Utilizing video-clips and written work to help preservice teachers understand student thinking

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Utilizing video-clips and written work to help preservice teachers understand student thinking

by

Tonia Land

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

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ABSTRACT

The National Council of Teacher of Mathematics has put forth a vision for how mathematics should be taught that is quite different from the traditional model that most preservice teachers have experienced throughout their education. Cognitively Guided Instruction (CGI) is an example of a program that exemplifies that vision, but challenges exist for teacher education programs to prepare preservice teachers for an approach of this type. Presenting video clips and written work are two methods that have been used by teacher educators to help prepare preservice teachers. This project reiterates the literature surrounding this topic in that video clips and written work are successful in prompting discussions among preservice teachers pertaining to student thinking and offers preliminary evidence as to what contributes to a meaningful context. However, even more can be learned as to which factors contribute specifically to a meaningful context for preservice teachers.
CHAPTER ONE

Introduction

If I were to ask a number of individuals to describe their math classes from elementary or high school, I would likely get the same response from a majority of people. The teacher explained algorithms to solve problems, and students took notes. After the explanation, students worked problems from the textbook individually at their seats. Most likely, there was little discussion or collaboration among peers. Unfortunately, the majority of mathematics classrooms continue to be facilitated in this highly predictable manner day after day (Wilson, 2003; Steigler & Hiebert, 1999)

Michael Battista (1999), a researcher in mathematics education, points out that one would not expect a doctor to use the same methods that were used fifteen years ago to treat medical conditions. You would expect that they would use the latest research to inform their medical practices. School systems, however, don’t tend to utilize the latest research to inform their pedagogical decisions. For instance, several documents, including *A Nation at Risk* (National Commission on Excellence in Education), *Workforce 2000* (Johnston, 1987) and *Mathematics Report Card* (Dossey et al, 1988), along with many others, have been published because there are concerns with the state of mathematics education in the United States.

The document, *A Nation at Risk*, reports that only one-third of seventeen-year olds in America can solve multi-step problems (National Commission on Excellence in Education, 1983). “Only half of the high-school students demonstrated an understanding of even moderately complex mathematical procedures (junior-high material)” was stated in the *Mathematics Report Card* (Dossey et al, 1988). In *Workforce 2000*, a workforce better
prepared in mathematics was demanded (Johnston, 1987). The document stated that the educational standards of American students needed to be raised dramatically for the nation to be competitive internationally. In response to this criticism, several organizations, most prominently the National Council for Teachers of Mathematics, have established curriculum and teaching standards outlining how and what students should learn in ways different from the “traditional” instruction described above (NCTM, 1989, 2000; Wang & Hartley, 2003).

The National Council for Teachers of Mathematics (NCTM) is the largest organization in the world dedicated to the improvement of mathematics education. Current membership of the NCTM is over 100,000 individuals and 240 affiliates. A major reform effort was launched when they published *Curriculum and Evaluation Standards for School Mathematics* in 1989. Creating the standards was the first attempt by any teachers’ organization to develop standards for school curricula in their area. Though they have encountered challenges toward reform, they remain strong in their efforts to accomplish their goals concerning mathematics education.

Through standards-based instruction, members of the NCTM wanted students to accomplish several goals: to value mathematics, to become confident in their ability to do mathematics, to become mathematical problem solvers, to communicate mathematically, and to reason mathematically (Frye, 1989). To accomplish this, the NCTM presents several suggestions within their publications. “*Principles and Standards for School Mathematics* offers recommendations about what mathematics students should learn, what classroom practice should be like, and what guidelines can be used to evaluate the effectiveness of mathematics programs” (NCTM, 2007, p. X). NCTM has established a vision for school
mathematics that includes learning for understanding, but the vision is not the reality in the majority of classrooms, schools, and districts (NCTM, 2007).

Numerous professional development programs and frameworks have been created to address this gap between NCTM’s vision and typical classroom teaching. One such program is Cognitively Guided Instruction (CGI). “A significant alternative to the typical preparation of teachers to manage activities within reform-minded curriculum is evident in research-based professional programs such as Cognitively Guided Instruction” (Rhine, 1998, p. 27). Students in Cognitively Guided Instruction (CGI) classrooms are presented problems to solve and are facilitated to invent their own strategies to find the solution. “When children invent their own algorithms, they often avoid some of the more serious misconceptions that children exhibit when they try to imitate symbolic manipulations that someone else shows them” (Carpenter et al, p. 75, 1999). As students solve more problems, they begin to develop more efficient strategies (Carpenter et al., 1999). Fundamentally, they understand the mathematical concepts embedded in a problem instead of memorizing a procedure that is used to solve a particular type of problem.

The teachers’ role in CGI classrooms is using their knowledge of students’ thinking to make pedagogical decisions that will facilitate students’ development toward deeper mathematical understanding. CGI teachers typically do not “explain” to a student how to solve the problem. This approach is based on the premise that problem-solving strategies come naturally to children even without formal instruction (Carpenter et al, 1999). A CGI approach to instruction is quite different from traditional methods. Therefore, the majority of practicing and preservice teachers have little or no experience, either as teachers or learners, with this type of instruction.
In fact, preparing preservice teachers to utilize their future students’ mathematical thinking to inform their pedagogical decisions could be a significant challenge because preservice teachers have often experienced mathematics as a set of procedures (Wang & Hartley, 2003). Wang & Hartley (2003) point out that preservice teachers have developed their thinking about teaching and learning through their own educational experiences well before they enter a teacher preparation program. Stigler and Hiebert (1999) contend that teaching is actually a cultural activity that is learned by observation and participation, not by study. One of the implications these ideas present for education is that preservice teachers have deep-seeded ideas about teaching. Therefore, changing preservice teachers’ ideas about teaching has become an emphasis for teacher education programs (Wang & Hartley, 2003).

Fortunately, research (Ambrose, Philipp, Chauvot, & Clement, 2003; Vacc and Bright, 1999) has found that preservice teachers’ beliefs can change if they are engaged with activities that prompt them to consider how to act with children. One of the challenges that presents itself in changing preservice teachers’ beliefs is creating meaningful contexts for learning (Wang & Hartley, 2003). Obviously, the authentic context for a preservice teacher is the classroom. Classroom situations can be brought to preservice teachers through several different approaches, including video clips, student work, case studies and role-playing. However, more needs to be learned as to which contexts preservice teachers can learn the most from and can prompt a change in their beliefs.

In their literature review, Wilson and Berne (1999) found that increased student achievement occurred when practicing teachers were engaged in professional development based on students’ thinking. There is also substantial research that has been conducted on CGI classrooms that indicates that focusing on student thinking is effective for in-service
teachers. However, we have very little evidence about how to assist preservice teachers in understanding children’s thinking. It is my hope that this project will help inform teacher education programs about how to help preservice teachers with this process.

Purpose of the Study

CGI is explored as part of the coursework in CI 448, an elementary mathematics methods class at Iowa State University. Through my work with the mathematics education program, I have come to know several other teacher education programs that also explore CGI. Therefore, using CGI is not specific to Iowa State University’s program. It could be quite common across the nation, but there is no research that indicates exactly how many universities incorporate it into their teacher education courses.

At Iowa State University, some math methods professors utilize the book, *Children’s Mathematics: Cognitively Guided Instruction* along with video clips that come with the text of students solving problems. The clips are used to prompt discussion concerning student thinking. A series of clips developed by researchers from San Diego State University entitled *Integrating Math and Pedagogy* (IMAP) are also explored, which is made available by purchasing the textbook, *Learning Math in Elementary and Middle School*. One of the premises behind using these materials is to prepare preservice teachers for their classrooms through helping them understand the way children think about and solve mathematical problems.

Individuals not affiliated with Iowa State University produced the video clips described in the above paragraph. Therefore, the preservice teachers have no direct experiences with the children solving problems nor do they have more information about
that child other than what they view in the clip, which is minimal. They have no way to question the teacher or the students themselves to find out more about them.

Video clips have actually been used in teacher preparation programs in a variety of ways since the 1960s. In her examination of video use, Sherin (2004) found several characteristics of video that can enhance a teacher education program. These features are described in detail in chapter two. One key characteristic of video is that viewing clips can be more effective than an actual live observation in terms of opportunities for analysis and reflection. However, more research is needed to understand how the distinguishing features of video can contribute meaningfully to analyzing student thinking.

Another context in which preservice teachers can examine student thinking is through written work, which is also explored in the teacher preparation program at Iowa State University. Teacher educators have found student work to be useful in prompting preservice teachers to discuss student thinking (Jacobs & Philipp, 2004). However, little research has been conducted on the use of student work (Kazemi & Franke, 2004) particularly with preservice teachers. The work of Franke and Kazemi et al. has mostly been with in-service teachers. Therefore, it’s not surprising that little guidance exists for how to use student work with preservice teachers (Jacobs & Philipp, 2004).

I investigated four authentic contexts in which preservice teachers explored student thinking. First, preservice teachers were presented with IMAP video clips. Secondly, three preservice teachers collected video clips during their practicum experience and shared them with the methods class. This context is different in that it allows the interviewer to provide additional information about the students and for the preservice teachers to ask questions. Next, the professor provided written work examples from five students. Finally, preservice
teachers were asked to share written student work they collected from their practicum experience with their classmates.

After each context was presented, preservice teachers were prompted to engage in discussion. My intent in investigating the discourse was to perceive how preservice teachers are thinking about and considering student thinking in all the contexts. The discussion was analyzed to determine what type of discussion was encouraged by each different context.

Statement of the Problem

Traditional methods of math instruction are ineffective. There is substantial literature to substantiate this claim, and the NCTM has made recommendations for mathematics teaching in response. Because many preservice teachers have been taught in the traditional manner, it is unclear to them what reform-based classrooms look like. Therefore, the responsibility for presenting effective teaching approaches to preservice teachers falls to teacher education programs. However, little research has been conducted to determine which contexts are effective and in what ways the contexts help preservice teachers consider student thinking and notice what is useful pedagogically about the situation.

Research Question

How do the four authentic contexts presented differ in how they prompt preservice teachers to discuss and analyze student thinking?
CHAPTER TWO
REVIEW OF THE LITERATURE

The National Council of Teachers of Mathematics (NCTM) published *Curriculum and Evaluation Standards for School Mathematics* in 1989 in an attempt to reform mathematics instruction. However, traditional methods of mathematics teaching are still prevalent in today’s classrooms. This review will first examine the current perceptions of preservice teachers concerning mathematics instruction. I include this because their views tend to not correlate with reform efforts. This is extremely important because teacher’s beliefs play a significant role in their classroom practices and implementation of reform-based curriculums (Roerhig & Kruse, 2005). In addition, the first segment will discuss findings in the literature suggesting that beliefs of preservice teachers can be changed and how those views need to change to correlate with the vision set forth by the NCTM.

The second segment will discuss Cognitively Guided Instruction (CGI). CGI is an approach to mathematics instruction that aligns with the NCTM Standards. Teachers using a CGI approach strive for students to conceptually understand mathematic ideas. Being able to notice student thinking is the key ingredient to this method along with being able to utilize student thinking in subsequent interactions with the students.

Finally, two strategies to prepare preservice teachers to utilize what they know about student thinking to inform their pedagogical decisions are reviewed. While there are many strategies that can be used in preservice teacher education classrooms, this review focuses on using video and examining student work. I chose these two frameworks because the literature suggests that using video and examining student work provides authentic contexts
and because they are currently being used in some math methods courses at Iowa State University. In addition to the literature concerning video, an examination on noticing classroom interactions pertaining to student thinking will be provided because noticing entails determining what is important in a teaching situation.

Methodology

My methodology for the literature review consisted of searching three electronic databases. These were the educational abstract database at Iowa State University, ERIC, and the Education and Information Technology Library. The keywords video and preservice teachers were used. An alternative word that I used in place of video was video cases. These searches provided several hundred articles. I narrowed down which articles to examine by focusing on articles that pertained to mathematics education, analyzing student thinking, and noticing classroom interactions. After finding a relevant article by a particular author, I would then do a search using the author’s name. I also searched the Internet using Google Scholar as a search engine using the same search terms.

Consultation with an expert in mathematics education indicated that I should review two key books, *Using Video in Teacher Education* and *Beyond Classical Pedagogy: Teaching Elementary School Mathematics*. The former provided substantial information regarding video use to inform instructional practice with preservice and practicing teachers. I examined the book in detail. Miriam Sherin’s chapter, *New Perspectives on the Role of Video in Teacher Education*, gave a history on the use of video in teacher education. Subsequent chapters described studies conducted regarding video use in teacher education. Additional resources were obtained by referring to the references section of each chapter.
Beyond Classical Pedagogy: Teaching Elementary School Mathematics supplied information regarding pedagogical practice with regard to mathematics instruction. I specifically examined the chapters concerning CGI. However, those chapters did not provide much empirical evidence that CGI was an effective pedagogical practice for students. Therefore, I did a search using the above databases using the term, CGI. The same team of researchers developed most of the research concerning CGI. Other references were found using their names as search terms. Again, additional resources were obtained by referring to the references section of each chapter and journal article.

Perceptions of Preservice Teachers

The state of mathematics education has been an area of concern and a focal point of reform efforts dating back at least to the early 1800s (Wilson, 2003). Traditionally, the focus of mathematics instruction has been on procedures to solve problems without giving students a basis for why the procedures work. In addition, there has been prevalence of drilling math skills with worksheets and of teachers talking while students memorize (Wilson, 2003). Today, this concern still exists as math is still taught in much of the same manner.

In the United States, widespread reform efforts began when the NCTM published Curriculum and Evaluation Standards for School Mathematics in 1989. This document “made recommendations for improving and updating the mathematics curriculum and the evaluation of students’ achievement” (Wilson, p. 25, 2003). The focus of reform efforts was for mathematics instruction to concentrate on conceptual knowledge as well as procedural knowledge. This is indicated in their publication when the NCTM discusses that “students
will reach certain levels of conceptual understanding and procedural fluency” (NCTM, p. 7, 2000).

Despite efforts made by reform groups and the NCTM, conceptual approaches to mathematics instruction are not common in today’s classrooms. Therefore, most, if not all preservice teachers in any given methods classroom are unfamiliar with a conceptual approach to instruction and the teacher’s role in facilitating instruction in this manner. This is evidenced by a study conducted by the National Center for Research on Teacher and Learning (1993, cited in Wang & Hartley, 2003). It found that preservice teachers tend to view the discipline of mathematics as a set of procedures to be memorized through practice (Wang & Hartley, 2003).

These findings present a challenge to methods instructors. Changing preservice teachers’ ideas about teaching has become an emphasis for teacher education programs (Wang & Hartley, 2003). Concerning mathematics education, a need exists for preservice teachers to alter their view of the discipline as a set of procedures to one of a collection of mathematical strands that are highly interconnected (NCTM, 2000).

In their research, Philipp et al. found that the beliefs of preservice teachers can change. They “tended to change when they were engaged in mathematical activities designed to position them either to act or to consider how to act with children” (revision in progress, p. 41). This suggests that teacher education programs should provide opportunities that allow preservice teachers to consider how to act with children.

Furthermore, a survey was developed by a team of researchers to measure the beliefs of preservice teachers before and after they were enrolled in a mathematics course (Ambrose, Philipp, Chauvot, & Clement, 2003). Specifically, they looked at three different
beliefs. 1) Mathematics, including school mathematics, is a web of interrelated concepts and procedures. 2) Understanding mathematical concepts is more powerful and more generative than remembering mathematical procedures. 3) During interactions related to the learning of mathematics, the teacher should allow the children to do as much of the thinking as possible.

During the course, preservice teachers explored video clips and learning episodes pertaining to children’s mathematical thinking. The researchers found that the beliefs of preservice teachers did change. The pre-test indicated that there was no evidence that the majority of preservice teachers believed in the notions listed above. After the course, there was evidence that indicated that more of the preservice teachers believed in those same concepts.

Another challenge that presents itself in changing preservice teachers’ beliefs is to create meaningful contexts for learning (Wang & Hartley, 2003). Clearly, the authentic context for preservice teachers is the classroom. However, there are still many unanswered questions concerning which classroom contexts are most meaningful and can prompt a change in the beliefs of preservice teachers.

Cognitively Guided Instruction

CGI is quite different from the traditional teaching focus on mathematical procedures, because the practice does not entail telling students how to solve problems. Instead, its focal point is on “understanding how children’s mathematical thinking develops and reflecting on how to help children build up their concepts from within” (Carpenter et al., p. xiv, 1999). “The major thesis behind CGI is that children bring to school informal or intuitive knowledge of mathematics that can serve as the basis for developing much of the
formal mathematics of the primary school curriculum” (Carpenter et al., p.6, 1996).

Essentially, students are constructing and building upon their own knowledge of mathematics.

“A significant alternative to the typical preparation of teachers to manage activities within reform-minded curriculum is evident in research-based professional programs such as Cognitively Guided Instruction” (Rhine, p. 27, 1998). Through my work with the mathematics education department at Iowa State University, I have come to know a number of mathematics methods instructors explore CGI in their courses. However, the number of universities that include CGI in their coursework across the nation is unknown because there is no research to indicate the number.

Inclusion of CGI approaches in teacher education programs is supported by the research conducted by Philipp et al. (revision in progress). Their work found that, “those who studied children’s mathematical thinking while learning mathematics developed more sophisticated beliefs about mathematics, teaching, and learning and improved their mathematical content knowledge more than those who did not” (n.d., revision in progress). Whether preservice teachers use a CGI approach to future teaching or not, the literature suggests that understanding how students think is vital for increased K-12 student achievement. Therefore, teacher preparation programs should consider providing opportunities for analysis in their coursework.

Students in CGI classrooms are given problems to solve, but they are facilitated to invent their own strategies to find the solution. After students have finished solving their problems, they are then asked to share their solutions with their class. The intent is to have students communicate their mathematical ideas with their peers, and for teachers to
understand those ideas. As students solve more problems, they begin to develop more efficient strategies (Carpenter et al., 1999). Fundamentally, they understand the mathematical concepts embedded in a problem instead of memorizing a procedure that is used to solve.

To give the reader a clearer image of how a CGI classroom may be facilitated, I include an excerpt from a study conducted by Carpenter et al. (1996). The class was given a word problem that involved the sum 54 + 48. After working on the problem for several minutes, students shared their strategies with the class. This is an exchange between Ellen; the teacher, Ms. G; and Norman, another student in the class.

**Ellen**: [Makes 54 and 48 with tens and ones blocks] I knew this was 54, so I went 64, 74, 84, 94 [Ellen moves one ten block for each count. Then she counts the single cubes, moving a cube with each count.], 95, 96, …, 102.

**Ms. G**: Now class, what question am I going to ask her? Norman?

**Norman**: You didn’t use the 54; did you have to make it?

**Ms. G**: Good Norman, that is just what I was going to ask her. Ellen, did you need to make that 54?

**Ellen**: No.

**Ms. G**: [Pulls the 54 away and covers it with her hand.] Ok, now show me how you can solve the problem without the 54.

**Ellen**: 64, 74…[Repeats the above strategy, counting on without the 54].

**Ms G**: Ok, now you told me that you could do this without moving to your desk. How would you have done that?
Ellen: Ok, I just put 54 in my head, and then I go 48 more. I go 54 [slight pause], 64, 74, 84, 94 [She puts up a finger with each count to keep track of the tens. At this point she has four fingers up. She puts down her fingers and puts them up again with each count as she continues counting by ones.] 95, 96, 97, …, 102. (Carpenter et al., p. 11, 1996)

In this one episode, Ellen uses three distinct strategies with different levels of abstraction (Carpenter et al, 1996). Ms. G and Norman facilitated the situation to lead Ellen to use more efficient problem solving strategies. She did not tell Ellen how to solve the problem, and it is evident from the excerpt that Ellen understands the problem. “The example suggests that students’ invented algorithms are constructed through progressive abstraction of their modeling procedures with blocks” (Carpenter et al, p. 12, 1996). It’s also obvious that this type of communication occurs frequently because Norman acted as a facilitator.

Carpenter, Fennema, Peterson, Chiang, & Loef conducted a study that explored the effects of a program that provided teachers with detailed knowledge about children’s thinking (p. 502, 1989). Forty first-grade teachers participated in the study where half were assigned to a CGI treatment group. For some of the data, there was no significant difference between the CGI group and the control with regards to student achievement. However, on an exam that tested complex addition and subtraction word problems, students in CGI classrooms outperformed the control group (Carpenter et al, 1989). Researchers also reported that the CGI students had more confidence in their abilities to solve problems. “In
addition, CGI students reported significantly greater understanding of mathematics than did control students” (Carpenter et al, p. 525, 1989).

An additional study examining the role of using children’s thinking in mathematics instruction was conducted by a group of researchers from the University of Wisconsin-Madison and the University of California at Los Angeles. “The study examined changes in the beliefs and instruction of twenty-one primary grade teachers over a 4-year period in which the teachers participated in a CGI teacher development program” (Fennema et al, p. 403, 1996). They found strong evidence to indicate that understanding children’s thinking is a powerful tool in changing instruction (Fennema et al, 1996). With regard to students, the changes in their learning were considerable. In addition to the data that was collected, teachers reported that students could solve more problems, were more enthusiastic about math, and were eager to discuss their thinking (Fennema, p. 431, 1996).

The teacher’s role in a CGI classroom is to “continually upgrade their understanding of how each child thinks, select activities that will engage all the children in problem solving and enable their mathematical knowledge to grow, and create a learning environment where all children are able to communicate about their thinking and feel good about themselves in relation to mathematics” (Carpenter et al., 1999). This suggests that teachers should be able to effectively analyze student thinking to make useful pedagogical decisions, which explains the complexity of how to prepare preservice teachers for their future classrooms.

In the literature, there is strong evidence of the effectiveness for CGI based professional development with in-service teachers. However, we don’t know very much yet about its effectiveness with preservice teachers. We could assume, based on the work with in-service teachers, that it will be effective. But we have little evidence that determines
effective strategies to help preservice teachers learn about student thinking. This study adds to that body of literature, which I will discuss in detail in Chapter Five.

Because being able to analyze student thinking is critical to CGI, I chose to examine four authentic contexts into which preservice teachers are presented with student thinking. Student work and video clips were collected by preservice teachers from their practicum experience and shared in their math methods classroom. The instructor provided other student work and video clips. These artifacts were used to prompt discussion pertaining to student thinking. The discussion was analyzed to determine what type of discussion was encouraged by each different context.

Use of Video

“Prospective teachers need authentic situations that require them to engage in the kinds of thinking and problem solving that more experienced teachers use” (Bliss & Reynolds, p. 31, 2004). One strategy to bring classroom situations, an authentic context, to preservice teachers is to utilize video clips of classrooms and students working in teacher education programs. Video clips have been used in a variety of ways in teacher preparation since the 1960s. Sherin (2004) provides a history of video use in her chapter, *New Perspectives on the Role of Video in Teacher Education*. The following paragraph is a brief summary of this chapter.

When video equipment became less expensive and more portable in the 1960s, universities and colleges across the nation soon used videotaped observations as part of teacher preparation (Sherin, 2004). Many applications of video have been used throughout the years. Microteaching entailed videotaping a brief lesson and then the participant would
analyze the video to determine successes (Sherin, 2004). Interaction analysis became popular in the 1970s and modeling expert teaching in the 1980s. Video has also been used to observe teaching cases where the goal was reflection and the development of teacher’s professional knowledge (Sherin, 2004). “In the early 1990s hypermedia programs for teacher education began to appear in which video was linked to text and graphics” (Sherin, p. 7, 2004). This allowed teachers to view video in different ways. Finally, video has been used to record field observations.

In her examination of video use, Sherin (2004) found several characteristics of video that can enhance a teacher education program. Video clips offer a lasting record (Latour, 1990 cited in Sherin, 2004), which can be replayed as many times as the viewers wish. Viewing video clips can be more effective than an actual live observation in terms of opportunities for analysis and reflection. “Live observations do not always provide novice and preservice teachers opportunities for focused critical analysis and deep reflection” (Stephens, p.76, 2004). When observing a live classroom, the moment is lost once it has passed. It is also difficult to notice a specific interaction when so much can be happening in a classroom. But a video clip allows for a more focused analysis and reflection because the viewer can replay.

Furthermore, the clip can be edited after it is collected. Video editing allows for teachers to choose segments based on a specific goal (van Es & Sherin, 2002). Frederiksen (1992) discusses the possibility of creating video libraries (cited in Sherin, 2004). For example, researchers at San Diego State University established a video library of clips exhibiting children solving problems.
Because of the distinguishing features of video, “it is possible to design a new set of practices for teachers based on repeated viewings and reorganizations of video” (Sherin, p. 13, 2004). She offers examples as to what types of practices video gives opportunities for that are quite different from typical pedagogical practices. As discussed in the preceding paragraph, video offers the viewer time for reflection and for detailed analysis. Teachers can think about what they want to say without having to act immediately. Moreover, video allows teachers to observe different teaching strategies. Sherin further explains that, “video allows one to enter the world of the classroom without having to be in the position of teaching-in-the-moment and to manipulate that world in ways not possible without the video record” (p. 13, 2004).

The importance of material to stimulate high quality reflection is a reoccurring theme in the literature. Reflection “refers to a purposeful, systemic inquiry into one’s personal theories about teaching and learning and the practices guided by these theories” (Abell & Cennamo, p. 109, 2004). Rodgers (2002) proclaims, “Thinking, particularly reflective thinking or inquiry, is essential to both teachers' and students' learning.” “Reflective teachers are able to think about their own or someone else’s teaching, reframe problems, compare practice with personal theories, and take new actions” (Munby & Russell, 1992 cited in Abell & Cennamo, p. 110, 2004).

In working with preservice teachers, Philipp, Thanheiser, and Clement (2002) found that using video to stimulate reflection is of particular importance. It prompts deeper and more specific discussion than without it. Their work consisted of centering classroom discussions around video clips of elementary children working on math problems.
Many others have found the distinguishing features of video to be helpful in their teaching. Bliss & Reynolds (2004) found that working with written case studies in teacher preparation classes had limitations because they have “limited capacity to simultaneously show teacher actions and students response” (p. 31). Thus, they began using docucases. Docucases were a video curriculum for teacher education and found that they were valuable in prompting discussion and reflection. Furthermore, they conducted a survey and found that 91% of the participants (preservice teachers) preferred viewing a video to reading a written case. They highlighted three main reasons why: video enables viewers to gain a richer understanding of the case by engaging their senses and emotions; video keeps a viewer from imagining what is not warranted; and video allows a viewer to see subtle communication and body language between teacher and student (Bliss & Reynolds, p.41, 2004).

Additionally, Abell and Cennamo (2004) used videocases in an elementary science teacher preparation class. They conjectured that, “videocases would allow students to enter a complex world and witness events as they unfolded from both teacher and student points of view” (Abell & Cennamo, p. 105, 2004). They found that the videocases helped preservice teachers to “think like a teacher as they refined their personal theories of science teaching and learning (Abell & Cennamo, p. 117, 2004).

Sherin’s work consists of working with teachers using video clubs. “In a video club, a group of teachers meet regularly to watch and discuss video excerpts from their classrooms” (Sherin, p.15, 2004). She found that teachers reacted differently to situations that were on the video compared to how they would respond in a typical teaching situation (Gamoran, 1995 cited in Sherin, p. 16, 2004). They were able to reflect upon the classroom situation rather than react.
Although video clips are an effective strategy to prepare preservice teachers, attention needs to be given to directing attention toward noticing certain situations. Sherin has found that teachers tend to focus on pedagogical issues first and foremost when viewing video clips (2001 & 2004). Her work involves video clubs where excerpts of teachers’ classrooms are taken and then later shown to them for analysis. After a prolonged viewing of clips, a shift occurs where the teachers start to focus more on what the students are doing.

The above work illustrated that when viewing classroom situations, preservice teachers tend to be more focused on what the teacher is doing rather than on the student. Although observing pedagogical strategies can be valuable, the premise behind CGI is to be able to analyze student thinking. The thesis supporting CGI correlates with Sherin’s work in that preservice teachers need to notice classroom situations where students are exhibiting their thinking. However, it is not known if video allows preservice teachers to notice student thinking in the way that is required for CGI.

Noticing Classroom Interactions

“Noticing involves being able to identify what is important in a teaching situation” (Frederiksen, 1992; Leinhardt et al., 1991; cited in van Es and Sherin, 2002). van Es and Sherin (2002) identify three key aspects for what it means to be able to notice classroom interactions: “(a) identifying what is important or noteworthy about a classroom situation; (b) making connections between the specifics of classroom interactions and the broader principles of teaching and learning they represent; and (c) using what one knows about the context to reason about classroom interactions” (p. 572).
While working with teachers in CGI classrooms, Carpenter, Ansell, and Levi, “try to reframe teachers’ thinking about their teaching so that the emphasis is on the development of student thinking rather than on teacher actions” (p. 30, 2001). For a CGI classroom to be facilitated effectively, teachers need to “notice” instances of student thinking, but that is not what teachers have a tendency to notice first while viewing video of themselves or others teaching. While working with teachers in video clubs, Sherin and van Es (2005) found that teachers direct their attention to pedagogy issues. However, over the course of the study, teachers focused their attention toward the students, and more specifically, student thinking (Sherin & van Es, 2005). This is the progression that Sherin became aware of with practicing teachers, but we cannot assume from that information that preservice teachers would do the same.

In another study, Sherin (2001) discusses developing a professional vision of classroom events while telling David’s story. Sherin videotaped David teaching mathematics. Initially, David would ask her questions concerning his pedagogy. Therefore, “David’s professional vision focused on pedagogy” (Sherin, p. 79, 2001). “Professional vision involves socially organized ways of seeing and understanding events that are answerable to the distinctive interests of a particular social group” (Goodwin, 1994; cited in Sherin, 2001). She identifies three factors that contribute to the development of a professional vision - the individual’s role in the classroom, the medium through which one observes a class, and the strategies one uses to interpret interactions (Sherin, 2001). Each of these factors is described in the following three paragraphs.

“One’s role in the classroom clearly influences one’s perspective on classroom practice” (Sherin, p. 87, 2001). Teachers tend to focus on classroom interactions in terms of
pedagogy. That is not to say that this role is not valuable, but playing out other roles, such as an observer, can be valuable for student achievement. Throughout the course of Sherin’s study, David shifted his role in the classroom similar to the teachers discussed earlier. He had taken on the role of observer through the use of video. Through video, he felt that he could choose where to focus his attention, which was difficult while teaching. He could focus on classroom interactions while viewing videos that he could not focus on while teaching. “He began to closely examine the student ideas that arose as well as to consider the mathematics that was discussed” (Sherin, 81, 2001).

Second, the medium through which a classroom is viewed affects the development of a professional teaching vision. Sherin (2001) discusses three mediums; observing, teaching, and viewing video. Information gathered from teaching or observing is different from viewing video. “The information one receives as a teacher is very different from the information presented to a classroom observer” (Sherin, p. 88, 2001). An unfamiliar observer may be able to see more in the classroom than the teacher, but would not be aware of background information. However, while viewing video, the teacher can direct her attention to interactions she was unable to notice while teaching. These three different mediums affect where one focuses their attention.

Finally, the development of a professional vision also relies on the strategies one uses to interpret classroom interactions. “Teachers tend to look at classroom practice on a broader scale, keeping track of multiple issues and decisions at the same time and assessing classroom practice as a whole” (Sherin, p. 89, 2001). On the other hand, researchers tend to choose a focus for their examination (Sherin, 2001). For instance, a researcher may choose to focus on student thinking to understand how students are developing mathematical
concepts. While they do this, they tend to utilize certain strategies that allow them to interpret the interaction.

In Sherin’s studies, it’s evident that teachers focus first on what the teacher is doing. After prolonged viewing of video clips, the focus shifts to what the students are doing. However, more research can be done as to what contexts is more meaningful and prompt deeper reflection with preservice teachers. This is needed because these studies were conducted with practicing teachers, and there is a limited amount of time that preservice teachers spend in a methods class.

In this project, preservice teachers were observers. They observed student thinking through two different mediums - video and written work - in two different contexts. Furthermore, they were given a strategy for interpretation by the professor when she asked them to talk specifically about student thinking. Through my analysis, I determined how these factors affected what preservice teachers talked about.

Examining Written Work

Another context in which preservice teachers can examine student thinking is through written work. Teacher educators have found student work to be useful in prompting preservice teachers to discuss student thinking (Jacobs & Philipp, 2004). “The use of student work has the potential to influence professional discourse about teaching and learning, to engage teachers in a cycle of experimentation and reflection and to shift teachers’ focus from one of general pedagogy to one that is particularly connected to their own students” (Kazemi & Franke, p. 204, 2004).
Kazemi and Franke’s work consists of audio taping ten teachers as they met regularly during the school year to discuss student work examples (2004). Similar to Sherin’s work with video clubs, they found that shifts occurred in the way that the teachers participated during the meetings. The first shift that occurred was centered on student thinking. At first, teachers were uncertain and unaware about how children think, but as they continued to work, they began to detail students’ strategies (Kazemi & Franke, 2004). In addition, the participants “learned that the practice of detailing students’ strategies provided opportunities to recognize that students have powerful mathematical ideas” (p. 223).

In another study, Franke et al. worked with a group of teachers at an elementary school that utilized student work examples as a basis for discussion (2005). Teachers brought student work to staff meetings to discuss. Through the course of the study, the researchers found that a similar shift occurred as in the Kazemi and Franke (2004) study discussed above. The staff found the experience so valuable that they continue the meetings on their own without facilitation by the researchers (Franke et al., 2005). Furthermore, the principal switched from conducting the standard classroom observations for teacher evaluations to a meeting where they discuss student work instead.

Little empirical research has been conducted on the use of student work (Kazemi & Franke, 2004) particularly with preservice teachers. The work of Franke et al. has mostly been with in-service teachers. Therefore, it’s not surprising that little guidance exists for how to use student work with preservice teachers (Jacobs & Philipp, 2004). Through their work, Jacobs and Philipp have developed a set of questions to focus preservice and practicing teachers on the mathematics thinking in student work. They have found that an effective approach is to focus discussions primarily on understanding the child’s strategy
first, and then to ask teachers to think about the relationship between the child’s thinking and the underlying mathematics (Jacobs & Philipp, 2004). These questions are stated below:

- How did the child solve this problem?
- Why might the child have done… (insert some specific aspect of the child’s strategy)?
- What is the mathematics embedded in this strategy?
- What questions could you ask to help the child reflect on the strategy?
- What questions might encourage the child to consider a more efficient strategy?
- On the basis of the child’s existing understanding, what problem might you pose next and how might the child solve it?

All the studies described in this review involved teachers analyzing their own students’ thinking, but no studies were found that described instances where teachers were given work from students with whom they did not have any experience. Furthermore, these studies were conducted with practicing teachers. Again, given the limited time in a methods course, more can be learned of how to best help preservice teachers. Preservice teachers in this project will be presented with student work from their own or classmates’ practicum experiences and student work provided by the instructor. The discussion following the presentations of student work will be analyzed to determine the type of discourse that ensued.
Summary

The vision set forth by the NCTM calls for a more conceptual understanding of mathematical concepts. Traditional approaches of memorizing a set of procedures do not lead students to conceptual understanding. Research-based approaches may need to be used for this to happen. One approach that focuses on student thinking and can lead teachers and students to deeper mathematical understanding is Cognitively Guided Instruction. The research discussed indicates that CGI can lead to increased mathematical understanding and confidence to solve problems.

Preparing preservice teachers to use their student’s mathematical thinking to inform their pedagogical decisions is a challenge because they typically view mathematics as a set of procedures. However, it has been found that their beliefs can change if they are engaged with activities that consider how to act with children. But the question still remains as to how best prepare preservice teachers for classroom practice.

It has been found that using student work and video can support preservice teachers in reflection and professional growth. It is also evident that the authentic context can be well represented with video and student work. However, more could be understood as to which contexts can be most effective in changing beliefs and greater understanding of student thinking. It’s evident that the contexts described in the review are effective, but they have not been compared within the same strategy. Furthermore, more can be learned as to which factors of the authentic contexts lead to greater understanding.
CHAPTER THREE

METHODOLOGY

The research approach used was a basic qualitative study. “In conducting a basic qualitative study, you seek to discover and understand a phenomenon, a process, the perspectives and worldviews of the people involve, or a combination of these” (Merriam & Associates, p. 6, 2002). This approach was used because I wanted to understand what preservice teachers thought about and considered when viewing student thinking in the different contexts presented. Furthermore, I wanted to understand how they were making meaning out of the contexts presented (Merriam & Associates, 2002).

Sample

Purposeful sampling was utilized for this project, which is based on the idea that the researcher wants to explore and understand. Therefore, the researcher must choose a sample from which the most can be learned (Merriam, 1998). This type of sampling is appropriate as I sought to gain insight into how preservice teachers understand student thinking. My goal is to be able to help preservice teachers learn about student thinking.

Because of my association with Iowa State University, I was able to choose my sample population from a course in the teacher education program. Dr. Sarah Walsh teaches a math methods course entitled Teaching Children Mathematics. Along with the course, preservice teachers are required to be enrolled in one credit of field experience, in which students spend approximately sixty hours in classrooms performing various tasks. While in the methods course, preservice teachers explore CGI through their textbooks, discussions with Dr. Walsh, watching video clips, examining student work, and teaching a CGI lesson in
their field experience. Thus, two of the contexts that I wanted to examine were already in place. Dr. Walsh and I only had to ask for volunteers to interview students from their field experience and to bring student work examples to class.

This study took place during the fall semester of 2006. There were twenty-four students participating in the course, twenty-one females and three males. Three females were nontraditional students. By nontraditional, I mean that these students did not attend college immediately after they graduated from high school. The make-up of this group represents a typical sample (Esterberg, 2002) because it’s comparable to a typical class of preservice teachers taking a math methods course in the teacher preparation program at Iowa State University.

Data Sources and Collection

The primary data source was observations of the methods course while the class was engaged in discussions centered on student thinking. Observation data was collected on four different dates for the four different contexts using a video recorder. After each context was presented, the preservice teachers were prompted to engage in discussion concerning the student work involved. How the context was presented and subsequent conversations were videotaped. Videotaping was chosen in order to be able to analyze the data intensely, which would involve repeated viewings. Video clips were then imported into iMovie, converted into QuickTime format, and burned onto a CD. The following paragraphs will provide specific details regarding the four contexts that were presented.

The first video clips shown were from the IMAP series developed by researchers from San Diego State University (Philipp & Cabral, 2005). The series was created
specifically to integrate children’s thinking into mathematics content and methods courses for preservice teachers. The clips were chosen because it involved students solving a specific problem type – “join: change unknown.”

A “join: change-unknown” problem is one of eleven different addition and subtraction problem types identified in Cognitively Guided Instruction. “Join problems involve a direct or implied action in which a set is increased by a particular amount” (Carpenter et al, p. 7, 1999). “Change-unknown” signifies that second quantity or the change is unknown (Carpenter, 1999). An example of this problem type is “Marcy has read seven books. How many more does she need to read to have read ten?” This problem type was chosen because the professor and myself thought it might prompt some interesting strategies from students. “Join: change-unknown” problems can be solved using addition or subtraction, and it may be a problem type that students are not used to. One clip that showed three different students from the IMAP series was shown to the preservice teachers.

All three students were solving the same problem type and involved the same numbers, but all three used different problem-solving strategies. This was also intended by the IMAP authors so that preservice teachers could observe the three levels of problem-solving techniques described in Cognitively Guided Instruction, which are direct modeling, counting, and number facts. Direct modeling involves children using physical objects or counters to represent the problem. Over time, counting replaces direct modeling, which does not require the use of blocks but may use some other means (i.e. finger-counting) to keep track of numbers (Carpenter et al, 1999). Use of derived facts follows the use of counting strategies. This entails students using their developing knowledge of number facts.
(Carpenter et al., 1999). An example of a derived fact is “6 + 7 is one more than 6 + 6” (Carpenter et al., p. 30, 1999).

Second, preservice teachers were shown video clips from their own and classmates’ interactions with elementary students from their field experiences. Three preservice teachers volunteered to collect clips of interviews they would conduct with students solving problems. Each preservice teacher created a “join: change-unknown problem” to remain consistent with the problem type that was shown from the IMAP series.

Jackie (a pseudonym) interviewed two students, while the other two preservice teachers, Lorena and Derik (also pseudonyms), each interviewed one student. Jackie indicated to me that she purposely picked one student who she thought was low-achieving and one who was a little higher. Lorena chose a student who was one of the lowest achieving students in the class according to her cooperating teacher. Derik also stated that his student was low-achieving, but was fairly confident in her mathematical ability.

Jackie’s interview took place at a table in the classroom, but set some distance away from the other students. She gave her students several problems to solve, but the methods class viewed only one of these problems. Lorena and Derik’s interviews took place in the hallway outside the classroom. Each interviewer provided paper and linking cubes for the students to use. I videotaped each interview, and then imported the clips into iMovie. After that, the clips were combined into one QuickTime movie with titles in-between to introduce each interview to the methods class.

The third context was one where preservice teachers explored written student work provided by the professor. Preservice teachers saw five examples (See Appendix A) of students’ written work for the problem: “Anna has 47 crayons. How many more does she
need to get so that she will have 112 crayons altogether.” This is also a “join: change-
unknown” problem. Each student used a distinctly different strategy that resulted in a variety
of answers.

Lastly, all participants were asked to collect student work from their practicum
experience. They could present the work in any form that they chose. More specifically, they
could share the actual work, orally describe the work, or illustrate the work on the
whiteboard. Four participants chose to share work they had collected.

After each context was presented, the professor used the discussion prompts, when
appropriate, from the Philipp and Jacobs work described in Chapter Two. Those questions
are listed below.

- How did the child solve this problem?
- Why might the child have done… (insert some specific aspect of the child’s
  strategy)?
- What is the mathematics embedded in this strategy?
- What questions could you ask to help the child reflect on the strategy?
- What questions might encourage the child to consider a more efficient strategy?
- On the basis of the child’s existing understanding, what problem might you pose
  next and how might the child solve it?

In addition to observation data, interview data were collected. Preservice teachers
enrolled in the course were asked to volunteer for an interview session. Interview questions
for this project were asked in conjunction with questions that pertained to a larger study conducted by Dr. Walsh. I’ve listed the interview questions below.

1. You watched several video clips this semester of children working on math problems. How, if at all, did watching the clips help you understand how children think about mathematics?
2. Were any of the clips more helpful than others?
3. Some of the class members brought in video clips or student work they had collected themselves to share with the class. How, if at all, did this differ from the video clips the professor brought in terms of helping you understand children’s thinking?

The Role of the Researcher

My role was primarily one of data collector. I was introduced to the preservice teachers at the beginning of the semester as a member of the research team along with others who were working on Dr. Walsh’s study. My interactions with the participants were minimal. I never discussed the project with any of them. I simply videotaped the discussion sessions.

Another individual who was already conducting an interview for the larger project collected the interview data. I believed this was the best way to obtain interview data because the participants had already been asked to complete an interview. I didn’t feel that they would be willing to participate in two separate interviews. Therefore, this was the best way to obtain the most interview data.
Method of Analyzing and Interpreting Data

Data analysis is the process of making meaning, and the first step is coding the data (Esterberg, 2002). The intent is to focus on the meaning your data may potentially possess (Esterberg, p. 158, 2002). I began this process by viewing the videotapes of the four conversations and taking notes pertaining to what I thought were the main topics of conversations. Along with these notes, I considered Sherin and van Es’s (2005) work that was described in Chapter Two and the premises behind CGI to develop an initial list of codes.

Then, I examined the conversations for a second time. While doing this, I wrote down the time each preservice teacher took a turn and attempted to apply a code to that particular turn. After this, I eliminated some codes, as they did not apply and created new codes, because I didn’t have any to describe some turns. After several viewings and comparing all the contexts, I refined my list, which is given at the end of this chapter. The following paragraphs describe my general thought processes during the development of codes.

When Sherin and van Es’s (2005) coded their data regarding video clubs, they used the following codes: pedagogy, student thinking, discourse, mathematics, and other. For this project, pedagogy was not relevant. No turns were taken to describe a teacher’s pedagogy because no teaching was present in the clips, only interviewing. Thus, possible teacher action was created to describe the instances where preservice teachers discussed how a teacher could act with a student. Possible teacher action to find out more was created, as it was more detailed in describing what preservice teachers were talking about. My goal was to distinguish between possible teacher actions in general from possible teacher action to find
out more because this second code was directly related to student thinking. In these instances, the preservice teachers had conjectures about what students could or couldn’t do and wanted to find more about their thinking through some type of action.

Instead of utilizing the code student thinking, I created two codes that pertained to student thinking. These were describing and conjecturing. There are distinct differences between the two that needed to be noted, but both codes corresponded with CGI principles. Jacobs and Philipp (2005) have found in their work that an effective approach when discussing student thinking with preservice teachers is to focus discussions primarily on understanding, or describing the child’s strategy first, and then to ask teachers to think about, or conjecture about, the relationship between the child’s thinking and the underlying mathematics. Because of this, I wanted to distinguish between turns taken describing the strategy and turns taken to make conjectures about the strategy.

There were several instances where the preservice teachers were talking about concepts other than student thinking. I wanted to pay particular attention to those instances as they can tell us information regarding what preservice teachers are thinking about when they are not thinking about student thinking. Many times they asked questions about how they should act with students. Thus, the code questioning future action was created. In addition to questioning how they should act, the preservice teachers would connect their personal experiences with the discussion in class. The code, personal experiences, was created to describe these instances.

During the discussion pertaining to collected student work, there were several comments made by preservice teachers that described how they felt during the process of collecting work. All of these comments were negative. It seems as if those who made the
comments were extremely unsure of themselves and prefaced presenting their work with negativity. I found these instances noteworthy as they have implications for future methods teaching situations. Thus, the code, *negativity*, was created.

After the above codes were utilized to describe turns, there were a few turns that had not yet been coded. I wanted all the turns to be coded, so I developed two more codes to describe these instances. *Asking to clarify* describes turns that preservice teachers took to ask questions to clarify how a student solved a problem. *Student feelings* describe turns where consideration for how a student might feel was discussed. A table describing the codes in further detail is provided at the end of this chapter.

Reliability and External Validity

Reliability refers to the extent to which the findings in a study can be replicated, but this concept can be problematic in the social sciences (Merriam & Associates, 2002). “Rather than insisting that others get the same results as the original researcher, reliability lies in others concurring that given the data collected, the results make sense – they are consistent and dependable” (Merriam & Associates, p. 27, 2002). Two strategies to ensure reliability in a qualitative study are to provide an audit trail and to conduct a peer examination. I provided an audit trail above when I described my process of analyzing data. In a qualitative study, the audit trail provides a description of how data were collected, how categories were established, and how decisions were made throughout the study (Merriam & Associates, 2002). In the next paragraph, I describe the peer examination.

After I coded all my observation data, Dr. Walsh coded segments of the data. This process consisted of Dr. Walsh watching a video clip along with the times each turn
occurred and description of the codes I had applied to the discourse to establish a framework for how I was coding the data. Then, she coded another segment of video without the codes that I applied. This resulted in 84% consistency. There were three instances where we didn’t quite agree. However, overlapping occurred in all three cases. For example, Dr. Walsh coded a turn as *describing* and *conjecturing*, whereas I coded it as solely *describing*.

To ensure external validity, I provide a rich, thick description in Chapter Four. Presenting a rich, thick description is a key strategy to establish external validity or generalizability in a qualitative study (Merriam & Associates, 2002). As the reader will see, I included several quotations from the discussions to support my analysis of the data.
<table>
<thead>
<tr>
<th><strong>Code</strong></th>
<th><strong>Description</strong></th>
<th><strong>Example</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Questioning future action</td>
<td>This code describes instances where preservice teachers asked how they should act with future students.</td>
<td>“Do we ever teach our kids how to explain a math problem?”</td>
</tr>
<tr>
<td>Describing</td>
<td>This code describes instances where a student strategy is described or simply repeated.</td>
<td>“She started at six and counted up to 13 on her fingers. Then, counted what was on her fingers, which was 7.”</td>
</tr>
<tr>
<td>Conjecturing</td>
<td>This code describes instances where conjectures about why a student did a certain action are discussed. It also pertains to discussion concerning what a student does or doesn’t know.</td>
<td>“He thought of 12, which is something that he knows how to add to. I think he misunderstood the problem, which is why he picked 12.”</td>
</tr>
<tr>
<td>Personal experiences</td>
<td>This code was applied to instances where the conversation was unrelated to the context, but related to a preservice teacher’s personal experience.</td>
<td>“I certainly remember being taught that way. All I would ever do when I got to word problems was be like ahh numbers and try to put random signs between them.”</td>
</tr>
<tr>
<td>Possible teacher action</td>
<td>This code describes instances where how a teacher should act was discussed. More specifically, it pertains to discussion about how teachers should act to lead students to the right answer.</td>
<td>“Show her that she has already counted out six. She doesn’t have to count that again, so start on the next number.”</td>
</tr>
<tr>
<td>Possible teacher action to find out more</td>
<td>This code also pertains to possible teacher action, but differs in the above code in that this describes instances where a teacher’s action was discussed to find out more information about what a student does or doesn’t know.</td>
<td>[Ask the student,] &quot;how did you know which number to subtract with?&quot;</td>
</tr>
<tr>
<td>Negativity</td>
<td>This code describes instances where preservice teachers describe their experience in a negative manner.</td>
<td>“I don’t know if I handled it very well.”</td>
</tr>
<tr>
<td>Asking to clarify</td>
<td>This code describes instances where preservice teachers asked a question to clarify a student strategy.</td>
<td>“What did they do?”</td>
</tr>
<tr>
<td>Student Feelings</td>
<td>This code was utilized to describe instances where preservice teachers discussed how a student might feel in a particular situation.</td>
<td>“I think that some might be embarrassed that everyone can do it in their head and they can’t.”</td>
</tr>
</tbody>
</table>
CHAPTER FOUR

RESULTS

A table is provided below that displays each context that was presented to the preservice teachers and the codes that were used to describe the conversations that were prompted by each context. The numbers represent how many instances each code was applied to a turn that was taken in each of the contexts. Tables indicating the amount of turns taken in each context are provided to provide a framework to describe and understand the data. The intent of including a table was not to statistically compare the different contexts, but rather to provide a description that captured the entire discussion and each turn within the discussion.

Table-2

<table>
<thead>
<tr>
<th></th>
<th>IMAP Clips</th>
<th>Student Collected Clips</th>
<th>Written Student Work</th>
<th>Collected Work</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>20</td>
<td>10</td>
<td>8</td>
<td>45</td>
</tr>
<tr>
<td>Conjecturing</td>
<td>4</td>
<td>13</td>
<td>21</td>
<td>7</td>
<td>45</td>
</tr>
<tr>
<td>Personal Experiences</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Possible Teacher Action</td>
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<td>11</td>
<td>6</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>Possible Teacher Action Find out More</td>
<td>0</td>
<td>4</td>
<td>13</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Negativity</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Questioning Future Action</td>
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<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
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<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Student Feelings</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>53</td>
<td>52</td>
<td>22</td>
<td>152</td>
</tr>
</tbody>
</table>
The following sections describe each context and the conversation that followed in more detail. Some dialogue is included to provide the reader a more concrete sense of the discourse. For the quotations, I used the acronym PST to refer to a preservice teacher. I also numbered the preservice teachers to illustrate how many different preservice teachers contributed to that particular conversation. The last sections pertain to three key findings that resulted from my analysis.

Viewing IMAP Clips

Video clips from the IMAP series developed by researchers at San Diego State University were the first context presented to the preservice teachers. One clip presenting three students were shown that each exhibited a student solving a “join: change-unknown problem” that involved the same numbers. In other words, all the problems were the same in that they were the same problem type and that the same numbers were used. For example, “Nicole had six stones. How many more stones does Nicole need to collect to have thirteen altogether?”

Each of the three students solved the problem they were presented with in a different manner. This was intended so that the preservice teachers could view the three levels of strategies described in the textbook, *Children’s Mathematics: Cognitively Guided Instruction* (Carpenter et al. 1999) The first student used direct modeling, which entails using counters to model the problem. The second student used a counting strategy, and the third student used derived numbers facts. All of the students in these clips answered the problem correctly.
After all three video clips were played, the professor asked the preservice teachers to explain the first student’s strategy. Below is the dialogue from that conversation. This was coded as two total turns relating to describing.

**PST #1:** Well, she started from like zero, ground zero. She took the six blocks and then she had to count up to six and then she kept counting and putting more blocks into her pile. Then she got to thirteen and then she separated out the six again and counted what she had left.

**Professor:** What is the name of this type of strategy?

**PST #2:** Direct modeling

For the second student, the discourse was similar. There were four turns taken and all pertained to describing. The student had used a counting strategy to solve the problem, but it was unclear if she had used her fingers or not to count. Therefore, all of those turns were about determining if the student had used her fingers to count. It was determined that the student had used her fingers to solve, but was trying to be discreet about it. The professor asked why a student might try to hide their fingers when solving a problem. Two preservice teachers guessed about why a student might do this. That discourse was coded as student feelings because they discussed how they thought a student might feel when they need to use their fingers to solve a problem.

The conservation was a little different for the third student. There was one turn taken to describe the strategy and then four turns were related to conjecturing. The student had also gotten the problem correct, but there was a discussion about if the student really knew
what he was doing. That dialogue is given below. The first turn from PST #1 was coded as describing and conjecturing because she did both in this instance. Thus, I counted it as two turns.

PST #1: He like took a number that he … six and then he thought of twelve, which is something that he knows how to add to. I think he misunderstood the problem, which is why he picked twelve. But, um 6 + 6 is twelve plus one more would be thirteen. So 6 + 1 = 7.

Professor: ...It’s an interesting question in this case, which is did he hear 12 so he thought about 6 and 6 is 12. Or did he hear thirteen, think I know six and six is twelve and one more is 7. Then when he was explaining kind of got confused in the twelve and the thirteen. Does anybody have any guesses about what he was thinking about?

PST #2: I think he did it by accident. I think he thought it was twelve.

PST #1: Cause he said six at first as the answer and he was so sure. So that’s why I think that.

PST #3: I think it was a little bit of both. He heard the question. Then his mind went automatically, oh I know six and six is twelve so the answer is…that’s when I think he did finish the problem. He just spit out six.

After each incident of student thinking was described and conjectured about, the professor asked the preservice teachers to discuss what a teacher could do to move students
to using more efficient strategies. Therefore, most of the remaining conversation (eight turns) can be coded as possible teacher action. Two examples are given below.

**Professor:** What could you say or ask or point out to that first student to help her think about that? (By that, the professor is referring to moving the student to a more efficient strategy.) What kind of connection could you make?

**PST #1:** That her way of doing it was basically the same thing, but she just took out, the counting person just took out the act of counting to six first.

**Professor:** Who can expand on that? What do you mean by basically the same thing? I think you’re exactly right.

**PST #2:** Show her that she has already counted out six, she doesn’t have to count that out again, so start on the next number.

Additionally in this conversation, there were four instances where a preservice teacher questioned future action, and one relating to personal experiences. The professor had asked the preservice teachers if there was anything else about the three students they would like to discuss. No turns in this conversation was coded as possible teacher action to find out more. This is notable because one of the premises behind CGI is for the teacher to create problems to test conjectures about what their students know. The first two examples below are of questioning future action and the third is of relating to personal experience. After each question, the professor addressed their concerns.
PST #1: When they’re told to explain it, do we teach our kids at all how to explain a math problem, because that’s a struggle?

PST #2: So do you never then sit down with kids and never explain to them base ten?

PST #3: I certainly remember being taught that way. All I would ever do when I got to word problems was be like ahh numbers and try to put random signs between them.

Viewing Collected Clips

Three preservice teachers volunteered to interview a student(s) solving a problem while being videotaped. In the interviews, they asked their students to solve one problem. Jackie interviewed two students, while Lorena and Derik each interviewed one. If they didn’t understand how their students solved the problem, they asked them to explain. Each preservice teacher created a “join: change-unknown” problem to remain consistent with the problem type that was shown from the IMAP series.

Before each clip was presented to the class, the professor asked if they wanted to provide any information pertaining to their student. Lorena’s interview was the first one that was shared, and she stated that her student was extremely low. I believe that she meant the student was low-achieving. Furthermore, she didn’t think he had ever used the blocks that were provided for direct modeling because he didn’t know what to do with them. After viewing the clip, the conversation that immediately ensued was detailed conjecturing. I consider this conversation detailed as evidenced by the number of turns preservice teachers
contributed to the conversation and because it delves deeply into this student’s thought processes. The conversation follows.

**PST #1:** He didn’t know what to do with the numbers. He didn’t know where to start.

**Professor:** O.K., he didn’t know what to do with the numbers. He didn’t know where to start. Macy, you said something similar?

**PST #2:** Yeah, he just didn’t know where to start.

**PST #3:** I don’t think he could understand what that thirteen meant. He could grasp the fact that he had six cookies. But, I don’t think he had any idea about that thirteen. Like why she even said it. He didn’t have any clue.

**Professor:** What’s your evidence that he knew something about the six?

**PST #2:** He set out six blocks. [This was coded as describing.]

**PST #3:** Yeah, he wrote six at the top of the paper when she said that. But then when the thirteen came, he wrote it down, but I don’t think he knew what it represented. The fact that that’s how many cookies he needed in the end.

**PST #2:** I think he kind of knew that he had to add to the six because he went from thirteen to fourteen. So, he knew that he needed to add somewhere, but he wasn’t sure exactly where.

**Professor:** The professor summarized what had been said and then asked the class what was hard for this student.

**PST #4:** The change part. He’s not used to that kind of problem I don’t think.
After this excerpt, the professor asked what they would do with the student next. Most of this dialogue was coded as *possible teacher action*, and *possible teacher action to find out more*. A portion of the conversation follows this paragraph. I identified the preservice teacher’s as PST #5, PST #2, and PST #6 because it’s a continuation of the conversation above.

**Professor:** Let’s say that you are in the teacher’s position and you are going to pose a next problem to this student. What problem might you pose next to him?

**PST #5:** I think that I would want to do a “join: result –unknown” just to see if he understands addition or if it was just the change part that threw him off. Or if he really doesn’t know what to do with any numbers at all. I don’t think you can entirely tell what he knows from this. (Coded as *possible teacher action to find out more*)

**Professor:** After confirming thoughts given by PST #5, the professor asked, what other questions might you have that you would want to test out?

**PST #2:** I would maybe just try smaller numbers that don’t have the double-digits. Like, I had four cookies and I wanted five; something smaller so he could grasp it better. (Coded as *possible teacher action to find out more*)

Later on in the conversation…

**PST #6:** I was also thinking that it seemed a little frustrating for him, you might want to give him a problem that you’re pretty sure that he’s going to get right. Second – so he’s willing to keep doing things that are challenging for him rather than being like no, I don’t want to do that either. (Coded as *possible teacher action*)
The table below summarizes the codes that were used to describe the entire conversation pertaining to Lorena’s student.

Table-3

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Lorena did not contribute to the dialogue. However, when asked at the end of the conversation if she wanted to add anything, she explained that she tried some additional problems that contained smaller numbers with him after her initial problem, and that he was able to use the blocks to solve. This was in response to another preservice teacher’s suggestion to use smaller numbers with him. She also mentioned that he guessed to solve several of the problems that she presented to him.

Derik’s interview was shown next. He prefaced the clip by saying that the student has trouble with math, and that she was pretty sure of herself during the interview, but did not solve the problem correctly. There were thirteen instances of preservice teachers contributing to the conversation, which are outlined in the table below.

Table-4

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As with Lorena, Derik did not contribute to the conversation. At the end of the conversation, when asked if he wanted to add anything, he discussed that he didn’t want to read the problem a second time to his student because he didn’t want to discourage her. This was in response to a classmate suggesting that Derik could have repeated the problem to the
student. He also mentioned that if he were to do it again, he would encourage her to use the blocks.

Jackie’s interview was the last to be shown. This conversation differed from the other two in several ways. First, it was extremely difficult to code because there were no distinct patterns to this discourse. It was tremendously random. For instance, several of the other conversations began with *describing* and *conjecturing* about the student strategy and then would move on to other aspects. But in this conversation, *describing* occurred throughout the entire conversation.

Second, because Jackie chose to interview two students, much of the initial conversation focused on that situation (interviewing two students at the same time) along with Jackie *describing* the students’ strategies. One of the preservice teachers felt that if a teacher was going to interview two students, they should be at the same level because the girl in the clip wanted to talk more. Another wondered if Jackie should have interviewed the students separately, so the girl would have been able to talk more. Three turns discussed this notion and were coded *possible teacher action*.

Other than the three turns described above about interviewing two students, there were twelve instances where preservice teachers other than Jackie contributed to the conversation. The amount of turns taken is comparable to the turns taken regarding Derik and Lorena’s students. However, almost all of it was focused on issues other than the student thinking. Three turns were of preservice teachers asking questions wanting to clarify what the two students actually did and was coded as *asking to clarify*. This is notable because being able to ask for clarification was not possible while viewing the IMAP clips. It is
unique to this context. An additional three turns were coded as questioning how they should act.

Unlike the other two preservice teachers that shared their collected clips, Jackie chose to contribute to the conversation in different times. Almost all of it was describing the students’ strategies, but one of those turns was coded as describing, conjecturing, and questioning future action because she talked about those three concepts in the same turn. Although Jackie spent considerable time describing student thinking, she did not describe one student’s thinking correctly. To solve the problem, the students needed to subtract fourteen from twenty-two. One of the students had written the problem horizontally with the fourteen first. Thus, it was written 14 – 22. This was only pointed out after another preservice teacher noticed it. Jackie either decided not to disclose that information, or she did not realize it was significant.

Being able to contribute to the description of strategies is also unique to this context, in that you have somebody you can ask for additional information. That is not possible while viewing the IMAP clips. Furthermore, there were two instances where a classmate asked Jackie to clarify how the student solved the problem, which is also unique to this context. The conversation is summarized in the table below. Because Jackie took several turns, I’ve added a row to distinguish between her contributions from those of the other preservice teachers.

Table-5

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Written Student Work

Written student work provided by the professor was the third context preservice teachers explored. They saw five examples of student work solving the problem “Anna has 47 crayons. How many more does she need to get so that she will have 112 crayons altogether?” This is also a “join: change-unknown” problem. The written work (See Appendix) was given to the preservice teachers in the form of photocopies. They were asked to discuss the work in groups before having a whole-class discussion.

The examples of student work exhibited different strategies to solve the problem resulting in correct and incorrect answers. The professor asked for the preservice teachers to describe the strategy each student used and think about what the students knew or didn’t know. I’ve listed below exactly how many turns were taken for each individual student work after the professor had questioned them. Later on, the professor asked who they would have share their strategy with the class and what problem they would pose next. Those conversations are described a little later.

What is notable about this context was that almost all the discourse focused entirely on the student work. However, it was the third context that was explored, but it was the first time that they explored written work.
As you can see from the table, much of the discourse for this context was centered on describing and conjecturing about the student work. For Student A and Student B, describing and conjecturing about student thinking dominated the discourse. However, for Student B this discourse was a little more detailed, which is evidenced by the number of turns that were taken. Furthermore, when discussing Student B’s work, there were two instances of discourse centered on possible teacher action, which is given below.

**Group #1:** We thought about asking them what does the 112 represent, and then maybe they’ll realize that there is another angle.

**Group #2:** Maybe have them write it out completely, cause he just had the sentences. He just wrote out the sentence, and I think that’s part of the problem.
The conversation for Student C was quite different as much of it focused on what the teacher could do to find out more about how the student was thinking. Thus, it was coded possible teacher action to find out more. The professor had asked the preservice teachers, “What questions would you have for this student?” Four of the seven turns related to this code. Two of those instances are given below.

**PST #1:** Maybe ask them how they came up with a subtraction problem instead of adding on to something.

**PST #2:** I would be interested if they do see the correlation. Like say, what is 112 minus 65 then. If they can pop it off that it would be 47. It shows kind of that they understand that it doesn’t matter what order it would be in. Well, it does matter, but you know what I mean.

Several different codes were used to describe the discourse concerning Student D. Initially, preservice teachers were engaged with describing and conjecturing about the student’s strategy. Then, the professor asked them again what questions that they would ask this student. This question was followed by instances of further conjecturing, possible teacher action to find out more, possible teacher action, and personal experience. A portion of this conversation is given below.

**PST #1:** It just seems like they know it’s a math problem, and they see numbers, and they feel like the need to do an algorithm. But, if you ask them to like talk through
what sense those numbers make. Obviously, you need more crayons than the total to get to a total. If you make them talk. Is it going to be a bigger number or smaller number or just some common sense questions to make the connection that math problems are not just about computing, it has to make sense too. There’s a story too.

(coded as conjecturing and possible teacher action to find out more)

**Professor:** She affirmed what PST #1 said and discussed further the importance of mathematics making sense. Then, she called on another student.

**PST #2:** You could ask them why they did 47 – 112 instead of 112 - 47. (coded as possible teacher action to find out more)

**PST #1:** Plus they verbalize it better, by saying subtracting 47 from 112. (coded as conjecturing)

**Professor:** She furthered conjectured about Student D’s strategy.

**PST #3:** I know these are pretty big numbers to work with. Have something concrete in front of them to show them, how can you get 112 from 47? Have them work through the problem by direct modeling it, and then maybe they can see that they took 47 from 112. (coded as possible teacher action)

Finally, conjecturing, asking to clarify, and possible teacher action to find more was used to illustrate the discourse pertaining to Student E. The first portion of this conversation where they discuss the strategy is given below. After they discussed the strategy, the professor asked what questions would you have? Then, one turn was taken that was coded as possible teacher action to find out more.
**PST #1:** She said that 5 plus 7. She knew that 5 + 7 is 12. So that she knew that there had to be a 5 in the number. Then, she said that she knew that 60 + 40 is 100. Then, 100 + 12 is 112. She knew that it had to be 65. (coded as **conjuring**)

**Professor:** Other things people want to say about this strategy? What does this tell you about this student’s understanding?

**PST #2:** I think it’s really clever. Cause, they thought about doing 40. What plus 40 gets me to 100? They know it’s sixty, but they still have to find the 7. So, they put the 7 to the side and then say, 100 plus 12. What do I add to the seven? … I think it’s great. (coded as **conjuring**)

**PST #3:** … I’m curious, is there another part to this problem? She’s talking about grapes. (coded as **asking to clarify**)

**Professor:** They had to write a similar problem for this assignment.

After discussing each student individually, the professor asked the preservice teachers which students they would have share their work. Sharing work with classmates is a component of a CGI classroom that serves several purposes. It encourages understanding, because in order to be able to report, they have to understand what they have done. It also enables the teacher to assess a child’s thinking while at the same time allowing other children to hear a variety of strategies (Carpenter et al., p.98, 1999). This is the only context in which the professor could model this particular teaching strategy, and as the reader will see from the dialogue below, it prompted the preservice teachers to further analyze student thinking.
Three preservice teachers chose to share what their table of classmates discussed. The first group’s turn was coded as describing, conjecturing, and possible teacher action because it entailed a little of each. Group #2’s discourse was coded as possible teacher action to find out more because their objective was to have Student B illustrate the subsequent knowledge they suspected he had. Finally, I coded the last group’s discourse as possible teacher action because they wanted Student B to catch their mistake. The dialogue for all three groups is given below.

**Group #1:** We said A, C, and E. We said A because they understood the problem really well. They just had a little adding error and they split it up into fifties to work with fifties. C was the one that did the subtraction right from the beginning, so understood that. Then E was the one that split up, she knew that $5 + 7 = 12$, then the 60 and the 40. So, all different strategies…

**Group #2:** We talked about B just because we wanted to see more about what they were thinking. We suspected that they had more knowledge. We also said A and D.

**Group #3:** We had a kind of mix. We thought that maybe have B verbalize it to us first to see if he could catch his own mistake. If they didn’t catch the mistake, have C share first.

Concluding this conversation was a dialogue pertaining to which problem they would present Students A-E with next. Four preservice teachers offered suggestions and were all based upon trying to find out more about how the student was thinking. Thus, all instances were coded as possible teacher action to find out more. I want to reiterate here that
conservation described by this code is directly related to student thinking. That dialogue is also given.

**Professor:** What problem would you pose next to this group?

**Group #1:** We said that we would maybe try one in the same format; just do like simpler numbers like 10s. Like Ana has sixty crayons, how many more does she need to get so she’ll have 120? To see if maybe the problem is with regrouping.

**Professor:** So take out some regrouping and use some easier decade numbers.

**Group #2:** We said that we would turn the problem around. You need 120 crayons altogether and, Ana has sixty already. See if they could get that?

**Professor:** So particularly for student D, that would help us understand are they writing the first number first or the one with the bigger digits first.

**Group #3:** We thought maybe make one of the two numbers a decade number, and one still stay the same.

**Professor:** Why did you think that?

**Group #3:** We just thought that might clarify more who understands the strategy. We didn’t want to make them too simple.

**Professor:** If you make something that is too simple, most students will just do it mentally and not have a lot to share in terms of their strategies.

**Group #4:** We said separate: change unknown to see if those that did subtracting could do it the other way and see the different strategies and what they do with that.
Collected Student Work

All participants were asked, but not required, to collect student work from their practicum experience. They could present the work in any form they chose. More specifically, they could share the actual work, orally describe the work, or illustrate the work on the whiteboard. There were twenty-four students in the class, but four chose to share work they had collected.

In this context, the preservice teachers were extremely reluctant to share the work they had collected. It took several moments of prodding and the professor making the statement that she was going to “pick on somebody” before someone finally shared. Of the four who chose to share their student examples, three of them made negative comments about their experience. These comments are listed below.

**PST #1:** I did a lesson on tall and long in kindergarten, so that wasn’t very exciting.

**PST #2:** I was really getting discouraged because no one was getting any right.

**PST #4:** I was going to mention it, but I was scared of it.

**Later she states:** I don’t know if I handled it very well.

Along with the preservice teachers being reluctant to share the student work they had collected, there was limited participation from the rest of the class when asked to discuss the work. Only one other preservice teacher added contributed to the conversation other than those who shared work. Furthermore, there was definitely a clear pattern in the dialogue. After a preservice teacher took a turn contributing to the conversation, the professor took another. It was a classic AB pattern. Therefore, the professor took as many turns speaking as
all the preservice teachers put together. In fact, of the approximately twenty-minute conversation, the professor was talking almost eleven of those minutes.

This conversation was not a case where the professor was trying to dominate the conversation. She provided plenty of opportunities for others to contribute along with allowing substantial wait time. Many prompts (examples below) were said in an attempt to prompt the preservice teachers to engage in dialogue.

- Volunteers? I know some of you have stuff to share.
- So, what does she understand in that instance?
- What else does she know?
- Anything else?

Interview Data

Five preservice teachers volunteered to participate in the interview. Two of the five were individuals that brought in student-collected clips. Given below are the questions.

1. You watched several video clips this semester of children working on math problems. How, if at all, did watching the clips help you understand how children think about mathematics?
2. Were any of the clips more helpful than others?
3. Some of the class members brought in video clips or student work they had collected themselves to share with the class. How, if at all, did this differ from the video clips the professor brought in terms of helping you understand children’s thinking?
Summary of Responses

There was a general consensus that observing children solve problems was helpful to understand how children think. Below are excerpts from each preservice teacher’s response to Question #1. PST #1 and PST #4 are the preservice teachers who brought in clips from their own interviews, but only PST #1 referred to that experience for this question.

PST #1: I was able to learn more about how a child thinks about math when I did my personal interview instead of watching the videos.

PST #2: … So it was really nice for me to have been able to have seen it and talked about it and like how to address it in class. So then, for him I could be like O.K. well, let’s look at this and see maybe why that doesn’t make sense.

PST #3: It helps to actually see them doing it and get ideas of what students might actually do if you gave them a problem.

PST #4: I think they just learn better when they can figure things out by themselves, and some kids create their own process, and they understand their own process and it works, and I think that’s a great thing.

PST #5: I thought that was neat how they don’t just solve it, they get involved and draw a picture and draw a picture so it makes sense for them and that was the big thing.

Question #2 was only posed to three preservice teachers. Of those three, two preservice teachers talked about a specific clip that they thought was memorable, but were not a part of this study. Quotations discussing these clips are given on page sixty-three. Both
of the students portrayed in the clips were ones that were having difficulties solving the problems. The third preservice teacher stated, “They were the same.”

All preservice teachers answered Question #3, and all mentioned in some way that IMAP and collected clips were basically the same thing in that the presentation of the children’s thinking was the same. However, three preservice teachers point out benefits to viewing the student-collected clips. Below are excerpts from each preservice teacher’s response.

**PST #1:** I was one them that brought it in, but one of them, she had two different students and it was interesting to see how well it would work if you had two different students compared to one. I think basically they were about the same, but we were able to give more input in how what was actually going on and environmental and background factors unlike when we watched the prerecorded videos.

**PST #2:** They were almost the same, I mean like I was kind of expecting like oh these are the best of the best that they put in our textbook, but it was practically the same thing. So, like I mean it’s nice to see those clips.

**PST #3:** I thought that it was pretty similar. It was nice to you know see our peers doing it so then we now we could think, oh, that could actually be me and me and these are students we work with instead of just random students.

**PST #4:** I don’t think it changed anything. I don’t think there was a big difference between the two. I happened to be one that brought in the clip and I can say that being in the mediators spot gave me a new respect for the person doing the interview. Cause it’s really hard when you see a kid doing the problem wrong and
they get the wrong answer and you know so badly just by going ‘you did this wrong’
or ‘you want to look at that again’ they’d be able to figure it out, but you can’t.

**PST #5:** We could tell how in both clips the students were using the same methods of thinking and ways of thinking. The ones the professor brought in were more professional of course, but the thinking was the same on both.

**Contributions Among Participants**

As mentioned in Chapter Three, there were twenty-four students participating in the study, twenty-one females and three males. Three females (Lorena, Jackie, and one other) were non-traditional students. How many participants contributing to each discussion varied across the contexts. Eight participated in the IMAP context, seventeen (including Lorena, Derik, and Jackie) in the collected clips, approximately sixteen (it was difficult to see exactly who was responding) in the written work, and six in the collected work. Of the males; one did not contribute at all, Derik only contributed when he discussed his own student, and the third contributed three times total. Concerning the nontraditional students, Lorena only contributed when she discussed her own student, Jackie contributed approximately thirty times, and the other contributed at least twice for every context she was present for. There were a few students who contributed more than others, but it seemed as if there were a wide variety of people contributing to the conversations.
Key Findings

From coding the classroom discourse, I developed three key findings. Then, I went to the interview data for confirming or disconfirming evidence. Specifically, I looked for instances where the preservice teachers were more likely to discuss student thinking. I also compared the video contexts with the written work contexts because of the distinct differences between the two. Furthermore, I compared the contexts provided by the professor versus the contexts provided by the preservice teachers. Additionally, I was interested in what the preservice teachers were discussing when they weren’t talking specifically about student thinking. Finally, I examined how this is all related to CGI. There were several notions that occurred, but I will discuss three in the following sections that I thought were the most valuable to teacher educators.

Correct as Opposed to Incorrect

First, there was a distinct pattern that occurred when the student work being examined was correct opposed to incorrect. When viewing the IMAP clips, all of the students had figured the problem correctly. I conjecture that because of that, not much discourse occurred centered on student thinking. For the first student in the IMAP clips, only two turns were taken exploring the student thinking, which were coded as describing. Four turns were taken to discuss the second student, but was concentrated on whether or not the student had used their fingers to count. The third student had gotten the problem correct as well, but there were several instances of conjecturing because there was a discrepancy of whether the student really got it right intentionally. Therefore, the discourse was
significantly different due to the discrepancy of the third student. I surmise that this is because there is more to talk about if the student was incorrect.

All of the students in the collected clips worked the problem incorrectly, except for one of the students that Jackie interviewed. When compared to the discourse regarding the IMAP clips, there were almost three times as many instances describing or conjecturing about the student thinking during the collected-clips conversation. Furthermore, there were four instances of possible teacher action to find out more during the collected-clip discussion, which again directly relates to student thinking. There were no instances of conversation described by this code during the IMAP discussion.

Next, I will discuss the discourse regarding the student work provided by the professor where some of the students had solved the problem correctly and some incorrectly. I’ve included a portion of Table-6 here for easy reference.

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<td><strong>Questioning Future Action</strong></td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Asking to Clarify</strong></td>
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<td>0</td>
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<tr>
<td><strong>Student Feelings</strong></td>
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<td>0</td>
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<td><strong>Total</strong></td>
<td>7</td>
<td>12</td>
<td>7</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>
The least amount of discourse occurred with Students A, C, and E. These students all figured the problem correctly with the exception of Student A who simply made an addition error, but exhibited correct thinking (i.e., a strategy that could have worked to solve this problem. Furthermore, of those three students, Student C used the standard algorithm, which prompted even less discourse describing and conjecturing about the student thinking. This may be due to the fact that when students utilize the standard algorithm, it doesn’t display much about how they were thinking from their work. Additionally, a teacher cannot determine if the student understands the algorithm. However, the remaining discourse did relate to student thinking as it was coded possible teacher action to find out more.

When I discussed the interview data, I mentioned that two preservice teachers talked about a specific clip that they thought was memorable. In addition, PST #1 discussed a clip that she thought was note-worthy in response to the first interview question. In all these instances, the students had difficulties solving the problems. Quotations from these three preservice teachers are given below.

**PST #1:** O.K., I have a really good example. We were watching this math clip and this little kid, she like got her problem and she solved it and then she solved it like on paper. Then, they gave her manipulatives and told her to solve it again, and she got a different answer than what was on her paper. Then, they gave her a one hundreds chart, and she got the same answer as the manipulatives, but both those answers were different than what she had on paper. So, she still thought what she had on paper was the right answer, cause that’s what she had figured out. And so, I was like, wow, you know like they obviously think that math doesn’t have to make sense.
**PST #3:** I remember there was one girl; I think she was a younger girl like in first grade. They gave her a problem, and she tried to do it the regular standard way, but she messed up and she thought that was the right answer. So then, she did it and the person interviewing helped her do it these other ways, and she got the correct answer. But she always thought the first answer was right. So, I remember that a lot and um, it really helped me understand why to use the CGI problems and so that was good.

**PST #4:** One girl was taught something two different ways and one of the ways was not typical of her teacher. She could get the right answer, but she didn’t know how she got it. She had no idea what the process was and then her teacher did the CGI lesson and she understood it a lot better. But, you could tell because of the way she was taught before, that it still wasn’t clicking the process of why. So, I think it’s almost like they need to, they need to have their own process or they have to be taught why they need this.

*Video-Clips versus Written Work*

For all the contexts, the professor started the discussion by asking the preservice teachers to describe the student thinking. Therefore, *describing* was common across all the contexts, but conversations of this type did not dominate the discourse. Once the strategy is described, there is really nothing else to say about it unless someone is trying to clarify what was done. However, discussion of this type seemed to be essential to the discourse, because it initiated the conversation and sometimes let to more detailed analysis of student thinking. This is consistent with Philipp and Jacob’s (2004) work where they have found that an
effective approach to prompt discussion is to first have preservice teachers describe the student strategy.

*Conjecturing* was also common across all the contexts and it often either followed or preceded instances of *describing* student thinking. It’s logical that these two codes would be in proximity together. If the strategy the student utilized has been described accurately, it’s reasonable to discuss what the student does or doesn’t know. Sometimes the preservice teachers started with *conjecturing*, but went back to *describing*, so that statements could be backed up with evidence.

There are no notable differences of when instances of *describing* and *conjecturing* occurred when comparing video clips to written work. I conjecture that the notable differences occurred according to correct and incorrect answers as described in a preceding section. There were also no notable differences when preservice teachers would talk about personal experiences. Conversations categorized by this code occurred three times across all the contexts, with three contexts having one instance and the other with none. Codes that had notable differences are described in the next paragraph.

The most notable difference was conversations that can be categorized as *questioning future action*. The table below summarizes when these conversations occurred.

<table>
<thead>
<tr>
<th>Questioning Future Action</th>
<th>IMAP Clips</th>
<th>Student Collected Clips</th>
<th>Written Student Work</th>
<th>Student Collected Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

For each context, the professor led the conversation toward analyzing student work. However, it’s apparent that some are thinking about how they should act as a teacher. The conversations described by this code occurred five times after watching the IMAP and six
times after watching the collected videos. No questioning of this type occurred in the other two contexts where written student work was examined. What’s unique about this line of questioning is that many times it occurred in instances where the focus of the conversation was on something else entirely, specifically student thinking. I surmise that because there is an interviewer present, this prompts preservice teachers to think about how they should act as teachers. Furthermore, below are two cases where the professor asked for a certain response, but was encountered by a question of how they should act as teachers.

**Professor:** What questions might you ask the girl in this clip?

**PST:** Are we going to learn how to explain to children like how when they are doing this? - From the rest of the conversation you can understand that the preservice teacher is referring to teaching students about two-digit addition.

**Professor:** What kind of questions might you ask? [This was asked in reference to a student who solved the problem incorrectly. The professor was asking for questions that could lead them to learn more about the student’s thinking.]

**PST:** Would it be appropriate to like say, “O.K., I want to you to listen very careful to the problem and then try and solve it again.” Or, would that be too discouraging, do you think?

Next, I will talk about instances where preservice teachers were discussing possible ways in which teachers could act. I’ll be referring to both codes that pertain to this and provide a summary below of the discourse.
As the reader can see, there were nineteen instances where the preservice teachers were talking about possible teacher action in both the video clip contexts combined. This is over twice as many instances compared to written student work. The conversations described by possible teacher action were not about further exploring student thinking. Rather, it was more concentrated on how to help students obtain the correct answer.

**PST:** “…You could explain that since six plus six is twelve … they could use doubles.”

**PST:** Sometimes I wonder if kids just aren’t auditory learners and that if you wrote the numbers, 6 and 13 or something like that on the paper to start … maybe that would help.

**PST:** Or even put in the form of like 6 plus the box equals 13, so they can see exactly how, I don’t know.

After watching the IMAP clips, the professor asked the preservice teachers how they could lead students to using more efficient strategies. This resulted in three of the eight turns for possible teacher action. Therefore, the professor prompted that conversation. However, it must not have occurred to the ones that spoke to give an additional problem instead of explaining something. Later on in the conversation, the professor specifically asked, “What
kind of problem would you give next?” Two preservice teachers responded to this, but did not give examples that would lead to further analysis. One simply said that she would give a similar problem, but offered no reason. The other made up a problem, but explicitly stated that she used random numbers, which had no connection to the students.

As described in the methodology section, *possible teacher action to find out more* differs from the above code in that it pertains to how teachers can act to find out more about student thinking. The objective behind conversations described by this code was to further analyze student thinking. Thus, they were beginning to utilize student thinking to inform pedagogical decisions. To successfully facilitate a CGI classroom, a teacher needs to choose problems carefully. An example of dialogue described this code was given pertaining to Lorena’s student. That dialogue was the only instance of this code for the video clip context. Turns described by *possible teacher action to find out more* occurred eleven times when examining written student work provided by the professor.

Because *possible teacher action to find out more* did not occur while viewing the IMAP clips or while examining collected written work, no substantial comparison can be made between the video clips and written work. However, it is notable that is occurred several times while examining student work. To prompt these instances, the professor asked something similar to, “what would you ask this student next?” and “what kind of problem would you pose next?”

*Developing a Vision for CGI*  
In my analysis thus far, I have discussed each context separately. Some consideration needs to be given to the order in which the contexts were presented. Like utilizing efficient
strategies to solve problem is a developmental process for students, it is apparent from the
discourse that developing the skills to analyze student thinking is also a process. This is
evident when the professor asked preservice teachers after viewing the IMAP clips to create
a problem that they would give next to that group of students. No one offered a problem that
was related to the student thinking involved. However, in subsequent contexts, there were
several instances where “next problems” were discussed.

A substantial amount of discourse in the first two contexts was centered on possible
teacher action and questioning future action, but did not occur as frequently in the later two.
Earlier, I surmised that this was due to the fact that there was an interviewer present, which
prompted them to think about how they should act. This could still be the case, but it could
also be related to needing to have those initial questions of how to act answered.

Additionally, the preservice teachers could also be attempting to establish
connections to the traditional teaching methods they know so well. When they viewed the
IMAP clips, it was only the second time they had encountered instances of student thinking.
In the interview, one of the preservice teachers made the following statement.

Cause it’s really hard when you see a kid doing the problem wrong and they get the
wrong answer and you know so badly just by going ‘you did this wrong’ or ‘you
want to look at that again’ they’d be able to figure it out, but you can’t.

It’s apparent that she wants to tell the student how to obtain the correct answer rather than
let him work through it himself. It’s natural that they would attempt to relate what they
should do to what they already know about teaching and learning. Focusing on the
procedures to solve problems and the teacher explaining is so prevalent and is a challenge to get away from. Over the course of the study, they may have been moving away from those beliefs about teaching and more toward developing a vision for the CGI approach. Thus, this may explain the decrease in instances of *questioning future action*. 
CHAPTER FIVE
DISCUSSION

From the data analysis, it’s evident that each context was helpful in providing a situation for preservice teachers to examine student thinking. When I express that each context was “helpful,” I’m proposing that each context presented was successful in prompting a discussion pertaining to student thinking. In the following four sections, I will provide an explanation for why I propose that each context was helpful. Within those four sections, I identify areas that are in need of further research specific to that context. After I explain how each context helped preservice teachers, I will revisit the literature outlined in Chapter Two. I do this in order to re-examine my findings through the lens of each of the key ideas found in the literature. That discussion will be followed by another discussion concerning implications of this project for teacher educators. Finally, I provide a conclusion section.

IMAP Clips

The IMAP series developed by researchers from San Diego State University was created specifically to integrate children’s thinking into mathematics content and methods courses for preservice teachers. The intent is for preservice teachers to begin the process of analyzing student thinking. One of the first steps in using a CGI approach to instruction is to be able to identify strategies that children tend to use. Watching clips of children using strategies provides a more meaningful context than preservice teachers reading about student
thinking. As explained in Chapter Two, the distinguishing features of video provide for a
more meaningful context.

By examining student thinking in this context, it’s evident that preservice teachers
were able to correctly identify the different levels of student strategies. They were also able
to explore other issues pertaining to teaching and learning. Specifically, they considered
why students might hide their use of fingers to count, examined how teachers could act in
specific situations, and questioned how they could act themselves in future situations.
Furthermore, they were introduced to the structure in which they would examine student
thinking by the professor.

For this project, the specific IMAP clips that were presented did not prompt as much
discussion as the other contexts did. Twenty-seven turns were taken in this context as
opposed to over fifty turns in both the collect clips and written work contexts. Furthermore,
only eleven turns focused on student thinking. The other turns were prompted by the video,
but were not directly related to the student thinking exhibited in the video. There were
several instances of the preservice teachers’ discussing possible teacher action and
questioning future action in this conversation.

I conjectured in Chapter 4 that not as much discussion occurred in this context for
two reasons. First, all of the clips shown were of students solving the problems correctly.
When a student utilizes an effective strategy, there is not much to discuss in terms of what
they know or don’t know. This is evident when the first two students in the IMAP clip
solved correctly, but there was a discrepancy with the third student’s strategy, which
prompted more discussion. The notion that incorrect answers prompt more discussion is
substantiated by the written work context where incorrect answers also prompted more
discussion. When preservice teachers were asked in the interview about which clips were the most meaningful, two of them mentioned IMAP clips. Although those particular clips were not a part of this study, we know from their responses that the students solved the problems incorrectly.

Second, several turns in the IMAP discussion were prompted by the interviewer present. I conjecture that seeing an individual working with a student causes them to consider teacher actions. This is consistent with Sherin’s (2001) and Sherin and van Es’s (2005) work when they found that practicing teachers tend to focus first on pedagogy when examining videos. After prolonged viewing, they tend to shift their focus to student thinking. While examining student thinking, they took on the role of observer in addition to their teacher role.

Because there is such a limited amount of time in a methods class, teacher educators need to consider which video clips (if they use video clips) will represent their objective. For instance, if they want to demonstrate the three levels of strategies outlined in the CGI text, video clips similar to the ones used in this project will accomplish that. However, if they want preservice teachers to engage in a focused discussion about student thinking, they’ll need to be selective when choosing a clip. Based on the preliminary evidence from this study, student work resulting in an incorrect answer may be more appropriate. However, more than incorrect answers need to be considered.

One possibility for future research relating to this context is to examine problem types that tend to prompt detailed discussions focused on student thinking. In this project, the student work was about solving a “join: change unknown” problem, but there are eleven different problem types concerning addition and subtraction word problems outlined by the
authors of *Children’s Mathematics: Cognitively Guided Instruction*. There may be certain problem types that prompt focused discussions. An additional concept to be explored is to further examine how the role of the interviewer effects discussions. In these particular clips, the interviewer partakes in a minimal role. I have viewed others where the interviewer plays a more substantial role. This would be useful to teacher educators as they need to be unaware of how certain factors prompt different discussions. Then, they could take certain actions to resolve those issues.

**Collected Clips**

The collected clips context was also successful in prompting a discussion. This is indicated by the fifty-three turns that were taken by preservice teachers. Even taking into consideration the nine turns that Jackie took during the discussion pertaining to her student, that is substantially more turns than in the IMAP context. Furthermore, the conversation was more focused on student thinking, which is evidenced by the thirty turns (not including Jackie) taken by preservice teachers to discuss it.

Interview data indicate that when comparing both video contexts that neither one was more valuable than the other when considering how they each presented student thinking. However, the collected clips provided characteristics that were unique to that context. These characteristics distinguish the two contexts from each other, and I describe them in the following paragraph.

First, there were two instances where classmates asked questions to clarify how students acted in the collected clips. Being able to do this is unique to this context and could not be accomplished with the IMAP clips. Second, several suggestions were made about
what could be done next with the students featured in the videos. The individuals that collected the clips were able to respond to those suggestions. In other words, the IMAP clips are only exhibiting a small segment of a larger context. But with the collected clips, more information can be obtained.

One interviewee indicated that seeing her classmates conduct the interviews could have actually been her. This suggests she can put herself in the interviewer’s place more easily being that it’s a classmate. It’s possible that the process of interviewing students to analyze their thinking is now not as abstract to her. This same interviewee also made a comment that the students are not random; they are actually students that they work with. This seems to insinuate that the context is more authentic to her.

In addition to the video clips being helpful in prompting a discussion, this project has evidence that conducting the interview was also helpful to one preservice teachers. She commented that she learned more by conducting the interview than by watching the clips. It could be that she found actually conducting the interview was more helpful than watching videos of others. On the other hand, it could also be the case that observing herself in the interviewer’s role was more helpful.

However, her role in this video clip was limited in that the only action she took was asking the question. After she conducted the portion of the interview viewed in this clip, she had subsequent interactions with the student. We know that because she provided additional information regarding her student during the whole-class discussion. Therefore, I conjecture that actually conducting the interview was more helpful to her.

The preliminary evidence from the observation data suggests that viewing collected clips prompts a more focused discussion on student thinking than the IMAP clips. To
substantiate this, more data needs to be collected that takes into account several considerations. Because the IMAP clips explored in this context were of students using correct strategies, a comparison needs to be made using different types of clips. The interviewees mentioned other IMAP clips not investigated with this project that were memorable to them. Clips of that type could be compared with collected clips. It seems in this project that being able to provide background information and the notion that the students were not random effected the discussion. Those notions could be further explored.

Written Work

Out of all the contexts, data suggest that written work provided by the professor prompted the most focused conversation. First, there were several more turns (forty-five) taken that related directly to student thinking than in the other contexts. There were also thirteen instances where preservice teachers described possible teacher action to find out more. This did not happen at all in the IMAP and collected work contexts and only four times in the collected clips context. Finally, no turns were taken to question future action or to express negativity. The turns not related to student thinking were mostly in relation to possible teacher action.

Along with facilitating the discussion, the professor was able to make contributions to this context in other ways. First, there was an instance where a preservice teacher asked a question to clarify what a student did, which the professor was able to answer. This also suggests that the professor could, if needed, provide background information. Second, she was able to introduce the facilitation of a CGI classroom. I discussed earlier (Chapter Two) that a vital component of a CGI classroom is to provide opportunities for students to share
their strategies. Because there were several examples of student work solving the same problem, it was possible to discuss strategies for the facilitation of a classroom. Dr. Walsh did this by asking, “who would you have share” and “what question would you pose next to the group?” The discussion of classroom facilitation strategies would not be possible with the video clip contexts. It is more appropriate in a written work context as viewing clips of several students solving problems would become time consuming.

Collected Work

As with the other contexts, this context also provided an opportunity for preservice teachers to discuss student thinking. There were fifteen turns taken to describe and conjecture about student thinking. However, several of those turns were of the preservice teacher who witnessed the work describing it to the methods class. Therefore, it did not provide substantial opportunities for others to describe student thinking, but did for those who shared.

It is notable in this context that preservice teachers were reluctant to share work they had collected. The code negativity was used four times to describe turns in this context and was unique to collected written work in that they did not occur in the other three contexts. Instances of negativity may be related to preservice teachers being unsure of themselves in a teaching situation.

In addition to being unsure of themselves, there are other considerations to be taken. Given that the preservice teachers have limited experience with student thinking, it may be difficult for them to choose work that illustrates an interesting strategy. It may also be the case that many of their students are not using interesting strategies. If the students are in a
traditional classroom, which is highly likely, they probably have been taught the standard algorithm for that particular problem. Use of the standard algorithm does not tend to allow for the use of interesting strategies.

It may seem from the above paragraphs that having preservice teachers engage in an activity like this may be ineffective in helping them understand student thinking. However, it’s possible that ideas from the collected clip context can be applied in this one. There were characteristics that the direct experience of the collected clip context brought to the discussion that could also occur in this context. First, the preservice teachers would not be collecting work from random students. They are students they work with, which also means they would be able to provide background information. Furthermore, clarification questions could be answered.

Consideration also needs to be given to the literature. As described in Chapter Two, Franke et al. worked with a group of teachers at Crestview Elementary School that used student work examples as a basis for discussion (2005). Teachers would bring student work to work sessions to discuss. “Initially, teachers saw the workgroups as disparate meetings they attended, not something connected to their teaching practice or their classroom work” (Franke et al., p.214, 2005). Over time, they saw the sessions as a part of their practice (Franke et al., 2005).

It’s possible that preservice teachers could go through a similar developmental process as the teachers at Crestview. Again, Sherin (2001) and Sherin and van Es (2005) found that a similar shift occurred with teachers in her video clubs as the teachers from Crestview. To determine if preservice teachers experience a process similar to practicing teachers, I propose that more research be done in this area. Each context was explored only
Once in this project. A study that examines the use of collected written work over time is needed. However, I suggest that certain parameters should be put into place. It may be needed to require preservice teachers to bring in student work because of the few number who volunteered for this project. It also may be advantageous for them to bring the actual written work, rather than describe it. Details could be forgotten if the actual work is not present. Furthermore, it would provide a visual for their classmates.

If a methods instructor wants to use this activity in their course, they may want to provide preservice teachers with some direction in how to collect work. For instance, the professor may want to give the exact problem that preservice teachers would give their students, or develop it together. Sometimes teachers have a difficult time creating problems. In addition, a problem type that is not usually explored in classrooms may be ideal. Students may not have been taught a procedure to solve that particular type, which could result in unique strategies. Preservice teachers that believe their student used a noteworthy strategy worth sharing could do so.

Revisiting the Literature

Thus far in this chapter, I’ve discussed each context explored in this project. Now, I will revisit the literature that was presented in Chapter Two to describe relationships between the literature and preliminary evidence from this project. I’ve described potential studies in the preceding sections, but offer further suggestions in subsequent paragraphs.
CGI

In the literature, there is strong evidence of the effectiveness of CGI-based professional development with in-service teachers, but not much is known about its effectiveness with preservice teachers. The preliminary evidence from this study suggests that each context was effective in helping preservice teachers talk about student thinking, but in a different manner. Work in the study provides a springboard for several other potential studies that would delve more deeply into how to best help preservice teachers.

Students who are given opportunities to invent their own strategies go through a developmental process. They build upon previous knowledge to obtain new knowledge. It’s possible that preservice teachers would go through a similar process when learning about student thinking. The authors of the CGI text outlined a framework for students’ development of strategies. Development of a framework for how preservice teachers develop a sense for student thinking could be extremely useful for teacher educators.

Use of Video

Sherin (2004) found several distinguishing features of video that can enhance a teacher education program. Some of these features contributed to the video contexts examined in this project, while others did not. Video clips offer a lasting record (Latour, 1990 cited in Sherin, 2004), which can be replayed as many times as the viewers wish. The IMAP clips reflect the idea of a lasting record more so than the collected clips. Teacher educators can utilize the clips for several semesters. The collected clips would lose the unique characteristics that they possess if they were used in a subsequent semester. They would become like the IMAP clips in that nothing else can be learned about the featured
students. During this project, the clips were not replayed after viewing them for the first time. Therefore, that feature was not used.

Sherin (2004) also claims that when observing a live classroom, the moment is lost once it has passed, which makes videotaping so valuable. This idea proved valuable in this context as the preservice teachers could view their classmates engaged in the entire interaction. Furthermore, when preservice teachers described their interactions with students during the collected work context, many aspects of the interactions were lost, suggesting that some type of artifact (either video or written work) from the interaction is needed.

Video clips can be edited after they are collected, which allows for teachers to choose segments based on a specific goal (van Es & Sherin, 2002). Video editing played a role in this project. It was relatively easy with video editing software to edit the collected segment so that it only exhibited each interview. I could cut out anything that happened before or after. For instance, Jackie had chosen to give her students several problems to solve. I was able to choose the segment where she asked them the “join: change-unknown” problem. Additionally, it was easy to incorporate each separate clip into one clip with titles in between.

Philipp, Thanheiser, and Clement (2002) found that using video to stimulate reflection is of particular importance when working with preservice teachers. It prompts deeper and more specific discussion than without it. Their work consisted of centering classroom discussions around video clips of elementary children working on math problems. This project reiterates that video can prompt substantial discussions among preservice teachers, but further contributes to that literature in that it found that the preservice teachers in this project had deeper and more specific discussions when certain student thinking was
displayed. In addition, the collected clips prompted even deeper and more focused discussions, and could provide the preservice teachers with more information regarding the students.

Bliss and Reynolds (2004) found that preservice teachers preferred viewing a video to reading a written case. They highlighted three main reasons why: video enables viewers to gain a richer understanding of the case by engaging their senses and emotions; video keeps a viewer from imagining what is not warranted; and video allows a viewer to see subtle communication and body language between teacher and student (Bliss & Reynolds, p.41, 2004). These concepts may have been the case in Bliss and Reynolds study, but does not necessarily hold true in this project. It was not evident that the preservice teachers gained a richer understanding of student thinking while viewing video compared to written work. In fact, it seems that the opposite may have been true. Bliss and Reynolds’s second claim that video keeps a viewer from imagining what is not warranted does not seem to be the case here as well. The written work did not prompt the preservice teachers to imagine other ideas; they remained focused in their analysis of student thinking. Their last claim is not relevant in this project. These ideas indicate that the claim that video is more meaningful than written cases is not true for all activities.

Reflection

A discussion pertaining to the idea that viewing of video clips allows for reflection was given in Chapter Two. One idea that was explored was, “Thinking, particularly reflective thinking or inquiry, is essential to both teachers' and students' learning” (Rodgers, 2002). It’s evident that preservice teachers were reflective from their responses to the
videos. An additional idea resulted from Mumby and Russell’s (1992) work (cited in Abell & Cennamo, 2004). “Reflective teachers are able to think about their own or someone else’s teaching, reframe problems, compare practice with personal theories, and take new actions.” This project did not examine all of those ideas. Therefore, more research could be done to explore them. Specifically, I’m concerned with how examining student thinking will prompt preservice teachers to take new actions. Evidence that explains the likelihood that preservice teachers will use student thinking in future classrooms would be useful in understanding teachers’ implementation of reform-based curriculums that reflect the NCTM’s vision.

Noticing Classroom Interactions

When working with practicing teachers using video, Sherin (2001) and Sherin and van Es (2005) found that a shift occurred after teachers watched videos of themselves or colleagues teaching. That shift constituted a change in what teachers “noticed” about classroom situations. Initially, their focus was on the actions of the teacher. Over time they directed their attention more toward student thinking.

While watching videos in the first context, preservice teachers tended to direct their attention toward the interviewer, or they asked questions about how they should act as future teachers. Therefore, discussions were similar among those practicing and these preservice teachers concerning initial viewings. However, there is not enough evidence from this project to indicate if a shift tends to occur among preservice teachers similar to the one that occurred with the practicing teachers that participated in Sherin’s study. It seems that a shift may have occurred over the length of this project, but it cannot be determined specifically why. It may be due to the different contexts presented and not to prolonged viewing.
Also discussed in Chapter Two was Sherin’s (2001) identification of three factors that contribute to the development of a professional vision. These are the individual’s role in the classroom, the medium through which one observes a class, and the strategies one uses to interpret interactions (Sherin, 2001). As teachers are engaged with different roles, it allows them to notice different things. With this project, the preservice teachers acted primarily as observers except those who brought in clips and student work. I recognize that the preservice teachers filled the teacher’s role in their practicum experience as well, but those experiences were not studied by this project.

Preservice teachers observed the classroom through two different mediums, by watching video and by examining student work. By viewing video, Sherin (2001) notes that viewers receive different information than by observing a classroom. That relates to this project in that the video clips seen exhibited an instance of student thinking. It did not show any other classroom interactions. Thus, the viewer should be able to focus on the student thinking. The discourse in these contexts confirmed that preservice teachers focused somewhat on student thinking, but they also directed their attention to the interviewer, which is consistent with Sherin’s findings when teachers would focus on pedagogy. While examining student work, preservice teachers focused on student thinking more so than in the video clips, which is evidenced by the amounts of turns taken relating to student thinking.

The professor also gave strategies for the preservice teachers to interpret interactions. Her method is substantiated by the work of Jacobs and Philipp (2004) in that she utilized some of the same discussion prompts. They have found that an effective approach is to focus discussions primarily on understanding the child’s strategy first, and then to ask teachers to think about the relationship between the child’s thinking and the underlying mathematics
Similarly, Dr. Walsh would ask the method’s class to describe the strategy and then would ask them to conjecture what the student knows. Furthermore, Dr. Walsh would ask, “what would you do next with this student?” This prompt was also successful in engaging the preservice teachers to discuss how they could find out more about students through subsequent problems. This is also consistent with the work conducted by Jacobs and Philipp.

As far as future research is concerned in this area, it would be advantageous to determine if the shift that Sherin (2001) and Sherin and van Es (2005) found tends to occur with preservice teachers as well. If a similar shift does occur, then even further research could be done to determine strategies to accelerate the process. Due to the limited amount of time in a methods class, there may be ways that teacher educators can use video and written work, or structure discussion that would contribute to the shifting process.

Returning to Sherin’s (2001) identification of three factors that contribute to the development of a professional vision, more can be determined as to which situations within those factors contributes effectively to the development. There are several things to consider. For example, how does viewing interview situations differ from actually conducting the interview? Does examining student work differ from watching videos for the purpose of developing a professional vision?

**Examining Written Work**

I discussed examining written work briefly above when I talked about strategies for interpretation in developing a professional vision. Nevertheless, I would like to discuss one other idea relating to written work. Even though preservice teachers could engage in
substantial conversations concerning written work, there still may be difficulties “noticing” what is important about a student’s strategy. For instance, Jackie had failed to tell her classmates that her student had written the problem 14 – 22. It’s possible that she didn’t understand this was noteworthy. Furthermore, it’s also possible that the preservice teachers were reluctant to share written work because they don’t understand what constitutes an interesting strategy or what a teacher can learn about that student’s thinking.

In addition, it could be beneficial to determine if the “noticing” concept that Sherin applies to video clips can also apply to written work. Studies similar to hers could be conducted, but would just differ in the medium that the student thinking is given in.

Implications for Teacher Education Programs

Up until now, I’ve discussed the methods course in isolation from teacher preparation programs as a whole. Now, I will discuss the implications this study has when looking at the entire teacher education program.

Each context that was presented in the project was helpful in prompting preservice teachers to discuss student work, which is also validated in the literature. However, from what we know from Sherin (2001), Sherin and van Es (2005), and Kazemi’s et al. (2004) work, examining student work in isolated instances (a few instances in a methods course) will not necessarily prompt preservice teachers to utilize the practice in future classrooms. There needs to be more time to allow the shift to occur. Furthermore, Vacc and Bright (1999) contend that, “the framework underlying the content presented in mathematics method courses needs to be consistent with the framework of the mathematics education program that preservice teachers observe and implement during field experiences” (p. 91).
Therefore, I propose that analyzing student thinking be a prominent feature of teacher education programs. I offer four ideas as to how that might be accomplished, along with challenges that need to be considered.

First, the practicum experience that is taken along with the methods course is a possibility for teacher educator programs to incorporate prolonged analysis of student thinking. However, many practicum experiences are limited in that they don’t provide the opportunity for preservice teachers to spend extended amounts of time in the classroom. Currently at Iowa State University, the customary practicum experience lasts for four weeks in which they spend two days of each week in the classroom. I conjecture that this is not enough time for a shift to occur.

The larger project that Dr. Walsh was involved in entailed altering the practicum experience at Iowa State University so that preservice teachers were spending time in classrooms over the entire course. Instead of spending all of the time required in four weeks, those hours were spread over a ten-week period. This situation would be more ideal than that the customary practicum requirement to engage preservice teachers in a prolonged experience of analyzing student work. During the experience, preservice teachers could interview students on an ongoing basis. Interviewing is not as large of undertaking as teaching a lesson. It may be a way to introduce preservice teachers to classroom interactions.

The interviews could be videotaped, but videotaping a student is a complicated situation. Parental permission must be obtained, which many parents may not feel comfortable with. Furthermore, districts are becoming increasingly hesitant about allowing the videotaping of classes or students. The camera also takes time to set up and tapes cost money. Taking all of this into consideration, it might not be feasible for some institutions to
implement an activity like this. On the other hand, interviewing a student and having them provide written work is feasible. Analysis of written work is not as cumbersome of a task as viewing video clips in that it’s more portable, readily available for viewing, and is not as time-consuming to review. After conducting the interviews, preservice teachers could bring in the written work to share with classmates.

A challenge to this activity would be in finding the time to conduct an interview several times. Cooperating teachers may not feel comfortable with their students being pulled out of a lesson to conduct an interview. In addition, conducting several interviews may restrict preservice teachers in experiencing different types of classroom interactions.

My second suggestion is to incorporate analysis of student work in the student teaching experience. During this experience, preservice teachers spend a substantial amount of time with students, as they are in the classroom everyday. As part of the requirements, they could also engage in a similar activity that was described for practicum students. However, student teachers would encounter more challenges to this process than practicum students. First, they have substantial teaching loads, which would make it difficult to incorporate. Second, they would not have the support from their methods instructor or from their classmates.

Instead of interviewing students, student teachers could teach a CGI lesson, analyze the student work that resulted from the lesson, and then teach a subsequent lesson. This would give them the opportunity to facilitate an entire CGI lesson incorporating strategies illustrated in the CGI text. I recognize that this would not allow for prolonged analysis of student work, but may be deemed beneficial.
I surmise that there would be significant challenges with this activity. In their chapter, *Research on Methods Courses and Field Experiences*, Clift and Brady (2005) discuss that preservice teachers encounter much resistance when they attempt to incorporate teaching strategies they have learned in their teacher education program during their field experiences. Cooperating teachers often want preservice teachers to mimic their own teaching styles – either because they believe these are the most effective teaching styles and/or because they want to maintain consistency for students.

The third suggestion is to dedicate a course to working with children’s mathematical thinking. Philipp, Thanheiser, & Clement (2002) describe an experimental course that integrates mathematics content and children’s thinking. It combines features of both a mathematics course and a methodology course. Through this course, the preservice teachers participated in a field experience that provided opportunities to interview and tutor children in mathematics and to reflect upon the process.

“Most enter the course believing that mathematics teaching consists of showing and explaining procedures and that children must be shown how to solve mathematics problems in a prescribed step-by-step fashion” (Philipp, Thanheiser, & Clement, p.199, 2002). To address these beliefs, the researchers limit the role of preservice teachers so that they assess children’s understanding of concepts by using carefully chosen tasks (Philipp, Thanheiser, & Clement, 2002). Based on their evidence, the researchers claim that the initial results look promising. “These deliberately chosen and highly structured experiences in the CMTE-L (Children’s Mathematical Thinking Experience – Live) support preservice teachers’ engagement in and motivation to learn mathematics to prepare them to support their future students’ mathematical thinking” (Philipp, Thanheiser, & Clement, p. 208, 2002). The
researchers believe that the potential success of the course, is impart due to preservice teachers wanting to help children.

The previous three suggestions all entail examining student work in conjunction with a field experience as suggested by Vacc and Bright (1999). This next suggestion does not involve a field experience, but it could be quite helpful to preservice teachers given what we know from other research studies. I propose that case study work of students solving problems be obtained and presented to preservice teachers. One such case study is available from Susan Empson, Professor of Science and Mathematics Education at The University of Texas at Austin, on her website. The case portrays interactions with four students, Jack, Sunny, Emilio, and Daniella, over a ten-week period. For each session, Empson provides the problem set she presented to the students and a description of the interactions. She also includes some examples of the four students’ work.

There are several components of Empson’s case study that are substantiated by the literature and this project. First, the medium she presents student thinking is in the form of written work. The preliminary evidence from the project seems to suggest that written work can create a focused discussion on student thinking more so than the other contexts. A prolonged analysis of written work seems to also be more feasible for preservice and practicing teachers than viewing video. Second, she provides examples of student work over a ten-week period. This may allow enough time for a shifting process if a shifting process occurs in preservice teachers like the one that tends to occur with practicing teachers. Third, the written work depicts several incorrect and interesting strategies from students that, in my view, causes the case to be interesting.
Again, when considering the literature and preliminary evidence from this study, a few components could be added. First, Empson does not provide work from each student each week. She has chosen which work to display and offers her own analysis of the interaction. All of the written work should be provided, and although her analysis is informative, it may be more appropriate for preservice teachers to draw their own conclusions. Second, background information and a means for preservice teachers to have potential questions answered needs to be provided.

Conclusion

Evidence from this study seems to suggest that the contexts presented are helpful to preservice teachers when considering student thinking. The IMAP clips are successful in meeting the intentions set forth by the researchers at San Diego State University in that they prompt preservice teacher to discuss student thinking. Collected clips possess the same characteristics as IMAP clips, but may provide a more contextualized interaction. Written work is an alternate medium to observing student thinking than viewing video clips and also provides a helpful context. Because the evidence in this study is preliminary, further research in needed to confirm the evidence and explore which factors contribute specifically to a more meaningful context for preservice teachers.

Exploring student-thinking needs to be a prolonged activity for preservice teachers to identify its importance. The literature (Sherin, 2001; Sherin & van Es, 2005; and Kazemi, 2004) pertaining video clips and written work identify that a shifting process tends to occur among teachers in what they tend to notice about classroom interactions. Furthermore, it is
evident that concepts explored in a methods course need to be consistent across the teacher preparation program (Vacc and Bright, 1999).
Student A

A1. Anna has 47 crayons. How many more does she need to get so that she will have 112 crayons altogether?

\[\begin{align*}
47 + 55 & = 112 \\
\text{I added up} & +3 = 50 \\
\text{from 47 till I} & +50 = 100 \\
\text{got to 112} & +12 = 112 \\
\text{It was hard} & \\
\text{because the numbers} & \\
\text{were not round, } \\
\text{one had a larger digit than the other.}
\end{align*}\]
31. Anna has 47 crayons. How many more does she need to get so that she will have 112 crayons altogether?

I know that $6 + 4 = 100$ so $3 - 7 = 10$

But she still need two crayon

so add 2 to the 10. So the

$5 + 7 = 12; \overline{100 + 12 = 112}$
#1. Anna has 47 crayons. How many more does she need to get so that she will have 112 crayons altogether?

\[112 - 47 = \boxed{65}\]

I tried to subtract 2 from 7 but I knew it wouldn't work, so I carried from the 10 in 112. 12 - 7 = 5, so I wrote that down. Then I subtracted the 10's column. I needed to carry again. 100 - 40 = 60 or 10 - 4 = 6. My answer was 65.
1. Anna has 47 crayons. How many more does she need to get so that she will have 112 crayons altogether?

\[ 47 - 1 = 46 \]

I did the problem by subtracting 47 from 112. I got 135. First I took 2 away from 7 and got 5. Then I took 1 away from 4 and got 3. Then I took 0 away from 1 and got 1. Altogether it was 135.
Anna has 47 crayons. How many more does she need to get so that she will have 112 crayons altogether?

\[ \begin{align*}
65 & \quad 57 \\
47 & \quad 40 \\
112 & \quad \frac{12}{100}
\end{align*} \]

Cici has 47 grapes. How many more does Cici need to get so she has 112?

I knew that 5 + 7 = 12, so it had to end with a 5 and 60 + 40 = 100 plus the extra from the 12 so it equaled 112.
REFERENCES


