement that is considered neutral towards ambitious and traditional teaching is "Don't move on until their questions are answered because they're going to have a lot of questions on [classifying functions]." This says that an important part of good pedagogy is to make sure students' questions are answered so that they can gain the knowledge they need. The statement remains neutral towards ambitious and traditional teaching because it doesn't say how the students' questions should be answered. If it had gone on to *how* teachers should make sure students' questions are answered then the statement could have been swayed to either ambitious teaching (if, for example, it implied that teachers should make sure students' questions are answered by referring to other students' thinking in the classroom) or traditional teaching (if it implied that teachers should act as authority in the classroom by answering all students' questions).

In the 1998 conversations, only about 28% of the PSM-coded statements sent messages about pedagogy that aligned with ambitious, student-centered mathematical teaching (see Table 7). In the 2006-2007 conversations that number increased to a huge majority, with 87% of all PSM statements promoting ambitious mathematics teaching. 37% of the 1998 PSM statements sent messages about pedagogy that directly conflict with ambitious mathematical teaching and instead promote a traditional teacher-centered approach. Only 4% of the PSM-coded statements from the 2006-2007 conversations encouraged pedagogy that was in direct conflict with ambitious mathematics teaching.

Table 7

Counts and Percentages of Statements Supporting Ambitious Mathematics Teaching, Supporting Traditional Mathematics Teaching, and Taking a Neutral Stance on Mathematics Teaching When Capturing What the Statement Says About Pedagogy

Traditional Mathematics Teaching	1998	2006-2007	Ambitious Mathematics Teaching	1998	2006-2007	Neutral	1998	2006-2007
Teachers must give clear explanations and examples.	24%	2%	Teachers should understand and use student mathematical thinking.	4%	13%	Teachers should do their best and expect the same from their students.	1%	1%
Teachers should expect students to memorize and reproduce learned definitions and procedures.	13%	2%	Teachers should expect students to actually think on their own about mathematics.	22%	67%	Teachers should help students gain correct knowledge.	26%	6%
			Teachers should push students to think about more than just correct answers.	1%	6%	Teachers must not make students struggle unnecessarily.	4%	2%
						Teachers need to encourage students to cooperate in order for learning to occur.	5%	2%
Total	37%	4%	Total	28%	86%	Total	35%	10%

To summarize, when the STs and CTs in the 1998 data were talking about pedagogy, students and mathematics simultaneously, the majority of their statements either promoted pedagogical perspectives that were neutral towards ambitious or traditional mathematics teaching, or statements that directly contradicted the perspectives of pedagogy that would allow for ambitious mathematics teaching. The 2006-2007 data reflects an interesting shift. When STs and CTs in the 2006-2007 data were talking about pedagogy, students and mathematics simultaneously, 86% of their statements not just remained neutral towards ambitious or traditional mathematical teaching, but actively supported the ambitious, student thinking-centered mathematics teaching approach.

Students

The answers to the question "What does this statement say about students?" were also sorted according to the traditional, ambitious and neutral teaching perspectives. The resulting definitions and examples of the categories for the statements for each year's conversations about students can be found in Figure 20.

Perspective Towards Mathematics Teaching	Category	Definition	Example
Traditional Mathematics Teaching	Students need clear examples and explanations that they can easily follow in order to learn.	Statements in this category implied that students learn best from clear examples and explanations that they can watch in order to learn.	"I know there were a lot of questions [on subtracting a negative], but they didn't give you a chance to finish your explanation and it would have been just fine if they did."
	Students often simply forget mathematics concepts and need to be reminded.	Statements in this category implied that when students are struggling with mathematics it is because they simply forgot a rule or formula and if they are reminded or given time to review they will succeed.	"You should stress [the rules] without going into details, especially the turning the division into multiplication, because they have a hard time remembering that."
	Students should rarely do "hands on" mathematics activities because they are difficult to manage.	Statements in this category implied that some students are not capable of "hands on" mathematics because they will get out of control if they are expected to do any talking or participating in the classroom.	"Something you've got to know, if you use those [manipulatives] every day, you're going to lose some kids."
Ambitious Mathematics Teaching	Students are capable of thinking about and making sense of mathematics.	Statements in this category implied that students should be expected to think about mathematics conceptually and to problem solve, make connections, apply applications, model, and understand the "why" of mathematics.	"And we could ask them, if they just estimate, we could say 'Well how else do you think you could check to see if it's right?""
	Students do not all think about mathematics in the same ways.	Statements in this category implied that the ways that students think about mathematics is not always obvious and that all students do not think in the same ways.	"I kept trying to get her to think about [integer operations] with the number line, but she just kept going back to the chips because that's what made sense to her."
	Students and their thinking should influence what happens in the classroom.	Statements in this category implied that students and their thinking can benefit other students and so their thinking should be made public and influence what is happening in the classroom.	"You need to ask her 'How are you thinking? Where is this coming from?' before you respond [to the students' incorrect answer] so you know what to build [your response] off of."
Neutral	Students sometimes have a difficult time learning mathematics.	Statements in this category implied that students learn at different levels and have difficult time learning without plenty of time and a teacher who builds off of their previous knowledge in order to help them learn mathematics.	"That [method of drawing a picture] is something I would show a student struggling with multiplication, but it's not something I would feel is necessary to teach the entire class."
	Students can have issues being motivated to do mathematics.	Statements in this category implied that some students have issues being motivated intrinsically and need extrinsic motivations to stay engaged.	"We're going to make them hand [the class work] in at the end of class to try to help them stay motivated and actually work on it."
	Students are capable of learning mathematics.	Statements in this category implied that students are smart and often want to be challenged in the mathematics classroom.	"You'll probably want to do more than 2 though because most students will be like '2+2+2? That's 6, I can do that in my head' and not try to learn multiplication."
	Students need to know that they are cared for and a lot is expected of them.	Statements in this category implied that students need to be treated as human beings by understanding teachers who care and expect a lot from them.	"You need to make sure that when you help them they know that you are interested in them doing good in math, that makes a big difference."

Figure 20. Definitions and examples of statements about students that are supporting the different perspectives of mathematics teaching.

Statements that supported a traditional mathematics teacher's view of students implied that students need only clear examples and explanations, with nothing "hands on", to learn mathematics, and when they make mistakes they often only need to be reminded of correct procedures. For instance, the first example in the "Traditional Mathematics Teaching" section of Figure 20 implies that the reason the students struggled with the concept is because they interrupted the teacher and did not allow her to give them the complete explanation that they needed in order to learn the mathematics.

Statements that supported ambitious views of teaching had perspectives towards students that implied that they are capable of thinking about mathematics and the variety of ways students think about mathematics should influence the way the mathematics is taught. An example of this type of statement can be found in the "Ambitious Mathematics Teaching" section of Figure 20. The final quote in that section implies that even when students give incorrect answers they still have correct thinking that can be found and built upon throughout the lesson to help them learn the mathematics.

Statements that were neutral towards traditional and ambitious teaching tended to send messages that students are capable of learning mathematics if they know there are high expectations for them, but they can struggle with the mathematics and have issues being motivated. For example, the second quote in the "Neutral" section of Figure 20 implies that students can have a hard time being intrinsically motivated to do mathematics and sometimes, in order to learn the mathematics, they need extrinsic motivators like a grade on their class work. The statement remains neutral towards ambitious and traditional teaching because it does not say *how* the students' should be engaged in the class work. If it had gone on to say what it looks like when students engage in class work then the statement could have been coded as either ambitious teaching (if, for example, it implied that students should be working together in developing conceptual understandings of mathematics) or traditional teaching (if it implied that students should work quietly on problems that let them practice procedures they had previously been shown).

Only 31% of the 1998 PSM-coded statements sent messages about students that aligned with ambitious mathematics teaching, whereas 48% of the PSM-coded statements sent messages about students that were aligned with traditional mathematics teaching (see Table 8). The 2006-2007 PSM-coded statements had substantially more statements aligned with ambitious mathematics teaching, with 86% (almost 300% as much as the proportion in the 1998 data) of all PSM-coded statements promoting perspectives about students that support ambitious mathematics teaching and only 3% of all PSM-coded statements sending messages about students that were aligned with traditional mathematics teaching.

Table 8

Counts and Percentages of Statements Supporting Ambitious Mathematics Teaching, Supporting Traditional Mathematics Teaching, and Taking a Neutral Stance on Mathematics Teaching When Capturing What the Statement Says About Students

Traditional Mathematics Teaching	1998	2006-2007	Ambitious Mathematics Teaching	1998	2006-2007	Neutral	1998	2006-2007
Students need clear examples and explanations that they can easily follow in order to learn.	27%	1%	Students are capable of thinking about and making sense of mathematics.	21%	53%	Students sometimes have a difficult time learning mathematics.	12%	7%
Students often simply forget mathematics concepts and need to be reminded.	15%	2%	Students do not all think about mathematics in the same ways.	6%	20%	Students can have issues being motivated to do mathematics.	6%	2%
Students should rarely do "hands on" mathematics activities because they are difficult to manage.	6%	0%	Students and their thinking should influence what happens in the classroom.	4%	13%	Students are capable of learning mathematics.	2%	1%
						Students need to know that they are cared for and a lot is expected of them.	1%	1%
Total	48%	3%	Total	31%	86%	Total	21%	11%

When STs and CTs in the 1998 student teaching structure were talking about pedagogy, students and mathematics simultaneously, they did not tend to send messages about students that supported ambitious mathematics teaching. When STs and CTs in the 2006-2007 student teaching structure were talking about pedagogy, students and mathematics simultaneously they were most often sending messages that supported ambitious mathematical teaching.

Mathematics

The answers to the question "What does this statement say about students?" were again sorted according to traditional, ambitious and neutral teaching perspectives. The resulting definitions and examples of the categories for the statements for each year's conversations about students can be found in Figure 21.

Definitions and Examples of Statements Supporting Ambitious Mathematics Teaching, Supporting Traditional Mathematics Teaching, and Taking a Neutral Stance on Mathematics Teaching When Capturing How the Statement Talks About Mathematics

Perspective Towards Mathematics Teaching	Category	Definition	Example
Traditional Mathematics Teaching	Mathematics can be told.	Statements in this category implied that mathematics is a transparent subject that can easily be learned by being told what to do.	"After they work on it you could just say 'This is the right way to factor it' and then just pop it on the overhead so they can say 'Oh, cool'."
	Mathematics is a set of rules to be copied.	Statements in this category implied that it is important to emphasize mathematical rules because mathematics can only be done in one way.	"So I felt like giving them a formula and pattern to follow really helped them to set up the story problems and run it through".
	Mathematics is meant to be memorized and reviewed.	Statements in this category implied that mathematics troubles arise when one cannot remember the rules and merely reminding or reviewing mathematical rules will help with any issues in completing mathematics tasks.	"Repetition is important, honestly I think so. I feel like if they can do [integer operations] so many times then they can do it."
Ambitious Mathematics Teaching	Mathematics can be thought about in many different ways.	Statements in this category implied that different people think about mathematics in different, equally valid ways, and learners can benefit from sharing and understanding others' mathematical thinking.	"As we're walking around we'll try to notice some interesting things they're doing and ask them if they'll come present it to the class."
	Mathematics should be made sense of.	Statements in this category implied that understanding mathematics is about more than getting the right answer and should focus instead of on problem solving, sense making, and making connections.	"We thought that if we had them explain what the quantity would be it would help them to make sense of it being the velocity when our time is 12."
Neutral	Mathematics sometimes uses calculators.	Statements in this category talked about the pros and cons of calculator use in the classroom.	"One of the things you're going to find when you use the graphing calculators s that it takes a little bit of time to get everybody going on them."
	Mathematics sometimes is exciting.	Statements in this category implied that mathematics can be intrinsically motivating, but sometimes learners need extrinsically motivating factors to engage in the mathematics.	"I liked when you did the matching because it didn't seem like math to them, it seemed like a puzzle."
	Mathematics is not always easy to understand.	Statements in this category implied that learning mathematics is not easy and requires both teachers and students to be aware of possible misconceptions and miscommunications that may arise.	"If this were a negative I'd say '3x subtract negative 2x' [instead of '3x minus minus 2x'] so that they always know we're subtracting or else they just get lost."

Figure 21. Definitions and examples of statements about students that are supporting the different perspectives of mathematics teaching.

Statements that supported a traditional view of mathematics teaching implied that mathematics is a set of rules that can be told and then copied and memorized. The second quote in the "Traditional Mathematics Teaching" section of Figure 21 gives an example of a PSM-coded statement that reflects a traditional view of mathematics teaching is. This statement implies that even when working with problems with mathematical applications it is important to give students a set of rules to follow and copy so that they don't make mistakes.

Statements that supported an ambitious view of mathematics teaching implied that mathematics is meant to be made sense of and is thought about in many different, legitimate ways. For instance, the first quote of the "Ambitious Mathematics Teaching" section of Figure 21 implies that teachers should be aware of the different ways their students will think about the mathematics. It implies that all different ways of thinking are good and that the class will benefit from sharing each other's thinking as they work to make sense of the mathematics.

Statements that were neutral towards traditional and ambitious teaching tended to send messages that mathematics is not always easy to understand and is engaging in different ways to different people. There were also some statements arguing that mathematics can or cannot be done with a calculator. For n example, the final quote given in the "Neutral" section of Figure 21 makes the point that mathematics can be confusing and that it is easy for students to get lost and lose interest if teachers are not aware of difficulties that could arise. The statement remains neutral towards ambitious and traditional teaching because it does not send a message about whether the mathematics should be made sense of or memorized, just that it should be clear to students.

In the 1998 PSM-coded statements only 27% of the statements promoted perspectives towards mathematics that aligned with ambitious mathematics teaching and 44% of the PSM-coded statements promoted perspectives towards mathematics that were in direct opposition to perspectives that would support ambitious mathematics teaching (see Table 9). In comparison, 87% of the PSM-coded statements in the 2006-2007 data talked about mathematics in ways that directly supported ambitious mathematics teaching and only 2% of the PSM-coded statements talked about mathematics in ways that conflicted with ambitious mathematics teaching.

Table 9

Counts and Percentages of Statements Supporting Ambitious Mathematics Teaching, Supporting Traditional Mathematics Teaching, and Taking a Neutral Stance on Mathematics Teaching When Capturing What the Statement Says About Mathematics

Traditional Mathematics Teaching	1998	2006-2007	Ambitious Mathematics Teaching	1998	2006-2007	Neutral	1998	2006-2007
Mathematics can be told.	24%	0%	Mathematics can be thought about in many different ways.	11%	49%	Mathematics sometimes uses calculators.	8%	0%
Mathematics is a set of rules to be copied.	15%	1%	Mathematics should be made sense of.	16%	38%	Mathematics sometimes is exciting.	9%	1%
Mathematics is meant to be memorized and reviewed.	5%	1%				Mathematics is not always easy to understand.	14%	9%
Total	44%	2%	Total	27%	87%	Total	29%	11%

When STs and CTs in the 1998 data were talking about pedagogy, students and mathematics simultaneously, they tended to talk about mathematics either in ways that were neutral towards ambitious and traditional mathematics teaching or in ways that directly oppose ambitious mathematics teaching. When STs and CTs teachers in the 2006-2007 data talked about pedagogy, students and mathematics simultaneously, the majority of their statements talked about mathematics in ways that directly supported ambitious mathematics teaching.

Strength of Mathematics

I also captured the strength of the mathematics in the PSM-coded statements. I was looking to see if the mathematics in the PSM-coded statements were referring to a specific piece of identifiable mathematics, a specific mathematical topic, or just using mathematics as a context. The results can be found in Figure 22.

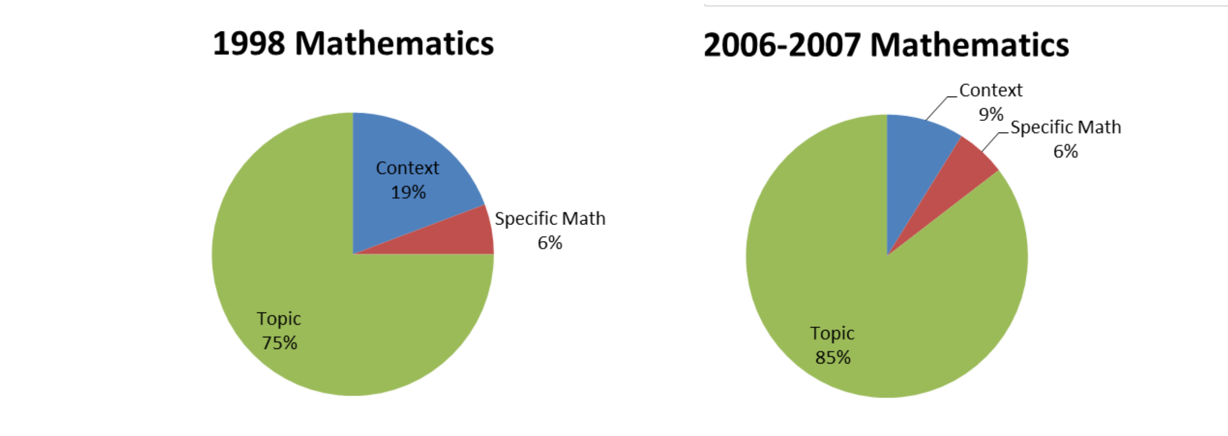

Figure 22. A comparison of the strength of mathematics in PSM-coded statements in both student teaching structures.

The strength of the mathematics in PSM-coded statements between the two data sets had some similarities. In both the 1998 data and the 2006-2007 data the STs and CTs were most likely to talk about the mathematics as a general topic. Statements with this strength of mathematics referred to a specific mathematical topic, without referring to a specific piece of mathematics. An example of this type of statement is "We should tell them it's okay for them to take the algebraic approach and see if they manipulate things." The STs and CTs from both data sets had some PSM-coded statements that referred to specific mathematics. Statements with this strength of mathematics referred to a specific piece of mathematics. In these statements STs and CTs were talking about a specific, identifiable piece of mathematics. An example of this type of statement is "I was just as surprised as you were when I went around and saw that they were all taking 80x15." In this statement the teacher identifies the specific mathematics that the students were doing (multiplying 80 and 15) instead of just referring to a specific topic of mathematics.

An interesting difference in the strength of mathematics in the PSM-coded statements between the 1998 data and the 2006-2007 data is the amount of statements with a weak strength of mathematics. Some of the PSM-coded statements referred to mathematics as a context. In these statements the statement was not really about the mathematics at all, it was just used as a context to make a point about something else. An example of this type of statement is "But we're not really sure how to do that [keep control of the classroom] because we know the kids are going to be super excited about the calculators." This statement is talking about calculators, which are a mathematics tool, but the mathematics is not the focus of the statement. Instead the statement focuses on how to control students when they get to use calculators. Mathematics is present in this PSM-coded statement, but it is not a strong reference to mathematics. The amount of statements with a weak reference to mathematics decreased significantly from the 1998 data to the 2006-2007 data. This is an encouraging decrease because it suggests that STs and CTs in the reformed student teaching structure actually tended to be talking about mathematics when their statements were given the M-code more often than the STs and CTs in the traditional student teaching structure were.

In conclusion, STs and CTs in both the traditional and reformed student teaching structure tended to be talking about a mathematical topic when talking about pedagogy, students and mathematics simultaneously. When talking about pedagogy, students, and mathematics, STs and CTs in the reformed student teaching structure, however, were more likely than STs and CTs in the traditional student teaching structure to talk about a specific mathematics topic and less likely than the STs and CTs in the traditional student teaching structure to be merely referring to a general mathematical context.

Comparing ST and CT Conversation Contributions

Previously in this chapter I provided evidence that, when coding for the PSM codes, there was no need to differentiate between STs and CTs within each data set. I analyzed the results of *how* STs and CTs talked about pedagogy, students, and mathematics in a similar manner. In order to explore this issue I again separated each data set into statements made by STs and statements made by CTs to compare the differences in how pedagogy, students, and mathematics were portrayed (see Figure 23).

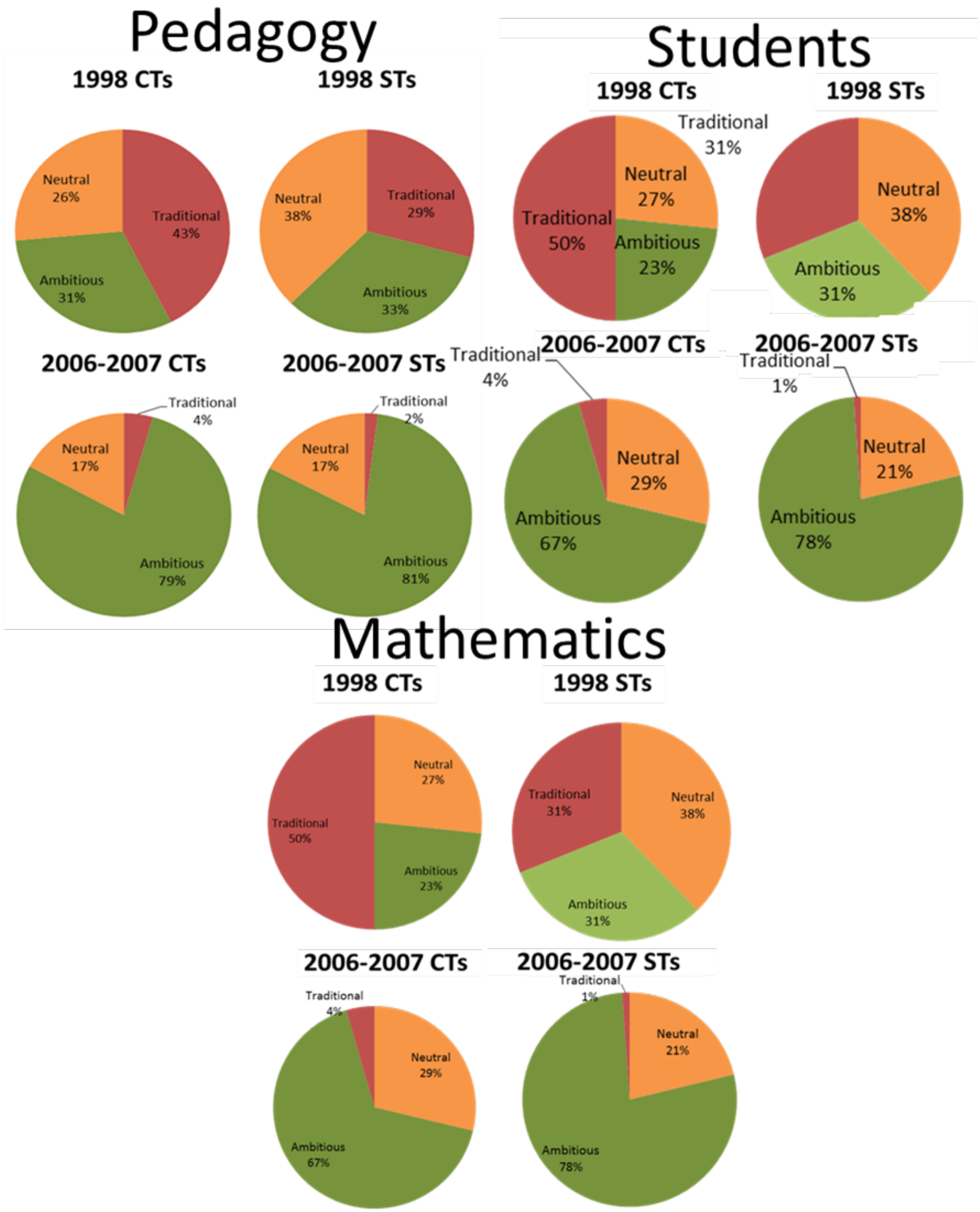

Figure 23. A comparison of how CTs and STs talked about pedagogy, students, and mathematics in each data set.

The comparison between the STs and CTs revealed some interesting results. The 2006-2007 data shows that the PSM-coded statements from both CTs and STs were similar and in both cases their statements were overwhelmingly supportive of ambitious perspectives towards mathematics teaching. The CTs in the 2006-2007 data made statements that aligned with traditional mathematics teaching perspectives slightly more than the STs did, but the difference is so minimal that differentiating between the CTs and the STs is unnecessary in the 2006-2007 data when looking at how they talked about pedagogy, students, and mathematics.

In the 1998 data the PSM-coded statements made by the STs were pretty evenly split between traditional, ambitious, and neutral perspectives of mathematics teaching when talking about pedagogy, students, and mathematics. By contrast, the CTs of the 1998 data made statements that promoted traditional perspectives when talking about pedagogy, students and mathematics more often than the STs did (right around half of the time, which is just over 150% of the proportion of statements supporting traditional perspectives that the STs made). Recall that I concluded that when the STs and CTs in the 1998 data were talking about pedagogy, students and mathematics simultaneously the majority of their statements either promoted pedagogical perspectives that were neutral towards ambitious or traditional mathematics teaching, or statements that directly contradicted the perspectives of pedagogy that would allow for ambitious mathematics teaching. Because the conclusion gathered from the analysis of the 1998 PSM-coded statements still holds in each individual case of CT and ST statements, there is still no need to differentiate between CTs and STs in the 1998 data when looking at how they talked about pedagogy.

Summary

The differences in how STs and CTs in each student teaching structure talk about pedagogy, students, and mathematics have been encouraging (see Figure 24). The data has shown that STs and CTs from the reformed student teaching structure were significantly more likely to talk about the topics of pedagogy, students, and mathematics in ways that promoted ambitious teaching rather than traditional teaching. In addition, the mathematics in the conversations among the STs and CTs in the reformed student teaching structure was a stronger presence than the mathematics in the traditional student teaching structure. This increase in the strength of mathematics in PSM-coded statements is encouraging because it implies that STs and CTs in the reformed student teaching structure were not just mentioning mathematics as a context, but actually having meaningful and specific mathematical conversations.

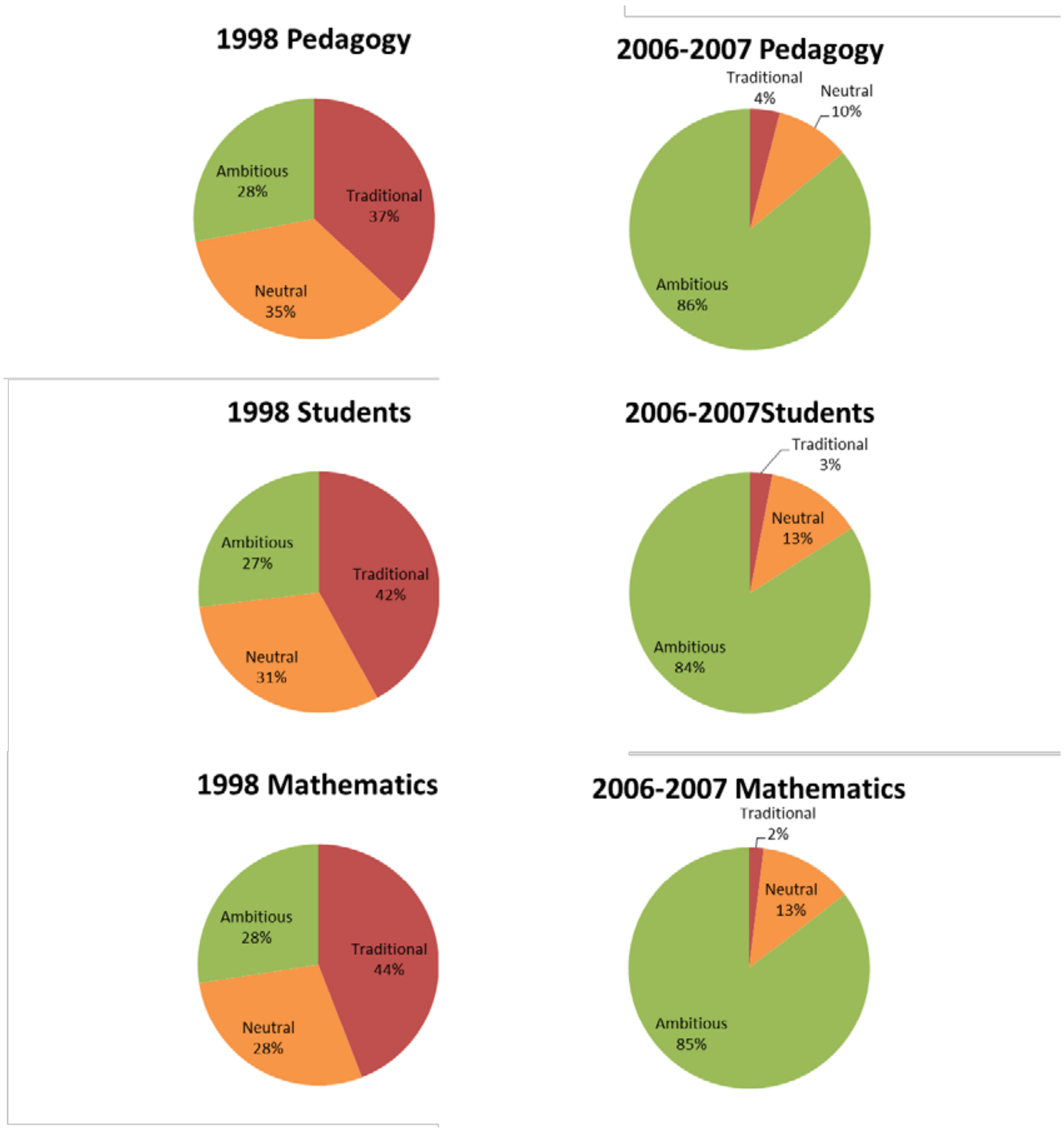

Figure 24. Distributions of how each data set talked about pedagogy, students, and mathematics.

The distributions of how the CTs and STs talked about pedagogy, students, and mathematics in 1998 are approximately evenly split between the two perspectives of traditional and ambitious teaching and statements that are neutral to the two perspectives. This even distribution seems to imply that throughout the traditional student teaching program there was no clear message about mathematics teaching. The overwhelming percent of statements that promoted ambitious teaching in the distributions of how the CTs and STs talked about pedagogy, students, and mathematics in 2006-2007 show just the opposite: that there must have been a clear emphasis on ambitious teaching in the reformed student teaching structure.

Conversations about Behavior

The data has shown that STs and CTs from the reformed student teaching structure tended to talk more often and in more ambitious ways about the interactions of pedagogy, students and mathematics in the classroom. This shift in conversation topics is an encouraging change compared to the traditional student teaching structure that I studied and compared to what the literature has said about traditional student teaching structures. The literature has implied that STs and CTs do not have the desired conversations about the interactions of pedagogy, students, and mathematics because they tend to talk about classroom management and behavior issues in the classroom. The hope was that the structure of the reformed student teaching program could overcome this norm and allow STs and CTs to have important conversations about teaching and learning mathematics rather than focusing the student teaching program on the student behavior of the classroom. This section of my results will report the results found about these behavior conversations in both the traditional and reformed student teaching program by reporting the frequency of statements coded as "behavior" in both the traditional and reformed student teaching structure.

Classroom management was not a major topic of conversation in the reformed student teaching structure. While 18% of all statements coded in the 1998 data were given the behavior code, this percent was drastically reduced in the 2006-2007 data, where only 5% of all statements were given the behavior code. Perhaps some of the reasons for this decline in conversations about classroom management is due to the increase in conversations about mathematics and a decrease in conversations about pedagogy and students (Table 10).

Table 10

Percents and Distributions of PSM Statements Coded as Behavior

	% of these statements coded as Behavior		% of Behavior-coded statements coded here	
Year	1998	2006-2007	1998	2006-2007
Pedagogy	7.5%	2.5%	14.2%	9.1%
Students	40.7%	27.3%	16.7%	13.0%
Mathematics	0.0%	0.0%	0.0%	0.0%
Pedagogy Students	37.7%	25.3%	67.3%	77.2%
Students Mathematics	3.8%	0.0%	0.7%	0.0%
Pedagogy Mathematics	0.3%	0.0%	0.3%	0.0%
Pedagogy Students Mathematics	2.2%	0.6%	0.8%	0.8%

Conversations about classroom management did not tend to show up when STs and CTs talked about mathematics in both data sets. Out of all of the statements with some form of mathematics in them (M, SM, PM, and PSM-coded statements) only 6% in the 1998 data and 0.6% in the 2006-2007 data were given the behavior code. When STs and CTs in both data sets talked about mathematics they tended not to talk about classroom management.

Most of the statements coded as behavior are PS-coded with 67% of behavior statements in the 1998 data and 77% of behavior statements in the 2006-2007 data being coded here. The remaining behavior codes go primarily to P-coded statements (14% of the 1998 behavior codes and 9% of the 2006-2007 behavior codes) and S-coded statements (17% of the 1998 behavior codes and 13% of the 2006-2007 behavior codes). STs and CTs in both data sets are more likely to talk about behavior when they are talking about both students and pedagogy and less likely when talking about strictly pedagogy or strictly students, although such statements do occur.

PS-coded statements and S-coded statements have significantly more statements coded as behavior than other combinations of the PSM codes. In the 1998 data only 32% of all statements were PS-coded, but 38% of all behavior statements in that data set were coded here. In the 2006-2007 data only 16% of all statements were PS-coded, but 25% of all behavior codes in that data set were coded here. Similarly, in the 1998 data only 7% of statements were S-coded, but 41% of all behavior statements in this data set were S-coded and in 2006-2007 conversations, only 2% of statements were S-coded with 27% of all behavior statements in that data set given the S-code. When STs and CTs teachers were talking solely about pedagogy and students they were more likely to be talking about classroom management, and so because the reformed student teaching structure spent more time talking about mathematics and had fewer statements about pedagogy and students (without mathematics) than the traditional student teaching structure did, the reformed student teaching structure had less of a focus on classroom management.

CHAPTER SIX: DISCUSSION AND CONCLUSION

In this chapter I draw on the results presented in chapter five to explicitly answer my research questions. I will then discuss how the results of this study make an important contribution to the field of mathematics education as well as comment on the limitations of this study and on directions for future research.

Answering the Research Questions

This study was designed to answer two questions: (1) What are STs talking about in traditionally structured student teaching programs versus in the reformed student teaching program? and (2) How do the conversations differ in each student teaching structure in the way topics of pedagogy, students and mathematics are discussed? I will answer each question individually in the following sections by characterizing the conversations from each data set. Answering these questions about the nature of the conversations in each student teaching structure is useful because it works towards answering the bigger question of how STs can be influenced by the structure of their student teaching programs. The characterizations of the statements made by STs and CTs in each student teaching structure reflect what kinds of things each student teaching program focused on, which then gives insight into what the STs were given the opportunity to learn.

What Was Talked About

STs and CTs in the traditional student teaching program from the 1998 data that I studied talked mostly about pedagogy and students, with relatively few conversations about mathematics. The focus of the conversations was clearly on the pedagogical moves from the teacher with some interactions from the students. There was not a strong focus on how mathematics related to teaching and to student learning. Statements about behavior were common and could be considered one of the focuses of the student teaching program.

By contrast, STs and CTs in the reformed student teaching program from the 2006-2007 data that I studied talked mostly about pedagogy and mathematics and how students interacted with those topics. There was a clear focus on the interdependence of the pedagogical moves of the teacher and the mathematics being taught as well the students in the classroom. Statements about behavior were scarce and classroom management was not a strong focus of the student teaching program.

How Pedagogy, Students, and Mathematics Were Talked About

Relatively few statements in the data from the traditional student teaching structure included mathematics and how it related to pedagogy and students. The ways the CTs and STs talked about the mathematics was sometimes quite weak, only referring to mathematics as a context instead of talking about an individual topic or a specific piece of mathematics. These statements about the relationship between pedagogy, students, and mathematics were often talking about pedagogy, students, and mathematics in ways that promoted perspectives about traditional, teacher-centered classrooms or else remaining neutral in the ways they talked about the topics.

Not only did the data from the reformed student teaching structure have more statements about mathematics and how it related to pedagogy and students, but the STs and CTs talked about mathematics in more specific ways than in the reformed student teaching structure. There were fewer statements where the mathematics was just a context. These statements about the interactions of pedagogy, students, and mathematics most often talked about these topics in ways that promoted ambitious, student-centered classrooms.

The Opportunity to Learn

The conversation topics and how those topics were discussed in the traditional student teaching structure shows that the STs participating in this student teaching structure had the opportunity to learn that teaching mathematics does not actually have a whole lot to do with mathematics. According to the conversations in this student teaching program the focus of teaching mathematics should instead be on teacher and student interactions and on getting students to behave and engage in the classroom activities, with mathematics merely a context of the conversations. It seems that these STs were merely learning how to run the shoe store, with very little discussion or focus on how to actually make shoes (Leatham & Peterson, 2010b). Perhaps this is because no one considered making the shoes (or actually teaching and facilitating the learning of mathematics) to be a problematic part of teaching. From the conversations among CTs and STs the STs had the opportunity to learn that mathematics is a set of rules that teachers must help students to learn by giving the students clear examples and explanations that the students can then be expected to follow, memorize, practice and repeat.

The conversations the STs had in the reformed student teaching program show a very different experience for the STs. These STs had the opportunity to learn that teaching mathematics is about the interactions between students with the teacher and with the mathematics. The focus of teaching mathematics should be on getting the student to engage meaningfully with the mathematics. The STs were not just learning how to run the store, but also how to make the shoes (or facilitate the mathematical learning of the students). From the conversations between the CTs and STs, the STs had the opportunity to learn that mathematics is about sense making and that teachers should encourage students to actually think about and make sense of the mathematics and then use their students' mathematical thinking to build and guide the mathematics lessons.

Implications

This study of the conversations that occur in different student teaching programs has given some insight into how to give STs the opportunity to facilitate student learning, and not just how to run a classroom. These findings will be particularly helpful to mathematics teacher educators because this study has shown that purposefully reforming the student teaching structure can have a positive effect on what the STs have the opportunity to learn during their student teaching. Mathematics teacher educators can design student teaching programs so that STs bump up against things like student mathematical thinking more and things like classroom management less and shift the focus and what STs are given the opportunity to learn away from classroom management, where it has been traditionally, towards student mathematical thinking and learning.

This study has some limitations that can be left for future research. The main limitation of this study was its limit in characterizing how pedagogy, students, and mathematics were discussed. Because of the limits of the scope of my study I was unable to study how pedagogy, students, and mathematics were talked about in each PSM code and chose instead to look more closely at a subset of PSM-coded statements. The results were encouraging and I imagine the same types of results would be reflected across the entire data set if I had been able to analyze all PSM codes instead of just the PSM-coded statements.

This research about the effect of student teaching structures on STs can be used as a foundation for future research. One interesting direction for future study would be to take this information and use it to compare a variety of reformed student teaching structures found in mathematics education. Another interesting direction of research would be to follow the STs (from both traditional and reformed student teaching programs) into their first few years of teaching and measure the affects of the student teaching program on their teaching in their own classrooms. This type of study could lead to studies on measuring actual knowledge gained from the student teaching program, rather than just measuring what the ST had the opportunity to learn.

This study has shown that changing the student teaching structure can have an effect on how STs talk and think about pedagogy, students, and mathematics, but the data do not reveal which part of the structure influenced the STs in this way. Another compelling direction for study would be to attempt to determine whether certain components of the reformed student teaching structure were more or less instrumental in influencing what STs had the opportunity to learn. For example, STs in this student teaching structure participated in reflection meetings led by a university supervisor with a premeditated purpose of focusing on student thinking and learning. Perhaps these formal reflection meetings were a key factor in influencing what STs and CTs thought about as important and that influence is showing up in the casual conversations between the STs and CTs. It would be worth investigating which components of a student teaching program most encourage STs to focus on students' mathematical thinking.

By studying the conversations that occur in differently structured student teaching programs I hoped to better understand how to affect what STs learn in their student teaching programs. This study has shown that student teaching programs can be structured so that students are consistently given opportunities to learn and focus on student mathematical learning and how to best facilitate this learning. These findings are important for mathematics teacher educators to be better able to teach mathematics teachers the value and importance of focusing their teaching on facilitating student learning. Student teaching programs should be structured in such a way that STs are given many opportunities to reflect and focus on not just running a classroom but on facilitating student learning. When student teaching programs are structured with this focus of facilitating student learning the STs that emerge will likely be better prepared to become ambitious teachers because of their experiences in the student teaching program.

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