A DESCRIPTIVE CASE STUDY OF THE BELIEFS OF THREE MATHEMATICS TEACHERS WHO CHOOSE NOT TO ASSIGN HOMEWORK

by

TONYA CHRISTINE BROOKS

(Under the Direction of Dorothy Y. White)

ABSTRACT

Research indicates that most students have to complete homework on a regular basis. In addition, studies suggest that assigning homework can have an impact in the classroom because teachers spend class time going over homework, assigning homework, and letting students work on homework. Research on mathematics teachers’ beliefs have indicated that teachers typically believe mathematics is a set of rules and skills, that learning mathematics consists of memorizing and repeating processes, and teaching mathematics is believed to be a process of transferring knowledge to students by showing examples and telling students how to work problems. Teachers’ beliefs have also been shown to impact their teaching practices, even with respect to specific instructional strategies. The purpose of this study was to investigate the beliefs about mathematics and teaching and learning mathematics of mathematics teachers who choose not to assign homework. This study investigated the teachers’ rationales for their homework policy and the challenges they faced because of their decision to teach without assigning homework.

This study investigated the cases of three mathematics teachers. Data consisted of two consecutive days of observations, lesson plans, and three semi-structured interviews.
Ernest’s (1988) framework for investigating teachers’ beliefs was used to understand the teachers’ views of mathematics, mathematics teaching, and learning. Thematic analysis, as described by Braun and Clarke (2006), was used to analyze the data.

The findings suggest that the teachers held different views about mathematics and its teaching and learning and that their beliefs had no apparent link to their homework policies. The teachers’ no-homework policies were related to their beliefs about students and students’ needs in general. Findings also suggest that teachers adjusted their class time to support students’ learning without assigning homework and that they made a distinction between homework and work students chose to do on their own. The challenges the teachers faced because of their no-homework policies varied but included helping others, such as parents, administrators, and students, understand the reasons they chose not to assign homework and encouraging students to do mathematics on their own.

INDEX WORDS: Homework, Mathematics Teaching, Teacher Beliefs, Secondary, Middle School, Lesson Structure
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DEDICATION

This dissertation is dedicated to my husband, Robert. You knew how hard this
decision and the resulting work would be, but supported me in my choice. You lifted me
up in those times when I was not sure I was going to make it, and your faith in me gave
me the strength and will to finish. Thank you, my love.
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CHAPTER 1
INTRODUCTION

Homework has been strongly connected to schooling practices and teaching philosophies throughout the years (Gill & Schlossman, 1996). Homework has many definitions but is most often defined as schoolwork to be done outside of the classroom, generally at home. According to the National Center for Education Statistics (NCES, 2010), 95% of elementary students (grades K–8) and 93% of high school students have to do homework outside of school on a regular basis. More specifically, students work on homework either three or four days a week (46.2% for elementary and 38% for high school) or five or more days a week (39.4% for elementary, 41.9% for high school). Students spend an average of 4.7 hours and 6.8 hours a week doing homework in elementary and high school, respectively. These statistics suggest that homework is a regular occurrence and plays a large role in many students’ lives.

Research has found that teachers assign homework for several reasons, including to help reinforce material through practice (Epstein & Van Voorhis, 2001; Murphy & Decker, 1989; Trautwein, Niggli, Schnyder, & Ludtke, 2009; Van Voorhis, 2004; Xu & Yuan, 2003); introduce new material (Epstein & Van Voorhis, 2001; Murphy & Decker, 1989); monitor a student’s progress on class material (Murphy Decker, 1989; Trautwein et al., 2009); serve as punishment (Corno, 1996; Epstein & Van Voorhis, 2001); and cover material that was not covered during class time (Coutts, 2004, Murphy & Decker, 2001). Teachers who assign homework for students to practice the skills taught in class
believe this practice will make steps for solving problems automatic. Other teachers assign homework so students can think about problems before they are covered in class. In this case, homework is used to introduce the material or to understand aspects of the materials students know or remember from past years. Teachers also use homework as an assessment to learn how much of the material students can do independently. Some teachers assign homework as a form of punishment when students act out or do not work in class. Finally, time constraints lead some teachers to ask students to learn material and try problems that extend beyond what was covered in class as a means of making sure all types of problems are covered.

Assigning mathematics homework is an instructional practice that many mathematics teachers employ. Stigler and Hiebert (1999) found that U.S. mathematics lessons typically began with “relatively long segments of checking homework” (p. 31) and end with assigning homework. The Trends in International Mathematics and Science Study (TIMSS, 1999) data show that in the United States, mathematics classes averaged 51 minutes in length with about 10 minutes spent on homework each day, either in the form of checking and going over homework, assigning homework, or letting students work on homework (Hiebert et al., 2003). Therefore, checking and assigning homework can play a large role in mathematics classrooms. With the ubiquitous nature of homework in the U.S., teachers who do not to assign homework are far from the norm.

There are several different viewpoints in regard to the value of assigning homework. Proponents of homework argue that practice plays an important role in learning, especially in the subject of mathematics (Epstein & Van Voorhis; Murphy & Decker, 1989; Willingham, 2004). They argue that practice allows students to work at
their own pace to master concepts and strategies needed for success. Practice is often needed in other areas of learning, such as learning to play an instrument or a sport, and proponents believe that homework allows students time to practice educational learning. Cooper, Lindsay, Nye and Greathouse (1998) argue that even though the link between homework and achievement is still largely unclear, homework offers other value that is not immediately seen, such as increasing a child’s responsibility and decision making. They advise that students do 10 minutes of homework each night per grade level; for example, a student in 5th grade should do 50 minutes of homework each night. Doing homework requires that the student learn to prioritize and manage time, and proponents believe that learning to do this helps a student learn to take responsibility in all facets of life. They also believe this allows students to learn how to make good decisions.

In contrast, opponents of homework argue that homework overburdens students and creates a situation in which students are not engaging in other activities with their families (Bennett & Kalish, 2006; Kralovec & Buell, 2000). Opponents argue that doing work outside of school stresses students, both physically and mentally. They argue that students have no time to relax and often do not get enough sleep due to working on homework late into the evening. They believe that students do work that has not been shown conclusively to have benefits, and this takes away students’ time to read, play games, play outside, pursue personal interests, and visit with family. Some of these opponents advocate abolishing homework.

Beliefs play a large role in both proponents’ and opponents’ arguments about homework. Researchers investigating mathematics teachers’ beliefs tend to study teachers’ beliefs about mathematics, and mathematics teaching and learning. Studies of
teachers’ beliefs of mathematics examine whether teachers view mathematics as a creation and process of exploration or whether teachers view mathematics as a static set of rules that must be memorized. These studies suggest that most mathematics teachers tend to view mathematics as a set of rules and procedures that are used to obtain a solution to a problem or as a connected field that is discovered but not created (Barkatsas & Malone, 2005; Connor, Edenfield, Gleason, & Ersoz, 2011; Schunk, 1997; Thompson, 1992). Mathematics teachers tend to believe that good mathematics teaching consists of teachers showing students how to work problems and explaining solution strategies (Barkatsas & Malone, 2005; Wilson, Cooney, & Stinson, 2005) and learning is viewed as a passive action that involves watching and memorizing information (Barkatsas & Malone, 2005; Thompson, 1992). These studies suggest that an understanding of teachers’ beliefs may help explain what they do in their classrooms.

Research has investigated the impact of teachers’ beliefs on their teaching practices (Beswick, 2006; Stuart & Thurlow, 2000; Swan, 2006). Many of these studies suggest that beliefs about mathematics and mathematics teaching and learning influence the classroom practices of the teachers. For instance, teachers who believe that mathematics is a set of rules and procedures that need to be transmitted from the teacher to the students are more likely to teach using a very teacher-centered model where they show procedures and tell students how to work problems (Beswick, 2006; Thompson, 1984). Some researchers have chosen to investigate teachers’ beliefs with respect to specific instructional practices, such as choosing to teach without computers (Norton, McRobbie, & Cooper, 2000), using writing in mathematics classes (Quinn & Wilson, 1997), and using communication in mathematics classrooms (Brendefur & Frykholm,
These studies suggest that teachers’ choices to engage or not engage in specific instructional practices are related to their beliefs about mathematics and its teaching and learning.

Assigning homework is an instructional practice that is common in most mathematics classrooms. However, very little is known about the beliefs of mathematics teachers who choose not to assign homework. This study is designed to investigate the beliefs and lesson structures of mathematics teachers who choose not to assign homework.

**Rationale**

Studies about homework have largely focused on finding the correlations between the amount of homework assigned or the amount of time spent on homework and student achievement (Cooper et al., 1998; Cooper, Robinson, & Patall, 2006; DeJong, Westerhof, & Creemers, 2000; Mikk, 2006; Pezdek, Berry, & Renno, 2002; Swank, 1999). Other studies looked at teacher practices in regard to homework assignments, for example, how much and how often homework is assigned (Brock, Lapp, Flood, Fisher, & Han, 2007; Pezdek et al., 2002). Studies about beliefs and homework have also investigated the reasons why teachers assign homework (Atkin, 2001; Brock et al., 2007; Murphy & Decker, 1989). However, very little is known about the beliefs and practices of mathematics teachers who choose not to assign homework. More research is needed in this area (Murphy & Decker, 1989; Trautwein & Koller, 2003; Xu & Yuan, 2003) in order to determine how beliefs and experiences influence a teacher’s choice to not assign homework and how this choice influences the lesson structure and practices of the teacher.
Teachers’ beliefs impact teaching practices (Ernest, 1988), including teachers’ use of homework. Deciding whether or not to assign homework and the role that homework will play in the classroom if it is assigned is a very complex decision for teachers. Several issues can be considered in this decision, including students’ needs and life outside of the classroom, professional needs, beliefs about teaching and learning, how class time will be used to address homework issues, how homework will be graded, and what needs to be done if homework is not assigned. However, because homework is so prevalent in schooling, studies on teachers’ beliefs largely encompass those teachers who assign homework. This study provides a starting point for investigating teachers who choose not to assign homework by researching the role of these teachers’ beliefs in their decision.

Previous research on homework has treated homework as a simple add-on activity where control and experimental groups were treated the same except for the amount of homework assigned to each group (Cooper, 1989; Grodner & Rupp, 2011). These investigations take a very broad view of the relationship between teaching and assigning homework. They assume that teachers who do not assign homework teach in much the same way as teachers who do. However, teachers who choose not to assign homework could face different challenges and have additional concerns due to their lack of reliance on homework. They must have strategies and practices to meet their teaching and students’ needs without assigning homework. Additionally, how these teachers use class time might be different for the simple reason that they do not have to collect homework, answer questions about homework, or assign homework. This study contributes to the literature by investigating the challenges and concerns of these teachers and the methods
they use to overcome them, including how the class time and lesson structure support their teaching.

Research Questions

The purpose of this study was to examine the beliefs about mathematics, mathematics teaching and learning, and homework held by three teachers who chose not assign mathematics homework. The research questions guiding this study were:

For mathematics teachers who choose not to assign homework:

1. What are their beliefs about mathematics and mathematics teaching and learning?

2. What are their rationales for not assigning homework?

3. What challenges do they face because of their decision to not assign homework and how do they address these challenges?
CHAPTER 2
LITERATURE REVIEW

I begin this review with a look into the studies on teachers’ beliefs and the impact of beliefs on instructional practices and then give a general history of the debate surrounding homework. It continues with a review of studies about homework in general. A deeper look into the studies about mathematics homework is followed by a review of why teachers assign homework.

Research on Teachers’ Beliefs

Understanding teachers’ beliefs poses special challenges due to the nature of beliefs (Pajares, 1992). Beliefs are part of interconnected and interacting systems where some beliefs might conflict with others (Cooney, Shealy, & Arvold, 1998; Handal, 2003), and to understand all the connections and interactions between different beliefs requires meticulous study. Additionally, people may not be able to explain their beliefs or they might hold beliefs of which they are unaware (Leatham, 2006). Beliefs cannot be seen; therefore, researchers must determine a teacher’s beliefs based upon what can be inferred from statements and actions while also being aware of the lens with which the researcher views the world.

In this study, I was particularly interested in teachers’ mathematical beliefs as defined by Ernest (1988). Ernest argued that teachers’ mental schemas and conceptions characterize their system of beliefs. He defined three key components of a mathematics teacher’s beliefs as the views surrounding: (1) the nature of mathematics, (2)
mathematics teaching, and (3) the process of mathematics learning. Within the nature of mathematics, Ernest described three views of mathematics: (1) the instrumentalist view where mathematics is a collection of facts and rules, (2) the Platonist view where mathematics is an unchanging but connected and discovered collection of knowledge, or (3) the problem solving view of mathematics as a cultural creation that is continually expanding. He also classified teachers into three categories based on their beliefs about teaching mathematics, with each category being defined by the intended outcome as well as the role of the teacher: (1) instructors whose emphasis is on students mastering skills and performing procedures correctly, (2) explainers whose emphasis is on students having conceptual understanding, or (3) facilitators whose emphasis is on students becoming problem posers and solvers. Beliefs about learning mathematics can be divided into two categories: (1) learning as an active process where students must construct their own understanding or (2) learning as a passive engagement where the learner absorbs information. The teacher’s system of beliefs informs his or her vision of how the different aspects of a mathematics classroom should interact. For example, teachers who believe that mathematics is a set of rules are more likely to view the teacher’s role as an instructor and the students as passive learners of mathematics. Teachers who view mathematics as a changing human product are more likely to view their role as that of facilitator where students are actively engaged in creating mathematical understanding (Ernest, 1988). For a more detailed discussion of Ernest (1988), see the theoretical framework of this study. Two categories of research on teachers’ beliefs are relevant for this study: (1) research on teachers’ beliefs about mathematics and mathematics teaching and learning, and (2) research on the influence of teachers’ beliefs on practice.
Beliefs about Mathematics and Teaching and Learning Mathematics

Research on teachers’ beliefs has suggested that most teachers view mathematics as a collection of rules, procedures, and skills that are used to reach a correct solution (Connor, Edenfield, Gleason, & Ersoz, 2011; Handal, 2003; Stipek, Givvin, Salmon, & MacGyvers, 2001; Thompson, 1992). This view is often referred to as a traditional view of mathematics. In the traditional view of mathematics, a person who knows mathematics is effective in doing a procedure or manipulating algebraic symbols, but he or she might not understand what the mathematics represents (Thompson, 1992). Few teachers view mathematics as a changing field that is created by humans and influenced by cultures. This view is sometimes called a reform-based, inquiry-based, or problem solving view.

Several studies have used Ernest’s framework to characterize teacher beliefs. For instance, Schuck (1997) used a research simulation to study 49 preservice primary teachers’ beliefs about mathematics and to help them become aware of their beliefs. The preservice teachers participated in a set of activities in which they played the roles of a researcher and research participant. The teachers each designed a research question of their interest and an interview guide that would allow them to gather data about their question. They then interviewed a peer and were interviewed by a peer. Once the data were collected, they analyzed the data and reflected on the data and their own responses when they were interviewed. They presented their findings to their peers and other researchers.

Following this set of activities, Schuck (1997) then used the interview guides and all the data collected by the preservice teachers to investigate their beliefs about mathematics. She found that the participants fell into two of Ernest’s (1988) categories of
beliefs about mathematics. Most of the preservice teachers were instrumentalists. They did not see connections between the different areas of mathematics and their mathematics learning “had the aim of achieving various ends, such as managing transactions in a supermarket, or passing tests in high school” (p. 535). Several preservice teachers were categorized as Platonists. These teachers thought that mathematics “starts with a series of laws and axioms from which all other mathematics is derived” (p. 534).

Other studies have used Ernest’s (1988) categories of beliefs to investigate the beliefs of inservice teachers (Barkatsas & Malone, 2005; Scott, 2001; Wilson, Cooney, & Stinson, 2005). Wilson, Cooney & Stinson (2005) investigated how nine secondary mathematics teachers viewed good teaching. The teachers participated in three in-depth interviews and a work session during the course of a 3-year research project. Rather than asking questions that were directly related to the teachers’ beliefs about mathematics teaching, Wilson et al. asked teachers about the qualities of a good mathematics lesson and how teachers learn how to teach. Using the teachers’ views of what comprises good lessons, Wilson and her colleagues were able to investigate the teachers’ underlying beliefs about mathematics teaching. They found that while the teachers often made statements that were similar to current mathematics educator statements about teaching, such as teaching mathematics for understanding, having multiple representations, the importance of assessment in teaching, and students playing an active role in the classroom, the teachers envisioned a very teacher-centered classroom rather than the student-centered classroom as described by NCTM and many mathematics educators. The teachers’ vision of mathematics teaching was one in which the students were making connections, using different methods, and seeing different representations but were not
creating their own methods or their own understanding. Instead, the students were expected to realize the methods and conclusions of the teachers. When the students did not make the desired connections or methods, the teachers thought that more direction should be given. Wilson et al. concluded that the “teachers’ comments reflected an essentially teacher-centered classroom although not one necessarily dominated by lecture” (p. 105). Teachers believed in guiding students a certain way rather than facilitating students’ thinking.

Schuck (1997) and Wilson et al. (2005) investigated just one portion of teachers’ beliefs, but other researchers have investigated multiple aspects of beliefs using Likert-scale surveys as a measurement tool. For example, Nisbet and Warren (2000) used a 56-item Likert-scale survey to study beliefs about mathematics and teaching mathematics. They mailed 1500 surveys to a sample of grade 1-7 teachers with a return rate of 96.5%. The teachers’ views about mathematics fell largely into two categories, a static view, which they compared to Ernest’s (1988) Platonist category, and a mechanistic view, which they compared to Ernest’s instrumentalist category. The beliefs about mathematics teaching fell into two categories they called traditional and contemporary. The traditional view “reflects a classroom environment that is dominated by timed tests, with little hands-on experience and little consideration of the relationship between mathematics and the real world” (p. 40). The contemporary view reflects a classroom that incorporates hands-on activities and “students explaining ideas to each other and exploring problems related to the world outside” (p. 40). Their results indicated that, while the teachers’ beliefs about mathematics fell into the Platonist view and the instrumentalist view, neither view rated very high on the Likert scale. However, the instrumentalist view was
rated stronger than the Platonist view. In addition, the teachers rated the contemporary view of mathematics teaching higher than the traditional view.

Barkatsas and Malone (2005) investigated teachers’ beliefs about mathematics and teaching and learning mathematics. They also used a Likert-type questionnaire to study these beliefs for 431 secondary mathematics teachers, 24 secondary mathematics teachers holding principal positions, and 10 regional mathematics consultants in Greece. They found that the teachers’ beliefs about mathematics and its teaching and learning fell into two large categories. Fifty-seven percent of the teachers fell into a *traditional-transmission-information processing orientation*. This view is much like the instrumentalist, instructor, and passive views of mathematics, teaching and learning mathematics as categorized by Ernest (1988). Forty-three percent of the teachers fell into the *contemporary-constructivist orientation*, which is much like Ernest’s problem solving, facilitator, and active categories of mathematics, teaching, and learning.

Barkatsas and Malone concluded that these teachers’ beliefs about mathematics and mathematics teaching and learning were an interconnected, inseparable system of beliefs.

Because beliefs are considered part of an interconnected system, some studies have investigated teachers’ beliefs about mathematics and its teaching and learning in relation to other beliefs, such as the usefulness of technology (e.g., Jusdon, 2006; Norton, McRobbie, & Cooper, 2000). For instance, in an investigation of how preservice teachers view proof, Connor, Edenfield, Gleason, and Ersoz (2011) studied the beliefs about mathematics, mathematics teaching, and learning held by six secondary mathematics preservice teachers. These beliefs were investigated over two semesters in which the preservice teachers participated in two mathematics education courses, one on
connections in mathematics and one on teaching methods. Participants completed a 20-item Likert-type survey and participated in semi-structured interviews at the beginning and end of the first course and the end of the second course. The surveys and interviews were designed to address the teachers’ beliefs about mathematics, its teaching and learning. Additional data were collected from class discussions and homework. They found that the six teachers exhibited views of mathematics that Ernest (1988) would have classified as instrumentalist and Platonist. Only one of the teachers held beliefs that were similar to a problem-solving view of mathematics. This study conveys the idea that even with the push for reform-based mathematics teaching, today’s preservice teachers continue to see mathematics as more instrumentalist than problem-solving.

These studies suggest that most teachers continue to hold traditional views of mathematics, mathematics teaching and learning. Most teachers continue to see mathematics as a set of rules and procedures or as a connected, discovered body of fixed knowledge. The next section discusses how these beliefs often manifest in the mathematics classroom.

**Beliefs and Teachers’ Practices**

Researchers have shown considerable interest in understanding how a teacher’s beliefs impact his/her instructional practices. These researchers have investigated which beliefs influence teachers’ classroom practices and how much influence beliefs about mathematics, teaching and learning mathematics have on instructional decisions. Many researchers have found correlations between beliefs and practices that suggest traditional beliefs about mathematics and teaching and learning lead to a more traditional practice of the teacher showing and telling students what to do to solve problems (Beswick, 2004;
Beswick, 2006; Phillip, 2007; Stipek, et al., 2001; Swan, 2006; Thompson, 1984, 1992; Wilkins, 2008). Some inconsistencies have been noted, both within teachers’ beliefs (Raymond, 1997) and between teachers’ beliefs and classroom practices (Ernest, 1988; Raymond, 1997; Thompson, 1984). However, in general, studies have suggested that beliefs have a significant influence on instructional practices.

Some researchers have taken an interest in how beliefs impact specific instructional practices. These studies investigate the interaction between how a teacher views mathematics and mathematics teaching and learning and his/her views and practices with regard to specific teaching strategies. For example, NCTM (2000) has recommended the instructional practice of having students write in mathematics classes because writing can be an important tool in students’ learning. Quinn and Wilson (1997) studied teachers’ beliefs and practices surrounding the use of writing in mathematics classes. Twenty-one second grade teachers, 17 seventh grade mathematics teachers, and 25 eleventh grade mathematics teachers completed a questionnaire that contained both open-ended questions and Likert-scale questions regarding beliefs about writing and their classroom practices with respect to writing. While the second and seventh grade teachers saw writing as important in a mathematics class, the eleventh grade teachers thought there were fewer benefits. Teachers thought that writing could help students understand mathematical concepts and could be used as a valuable assessment tool. Some teachers thought that writing in mathematics was not necessarily beneficial to mathematics learning but could help students with writing skills in general. However, most of the teachers in the survey did not use writing in their own classes. The teachers were concerned about students who did not have good writing skills, and concerns about time
kept many teachers from using writing activities more often. This study emphasizes that while teachers might believe in the benefits of a specific teaching practice, perceived external factors can limit their use of those practices.

Teachers’ beliefs have also been shown to have an impact on their instructional practices with regard to computers and technology. For instance, Norton, McRobbie, and Cooper (2000) examined the relationship between teachers’ beliefs about teaching mathematics and their attitudes and practices with respect to using computers to teach. Eight secondary mathematics teachers were chosen to participate because there were many computer laboratories and graphing calculators available to the teachers at their school. The teachers completed a survey on their use of the computers, their beliefs about their teaching effectiveness, and beliefs about mathematics and teaching mathematics. Then, five of the teachers were interviewed to further investigate their beliefs. These teachers were observed several on days and interviewed after the observations to determine the typical amount of computer use. Following the interviews, the researchers conducted an intervention with the teachers by sharing and discussing a lesson plan that incorporated computers. Norton taught some lessons in which students were expected to use the computers in five of the teachers’ classrooms. Three of the teachers refused his offer to teach their classes. The teachers were asked to critique the lesson and suggest improvements. The suggestions and comments were used as additional evidence of the teachers’ beliefs about teaching mathematics and the value of computer use in mathematics learning.

Most of the teachers viewed mathematics teaching and learning as a transmission of knowledge, where the teacher shows students how to work problems and students
absorb the methods. The researchers stated that these teachers’ pedagogy was content-focused but had an emphasis on understanding. The teachers’ classrooms were very teacher-centered but the teachers’ explanations focused on helping students understand the concepts. Even though there was ample opportunity for the teachers to use the computers in their classes, they rarely considered doing so. Their beliefs about using computers were shown to be connected to their views about mathematics teaching and learning. The teachers “indicated that they would use computers to support their present transmission of mathematical knowledge or to take the tedium out of large calculations” (Norton et al., 2000, p. 104), but they felt that they were better able to transmit knowledge. Some worried that letting the students use the calculators for computational purposes could deprive students of the opportunities to practice basic facts and skills. One of the teachers believed students should create their own knowledge through interactions with peers, and her classrooms were very student-centered. Unfortunately, she was isolated in the school because she held beliefs that were considerably different from her peers. She used the computers very little, but she wanted to use them more in order to support the students’ learning. However, her colleagues held more influence when it came to ordering supplies, so it was difficult for her to get computer software that would allow her to use technology in a more student-centered manner. Norton et al. concluded that, “it appeared that most of the senior staff had philosophical and education reasons for rejecting the integration of computers into mathematics learning” (p. 106). This study found an influence of the teachers’ beliefs about the best way to learn and teach mathematics on their beliefs about the benefits or problems with using computers in the classroom.
Assigning homework is an instructional practice that most mathematics teachers engage in. Little is known about how teachers’ beliefs influence their homework practices, especially in the case where mathematics teachers choose not to assign homework. Studies on how beliefs impact certain teaching practices suggest teachers’ beliefs about mathematics and teaching and learning mathematics influence which specific instructional practices they choose to engage. This study investigated the beliefs of teachers who choose not to engage in the instructional practice of assigning homework to understand if and how beliefs influenced that decision.

**Homework**

**History of Homework**

Homework has been an issue of debate for about a hundred years. Throughout history, educators and teachers were not the only people involved in the discussion. Writers, doctors, politicians, psychologists, and parents have all played a role in the practice of assigning homework. Assigning homework has been impacted by a range of beliefs, including beliefs about learning (Gill & Schlossman, 1996).

In the late 1800’s, homework was limited to those students who continued their education beyond fourth grade (Gill & Schlossman, 1996). Most students only went to school for a few years and were needed at home, either to work on the family farm or to help the family unit by working for income or by doing other work as needed. However, in the fifth grade “the classic trinity of nineteenth-century pedagogy – drill, memorization, and recitation – was integrated fully into the instructional process” (Gill & Schlossman, 1996, p. 30). Students continuing their education during these later years were expected to take time outside of school to work on their studies, and homework
consisted of repetitive practice of problems and memorization of information and data. Education centered around the behaviorist theory of learning where students were passive receptacles of knowledge. During the 1920’s, alternative learning theories started to emerge, and learning was believed to be an active process instead of a passive process (Gill & Schlossman, 1996). Some educators argued that homework would make sense if students were clean slates but instead, if current learning theories were to be believed, students must actively engage in learning and make sense of their surroundings. They argued that homework centered on the memorization of facts and procedures would not be adequate and helpful for student learning. They also argued that homework was not consistent with new learning theories that were centered around a lab-like classroom setting. Not too long after beliefs about learning changed, homework became less popular, and many schools eliminated it for elementary grades and limited it for other grades (Gill & Schlossman, 1996). When assigned, homework consisted of activities that encompassed building skills beyond school education, such as taking trips to museums, sewing, and playing (Gill & Schlossman, 2000).

The use of homework in education remained a subject of much debate and controversy among education experts and parents for several decades. Into the 1960’s, some school districts continued to enforce anti-homework standards and a few educators continued to argue for the abolition of homework into the 1970’s. In the 1980s, educators, teachers, and parents of various political ideologies came together in support of homework in response to increased fears over global competition, poor student achievement, and low standards. Today, the debate surrounding homework continues,
with arguments for and against ranging across several different areas including important subjects such as mathematics and reading as well as in general theories about learning.

Although several other factors interacted and continue to interact with homework practices, beliefs about learning played a large role in the history of homework. Moving from a belief of learning as a passive process to learning as an active process changed the debate about homework as well as the homework practices of teachers. For a more detailed review about the history of homework in the United States, see Gill and Schlossman (1996, 2001).

**Research on Homework and Achievement**

Much of the research on homework looks at links between the amount of time spent on homework and student achievement scores. Achievement was usually based on standardized exams or exams that either the teacher or the researcher designed to cover problems from the homework.

Cooper (1989) conducted a meta-analysis of studies investigating homework and its effects on achievement. His analysis categorized studies into three groups: (1) experimental and quasi-experimental studies, (2) studies examining the relationship between time spent on homework and achievement, and (3) homework versus in-class supervision. Studies were analyzed by estimating the average effect size and 95% confidence interval and a homogeneity analysis to determine if effect sizes within a research area were drawn from the same population. Twenty studies looked at homework versus no-homework and showed a small positive correlation between homework and student achievement, but studies with counterbalancing and repeated measures showed smaller effects. Higher effects were seen for experiments where the teacher was the
experimenter. In addition, homework was more effective for science and social studies than for mathematics and for older students than for younger. Furthermore, these studies treated homework as an add-on to classroom practice where both groups were treated the same way but one group would have homework assigned and the other would not. Seventeen studies investigated the correlation between time spent on homework and achievement. Of these studies, 50 correlations were analyzed and 43 showed positive correlations. Mathematics was found to have the strongest correlation for these studies. Averaging and quantitatively analyzing data from 8 studies on homework versus in-class supervision showed that students doing homework were about one standard deviation above those with in-class supervision, but this depended upon the grade level. Cooper concluded that homework has substantial benefits for high school students, some benefits for middle school students, and that the benefits of homework are negligible for elementary grades. While homework versus no-homework studies showed positive benefits to doing homework, these studies have ignored the role that teacher practices and teacher beliefs play in student learning. Without taking into account that teachers who choose to assign homework may very well teach and believe differently than those who choose not to, these results are very limiting in their usefulness.

Trautwein and Koller (2003) also reviewed the research on homework to try to clarify the relationship between homework and achievement. They reviewed Cooper’s (1989) studies and research that had been conducted following the review. They focused on the methodological and theoretical frameworks of the research and concluded, “there is still much uncertainty over the nature and strength of the relationship between homework and achievement” (p. 141). They found that results are contradictory, and that,
many times, associations are not significant. “The relationship between homework and achievement at the individual level is not yet fully understood, and it is unclear to what extent homework behavior improves grades” (p. 134). They also noted that few studies have investigated the interaction effect between homework and student characteristics. Much of the research on homework came from data-sets that were not designed for homework research, in terms of the study design or the homework variables used. For example, randomization procedures were not used in many of the studies, pretreatment differences between subjects were uncontrolled, small sample sizes limited the statistical validity, and shortcomings in the handling of the data all complicated the final conclusions that could be drawn. This operationalization of data and the problematic handling of the data led them to their conclusions (Trautwein et al., 2003). More studies that overcome the methodological problems are needed, but homework research needs to be “more closely linked to well-founded psychological theories of learning and instruction” (p. 142). They offered three links: research on time on task, self-regulation, and teaching, and they see a possible link between teachers’ homework practices and teachers’ philosophy of teaching or personal teaching style. This study investigated links between teachers’ homework practices and philosophies of teaching.

In a research review of 80 studies, Cooper, Robinson, and Patall (2006) maintain that overall there is generally a positive influence of homework on achievement, as measured by standardized exams and classroom grades. However, they also stated that this correlation is stronger for Grades 7–12 than K–6. “A significant, though small, negative relationship was found for elementary school students, using fixed-error assumptions, but a nonsignificant positive relationship was found using random-error
assumptions” (p. 49). However, “there was strong evidence that homework and achievement were positively related for secondary school students” (p. 49). They summarize that “no strong evidence was found for an association between the homework–achievement link and the outcome measure (grades as opposed to standardized tests) or the subject matter (reading as opposed to math)” (p. 1). Cooper et al. suggested that future research should include a qualitative aspect to investigate homework processes, moderators and mediators of the effect of homework, as well as its intended and unintended consequences. The studies that have investigated the correlation between student achievement and homework suggest there are many questions in regards to just how much benefit students gain from homework, especially at the lower grades and in the subject of mathematics.

Overall, research on homework has been limited to looking for correlations between homework and achievement. With the focus of much of the research looking at correlations between homework and student achievement, how a teacher’s philosophy of teaching and learning relates to his/her homework practices needs more research. Even though most of this research looked at homework in general, a few studies investigated mathematics homework in particular. These studies are discussed next.

**Research on Mathematics Homework**

Many of the studies that examined the link between amount of homework and achievement did not distinguish between the different subjects. Pezdek, Berry, and Renno (2002) studied the correlation between time spent on mathematics homework and achievement on a test designed for the study. They wanted to determine whether the amount of time the parent spent helping the child with homework related to how well the
child did on the test. They also wanted to assess whether the parents were able to predict how their child would do on the test and whether this was related to time spent helping with homework. Two studies were conducted: one with 165 fourth, fifth, and sixth graders from an elementary school in the Los Angeles area; and the second with 215 fourth, fifth, and sixth graders at two other public schools in the same district. In each study, students were given a 45-item test, and a blank copy was sent home to parents. Parents were asked to predict how well their child did on the test as well as answer questions relating to how much time was spent by the student on homework, how much time was spent by the student on mathematics homework, and how much time the parent spent helping the child with homework and mathematics homework specifically.

The researchers concluded that parents severely overestimated their child’s mathematical ability (about one and a half grade levels higher) and had mixed results on the correlation between time spent on mathematics homework and achievement. Study 1 indicated that students’ achievement was lower for those students whose parents who spent more time helping their students with homework but that this correlation was not significant. Study 2 also found that the amount of time parents helped their child with homework did not significantly impact the students’ achievement. In addition, Study 1 did not show a significant correlation between the amount of time spent on mathematics homework and achievement, but Study 2 showed a modest but significant correlation between the two. These studies suggest that even when parents work with their child on homework, they do not necessarily have a better understanding of how well their child understands the mathematics. However, parents often have an influence on teacher classroom and homework practices. Pezdek et al. concluded that “these findings suggest
that for elementary school students, typical mathematics homework assignments provide little added value beyond the mathematics instruction and practice provided in the classroom” (p. 775).

De Jong, Westerhof, and Creemers (2000) investigated the effect of homework practices of 56 mathematics teachers on the mathematics achievement of 1394 of their first-year secondary students from 28 schools in the Netherlands in 1994. Schools chosen shared a homogenous mathematics curriculum and were already taking part in a large national longitudinal study. A mathematics achievement test was designed around common topics that were taught from the two textbooks the schools were using. Students completed questionnaires about homework practices and behaviors of the teacher in the classroom. Both teachers and students filled out a logbook to write down information related to homework, and teachers were observed three times during the school year.

De Jong et al. (2000) found that although most of the schools did not have a homework policy, most teachers assigned homework after almost every class. More specifically, for classes that met three times a week, the frequency for mathematics homework was 2.6 times per week and for classes that met four times a week, frequency was 3.5 times per week. There was, however, a big difference between teachers in regard to the number of tasks that homework contained. On average, 6.6 tasks were assigned for each assignment, but the range was from 3 to 10 tasks. Students reported spending an average of a little more than 30 minutes on each mathematics homework assignment, but because 84% of teachers allowed students to work in class on the assignment, there was a large difference in the amount of time students reported for homework. Observations showed that, in addition to giving students time to work on homework in class, the
teachers also spent another 34% of class time discussing the homework assignments. Therefore, while this study largely included teachers who assigned homework almost every day, the quantity of problems and the amount of time students spent working on homework varied. De Jong et al. (2000) found a negative correlation between the amount of time spent working on mathematics homework and mathematics achievement, but they did find that prior knowledge played a large role in students’ achievement. The range between the number of homework tasks assigned, coupled with the lack of significant positive correlations between time spent on homework and achievement, suggests that teachers’ instructional practices varied.

Mikk (2006) investigated the relationship between homework and 2003 TIMSS mathematics results from 46 countries. For this study, teachers were assigned to three groups based on the amount of homework they assigned. The teachers in the high-emphasis group assigned homework for at least 1.5 hours each week, the medium-emphasis group assigned 1–1.5 hours of homework a week, and the low-emphasis group assigned less than 1 hour a week. Using correlation coefficients, Mikk found that in the inter-country comparison, teachers’ high emphasis on homework had no significant correlations to the TIMSS results. Several countries had a low emphasis on homework yet scored very high on the exam (Belgium, Hungary, the Netherlands, Lithuania, Latvia, and Estonia were among this group of countries). Within-country comparisons were also made. Teachers who had a high emphasis on homework had students with higher scores than those who had a low emphasis on homework. However, teachers who had a medium emphasis had scores that were fairly close to those with high emphasis, and in a third of the cases, those teachers had higher scores. Although most teachers assign homework in
the United States, examining the beliefs and practices of mathematics teachers who do not could help us understand what practices they use to make up for the lack of assigned homework.

Other interesting results were found by Mikk (2006). When he investigated the correlation between time spent on mathematics homework and the TIMSS scores for students, no significant correlation was found on the inter-country comparison. He also found that 78% of the teachers in the TIMSS sample monitored whether homework was completed or not. He found this to have no significant correlation with the TIMSS scores. A negative correlation was found between TIMSS scores and teachers who, according to the students, gave feedback “always” or “almost always.” Teachers who used homework as a basis for class discussion and those that used homework to contribute to students’ grades both showed a negative correlation with TIMSS scores. Mikk concluded that the missing relationship between time on mathematics homework and TIMSS results can be explained by the differences between the students and teaching styles in the classroom. This study shows just how complicated studying homework can be, especially when there are so many factors that can determine student learning.

Quizzes are one form of assessment that some teachers use to help assess students’ knowledge and understanding. Swank (1999) conducted a study to give teachers and principals proof that weekly mathematics homework increases academic performance. Twenty-one fourth graders were given weekly homework and quizzes. Homework was assigned on Monday to be due on Friday but was optional for students. Because the homework was optional for students, different students completed the homework each week. At the end of the week, a quiz that covered material from the class
and homework was written by the teacher or the researcher and was given to the students
to determine which cluster of students scored better, the ones who did the homework or
the ones who did not complete the homework for that week. This was repeated for a total
of nine weeks. The first week only one student did not do the homework, and that student
scored higher than the others. The following weeks, more and more students were
choosing not to do homework; by the third week, more were choosing not to do the
homework than were choosing to complete the homework. In five of the weeks, students
who chose not to do homework outsored those who chose to complete the homework.
The other four weeks showed the opposite. However, in all of the nine weeks, only one
week showed a significant difference, and the outcome was in favor of homework. This
significant week was covering multiplication with two digits, and the homework gave
students the added practice to score better on the weekly quiz. Swank concluded that
there was, in general, no significant difference between those students who did the
weekly math homework and those who chose not to.

Overall, studies that investigated possible links between mathematics homework
and achievement were just as unclear as those that looked at homework in general. Some
of the studies found positive benefits and some showed no positive benefits. Reflection
on whether or not a practice is working could lead to changes in that practice and in
teaching in general.

**Research on Teachers’ Homework Practices**

Teachers assign homework for several different reasons, and the homework can
look very different depending upon the teacher. In their review of homework studies,
Epstein & Voorhis (2001) report several reasons why teachers give homework, with the
most common reason being to ensure that students get more practice. Other reasons for assigning homework are to ensure that students are prepared for future lessons by having mastered prior lessons, increase student participation in learning for those students who do not fully engage in class, and increase a student’s personal development such as responsibility, perseverance, and self-confidence. Homework is also used to communicate with parents and to promote communication between a student and his/her parents about what is going on in school and what the student is learning, increase peer interaction through homework that requires they work together and learn from others, or fulfill policy requirements that are in place within the school or district. Teachers use homework to promote public relations by showing that the school has high standards for students and as a form of punishment for bad behavior (Epstein & Van Voorhis, 2001).

Murphy and Decker (1989) investigated 3000 Illinois high school teachers to determine why they assigned homework, how often they assigned homework, and how they designed typical homework assignments. Out of the 3000 teachers, 2550 teachers chose to assign homework. Fifty-five percent of the teachers assigned homework to reinforce class material by giving students a chance to practice. Other reasons for assigning homework were to: help students master class objectives (22.5%); introduce new material (10.8%); help students prepare for a test (2.9%); and monitor student progress (2.8%). The most common type of assignment was questions from the textbook (49.5%) followed by worksheets (24.9%), essays and written assignments (7.4%), reading and research reports (5.3%), independent projects (3.6%), and watching television programs (5%). Homework was most frequently assigned either 3 days or 5 days a week, with 560 teachers saying 3 days a week and 554 saying 5 days a week.
Teachers generally expected homework to take between 15 and 30 minutes to finish (1202 responses) or between 30 and 45 minutes (823 responses). Murphy and Decker called for more research studies that are better theoretically and conceptually grounded as well as research on homework and teacher practices and opportunity costs associated with homework. There are several reasons why teachers assign homework, but a good portion of the homework comes either from the textbook or from worksheets. The reasons why teachers give homework are just as important as the reasons why teachers choose not to give homework. Teachers who assign homework have specific reasons and ideals that they think their students are getting from the extra work, such as practice; teachers who choose not to assign homework must also have specific reasons for why they think they can do without homework. However, if homework is seen as necessary for meeting needs of students (as in the case of practice), we need to also understand how teachers who do without homework meet those needs.

Xu & Yuan (2003) conducted open-ended interviews with 9 urban middle school teachers, 18 students, and their families. Teacher, student, and family attitudes about homework were presented using four categories: “(a) the importance of doing homework, (b) reasons for doing homework, (c) doing homework in the home context, and (d) other concerns over homework” (p. 31). They found that all three groups felt that homework was a way to review, practice, and reinforce learning. Teachers and parents also stated that homework helped increase students’ personal responsibility and study skills, but only a few students mentioned this aspect of homework. Parents and a few students also mentioned that homework kept students away from after school activities that could be harmful and could get them in trouble, such as loitering on the streets or getting in trouble
with the law. Additionally, students were asked to discuss reasons for why they
completed homework, and two common reasons for doing homework were “to earn good
grades or to avoid getting bad grades” (p. 33) and “to please significant others or to
comply with their expectations” (p. 33).

Xu and Yuan (2003) concluded that, “instead of imposing adult views on
children, teachers and parents need to take the children’s perspective into consideration in
the homework process by designing “homework assignments that are more purposeful
and motivating for students” (p. 40). More research needs to “examine and monitor
student attitudes toward homework during the middle school years, along with the views
of their teachers and parents” (p. 42). The fact that students often did not see the benefits
to homework and thought that homework took time that was better spent doing
something else leads to questions about student enjoyment of learning. Students who
might otherwise enjoy school could end up with very negative views of learning due to
homework if they see homework as a waste of time. Teachers who choose not to assign
homework might have reasons related to these students’ views or might consider these
students’ views when making decisions about homework.

Xu and Yuan (2003) were not the only ones to find that students do not always
see the same benefits to homework that adults do. Coutts (2004) conducted interviews
with parents and students in Australia about the purpose of homework, costs associated
with homework, and the benefits of homework. Once again, students did not see the same
benefits to homework that parents did, such as building responsibility or increased
achievement. She stated that, “for adults, it may appear obvious that there is a link
between learning and achievement, but for young children this may not be the case” (p.
In addition, she found that some parents expected their children to have homework because they believed there was not enough time in the school day to cover all the material.

Some schools have decided to incorporate a no-homework policy for their students. Several factors were key in the decisions of these schools, including beliefs about learning and the value of children doing other activities. Kohn (2007) interviewed teachers and administrators of schools that continued to achieve success with their students despite moving to a no-homework policy. Many school administrators stated that they saw an increase in student achievement, which they attributed to the lack of homework assigned. They believed that the students were more interested in learning and took more initiative to learn outside of class because they were not required to work on something that did not interest them. Kohn further discussed how teachers said they pushed themselves to make class activities interesting to students so the students desired to learn more and spend time outside school extending what was done in class.

Grant Elementary School in Glenrock, Wyoming decided to adopt a no-homework policy. They sent a letter home to parents explaining that they do not assign homework because the research shows no conclusive evidence that homework helps elementary students’ achievement. They gave several suggestions on what parents can do with their child that has been shown to have positive effects on learning such as eating dinner together, taking time to read together, playing outside for at least an hour after school, and getting to bed early. The school conducted an informal study using parent survey responses during parent-teacher conferences and found that a large percentage of the parents liked the no-homework policy (Bennett, 2007). Parents believed their children
spent more time on other activities such as playing, sleeping, reading, and eating dinner with their families, and they believed that their children spent less time watching television. Parents also thought that their children had an improved attitude toward school and stated they had fewer conflicts with their children.

The Prince of Wales Public School in Barrie, Ontario also decided to change homework policies. Students do not get homework until they are in seventh grade, where homework is limited to one hour a night for students in Grades 7 and 8 and no more than 2 hours of homework a night in high school. The choice to move to this homework policy caused quite a bit of anxiety with parents and teachers, but grades have not declined since the policy was implemented, and some classes have actually seen an increase in student grades and understanding. Teachers were also concerned about the new policy but have changed teaching practices in order to make sure students did not suffer from a loss of extra practice. The school administrators said that classes incorporate many different subjects, teachers work more collaboratively, and mathematics classes incorporate more discussion and student thinking (Rushowy, 2008). In an interview with CTV’s Canada AM News in 2009, the principal, Jan Olsen, stated that the school’s achievement scores had increased for all groups of students including special needs, gifted, low SES and high SES. There were fewer behavioral issues and teachers had more time to focus on good classroom practices and students were more engaged because of it (CTV News, November 2009). These schools seem to suggest that homework might not be necessary if other classroom factors can be changed to increase student learning while in school. Changes in classroom environment, teacher preparation and teacher practices might make up for the extra time students spend working on homework.
Julia Atkin, a professional developer in Australia, helps school communities align their beliefs and values to their practices. She uses a process in which teachers and schools are asked to make explicit exactly what they stand for in regards to beliefs about learning and values that guide their actions. She then has them discuss how their practices follow their beliefs and values. Homework is one topic that she discusses with teachers. In her informal work with teachers, Atkin (2001) has collected some reasons that teachers state for why they assign or do not assign homework. She asks teachers to think about the educational reasons for why they assign or do not assign homework. Following this, teachers think further about the underlying values and beliefs about learning for each of those reasons.

Teachers regularly give several reasons for why they assign homework to their students (Atkin, 2001). Homework gives students the opportunities to consolidate their learning through practice. These teachers believe that learning requires practice to help consolidate thoughts and create automaticity. Teachers also state that homework helps keep parents informed about what is going on in the classroom. These teachers think of parents as partners in the education of their children and believe that parents play a positive role in that education. Another reason to assign homework is to instill good work and study habits. Teachers state that students are expected to continue to learn outside of school and work and doing homework helps instill that habit. Teachers state that homework helps to link learning in school to learning outside the classroom. These teachers believe that learning occurs in all aspects of life, and homework links the learning in school to outside learning. Finally, teachers sometimes state that homework
allows students to learn at a different pace than others. These teachers believe that
different people learn at different paces and homework helps cater to those differences.

Atkin (2001) found that teachers usually give four reasons for not assigning
homework. First, teachers state that homework can lead to inequities. Students have
different resources outside of school, including parents. Equal opportunity is important to
these teachers who believe that homework further increases equity gaps. Second,
homework takes away opportunities for playtime, which teachers state is important for
development and who believe playtime should be valued. The third reason why teachers
do not assign homework is a fear that students will get confused and stressed if parents
cannot help with homework. These teachers state that learning, either alone or with
family, should be a positive experience. The final reason teachers generally give for not
assigning homework is because participating in activities with family and learning to be a
vital part of the family unit is important. These teachers say they value the social skills
that students gain from being part of the family group. Table 1 summarizes her findings
on the educational reasons against giving homework.

Table 1

Reasons and Associated Beliefs and Values Against Assigning Homework

<table>
<thead>
<tr>
<th>Educational reasons against giving homework</th>
<th>Underlying values and beliefs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can lead to inequities because students have different resources at home and parents have different attitudes</td>
<td>Equal opportunity is valued for all students</td>
</tr>
<tr>
<td>Takes away children’s time to play</td>
<td>Play is important for healthy development and leisure time as well as work should be valued</td>
</tr>
</tbody>
</table>
Students can get confused and stressed if parents do not understand the process or the homework

| Learning and learning together should be a positive experience |
| Participating in family activities and learning to be cooperative members of a family unit are important |
| Social skills learned by cooperating in the family group are important |

The research on homework and beliefs shows underlying beliefs about homework’s impact on learning, and they range from achievement to instilling life-lessons to remembering mathematical facts. Within schools that have chosen to eliminate or limit homework, beliefs have also played a role in that decision as well as the decision to continue with the policy. However, more research is needed in the area of beliefs of teachers who do not assign homework as well as how those beliefs influence the teaching practices of these teachers.

**Theoretical Perspective**

Ernest (1988) argued that reforms in mathematics teaching will not take place until teachers’ deeply held beliefs about mathematics and the teaching and learning of mathematics change. He suggested that the practice of teaching mathematics depends upon a number of key elements, most notably: “(1) the teachers’ mental contexts or schemas, particularly the system of beliefs concerning mathematics and its teaching and learning, (2) the social context of the teaching situation, particularly the constraints and opportunities it provides, and (3) the teachers’ level of thought processes and reflection” (p.249). Ernest asserted that the key belief components for mathematics teachers are their views of the nature of mathematics, their views of the nature of mathematics teaching, and their view of how people learn mathematics.
Drawing upon the literature, Ernest (1988) argued that mathematics teachers typically hold one of three views of mathematics: instrumentalist, Platonist, and problem solving. Teachers holding an instrumentalist view of mathematics believe that mathematics is an accumulation of what they perceive to be the facts, rules, and skills of mathematics. Mathematics is largely seen as a set of unrelated facts and rules that are the means used to obtain a result. A Platonist view of mathematics holds that “mathematics is a static but unified body of certain knowledge” (Ernest, 1988, p. 150). Teachers with this view believe that mathematics is discovered but not created. Finally, some teachers hold a problem solving view of mathematics. They believe that mathematics is a “continually expanding field of human creation and invention, a cultural product” (Ernest, 1988, p. 150). “Mathematics is seen as a process of enquiry and coming to know, not a finished product” (p. 150), and results remain open for continual exploration.

In addition, Ernest (1988) argued that a teacher’s beliefs about the role they should play in the classroom as well as their use of curriculum materials also impacted teaching practices. Mathematics teachers could play the role of Instructor, Explainer, or Facilitator. Each role for the teacher was expected to have a certain outcome. Instructors expected that students master material and skills and expected students to perform correctly on problems. Teachers that expected students to have conceptual understanding of mathematics with unified knowledge were positioned in the role of explainer. Finally, teachers with the role of a facilitator expected students to become confident problem posers and solvers.

Teachers’ beliefs about the process of learning mathematics are also important in teachers’ classroom practices. Ernest (1988) described two key constructs for the learning
of mathematics: (1) learning as active construction in which the teacher’s goal is to
develop autonomy and child interests in mathematics and (2) learning as a passive
reception of knowledge in which the teacher expects students to be submissive and
compliant in the mathematics classroom. Table 2 summarizes Ernest’s classification of
teachers and their beliefs.

Table 2

Summary of Ernest’s Teacher Belief Classifications

<table>
<thead>
<tr>
<th>Beliefs about:</th>
<th>Classification of beliefs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>Instrumentalist:</td>
</tr>
<tr>
<td></td>
<td>Mathematics is an accumulation of facts, rules, and skills. Mathematics is seen as a set of unrelated utilitarian facts and rules that are the means used to obtain a result.</td>
</tr>
<tr>
<td></td>
<td>Platonist:</td>
</tr>
<tr>
<td></td>
<td>Mathematics is a static but unified body of certain knowledge. Mathematics is discovered but not created. A global understanding of mathematics as a consistent, connected and objective structure.</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>Mathematics is a continually expanding field of human creation and invention, a cultural product. Mathematics is seen as a process of enquiry and coming to know, not a finished product, and results remain open for continual exploration.</td>
</tr>
<tr>
<td>Teacher’s Role</td>
<td>Instructor:</td>
</tr>
<tr>
<td></td>
<td>Mastery of skills with correct performance.</td>
</tr>
<tr>
<td></td>
<td>Explainer:</td>
</tr>
<tr>
<td></td>
<td>Conceptual understanding with unified knowledge.</td>
</tr>
<tr>
<td></td>
<td>Facilitator:</td>
</tr>
<tr>
<td></td>
<td>Confident problem posing and solving.</td>
</tr>
<tr>
<td>Learning</td>
<td>Passive Reception of Knowledge:</td>
</tr>
<tr>
<td></td>
<td>(1) Compliant behavior and skill mastery model</td>
</tr>
<tr>
<td></td>
<td>(2) Reception of knowledge model</td>
</tr>
<tr>
<td></td>
<td>Active Construction of Knowledge:</td>
</tr>
<tr>
<td></td>
<td>(3) Active construction of understanding model</td>
</tr>
<tr>
<td></td>
<td>(4) Exploration and autonomous pursuit of student interest model</td>
</tr>
</tbody>
</table>

A teacher’s view of mathematics and his/her model of mathematics teaching and
learning are linked together (Ernest, 1988). An instrumental view of mathematics “is
likely to be associated with the instructor model of teaching, and with the strict following of a text or scheme” (p. 151). It could also be associated with students’ compliant behavior in the classroom and the mastery of skills model of learning (Ernest, 1988). Teachers who view mathematics as a Platonist would likely be an explainer in the classroom with children playing the role of receptors of knowledge (Ernest, 1988). Teachers who play the role of facilitators in the classroom probably view mathematics as problem solving, and learning is likely viewed as active construction of mathematical understanding, possibly even as autonomous and confident problem posing (Ernest, 1988).

The perspectives from Ernest (1988) were used in this study to gain an understanding of beliefs about mathematics, mathematics teaching and learning, and homework. Ernest’s framework helped me categorize the beliefs of my participants and to make connections between the teachers’ beliefs about homework to their beliefs about mathematics and mathematics teaching and learning.
CHAPTER 3
METHODS AND METHODOLOGY

In this descriptive case study (Yin, 2003) I examined the beliefs held by three mathematics teachers who chose not to assign homework. A descriptive case study was suitable for this investigation because my goal was to describe the teachers’ beliefs and views on mathematics, teaching and learning mathematics, and homework. Descriptive case studies are useful “in presenting basic information in areas of education where little research has been conducted” (Merriam, 1998, p. 38). In this study, the phenomenon was the beliefs of mathematics teachers who chose not to assign homework and how their beliefs influence their decision to have a no-homework policy within the context of their classrooms and schools.

This chapter describes the participants, data sources, and data analysis methods employed in this study. One middle school and two high school mathematics teachers participated in this study from November 2010 through January 2011. Qualitative data were collected from classroom observations, lesson plans, and semi-structured interviews. The research questions guiding this study were:

For mathematics teachers who choose not to assign homework:

1. What are their beliefs about mathematics and mathematics teaching and learning?

2. What are their rationales for not assigning homework?
3. What challenges do they face because of their decision to not assign homework and how do they address these challenges?

Participants

Participant Selection

This study focused on middle and high school mathematics teachers because students in these grades typically spend several more hours each week on homework than elementary students (NCES, 2010). Two criteria were used to select participants: (1) currently teaching mathematics and (2) made a personal decision not to assign homework. The first criterion was important because I wanted to describe how these teachers met the demands of teaching in today’s schooling environment. Today’s classrooms are very different than classrooms from several years ago for many reasons (including student differences, stress on standardized tests, and technology available). The second criterion was necessary to better investigate the beliefs of teachers who did not assign homework. I decided that the decision of not assigning homework had to be a personal decision rather than a decision mandated by school or district administrators.

Participants were recruited for the study based on electronic media and word-of-mouth. I asked educators and teachers if they knew of any teachers who taught mathematics without assigning homework. This method led to two of my participants. I also emailed several people who conducted research on homework and/or wrote about issues surrounding the assignment of homework, including Sara Bennett, Harris Cooper, Alfie Kohn, and Etta Kralovec. During the search, Sara Bennett, Alfie Kohn, and Etta Kralovec mentioned several schools that might have teachers who qualified for my study. I emailed 26 middle and high schools to determine whether they had any teachers who
qualified. One middle school and two high school mathematics teachers were selected to participate in this study. The participants taught at a variety of schools including public, parochial, and private Montessori schools. All teachers taught in the southeastern United States.

**Thomas**

Thomas was a White male in his early twenties. He held a Bachelor of Science degree in Applied Mathematics from a southern college and a master’s and specialist’s degree in mathematics education from a large southeastern university. During his master’s program, he received his teacher certification. At the time of this study, he was working on a doctoral degree in mathematics education at the same large southeastern university. Thomas also had a fellowship with the Knowles Science Teaching Foundation at the time of this study. The Knowles Science Teaching Foundation was created in 1999 to encourage and support high-quality science and mathematics teachers. The teaching fellowships are designed to support, sustain, and inspire teachers through professional development, mentoring, and a community of peers with the intent of retaining these teachers and helping them become educational leaders.

Thomas was in his third year as a high school mathematics teacher and his second year teaching at Range High School. Range High was considered a rural public school with approximately 625 students. Thomas taught six 90-minute mathematics classes a week: Advanced Placement (AP) Statistics, Discrete Mathematics, and four sections of Mathematics III. Mathematics III is an integrated mathematics course covering topics in Algebra, Geometry, Data Analysis, and Probability. More specifically, it includes a study of exponential and logarithmic functions, matrices, polynomial functions, conic sections,

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1 All names are pseudonyms
and normal distribution. His teaching schedule alternated each week. For example, a class would meet on Monday, Wednesday, and Friday one week, then Tuesday and Thursday the next. Thomas stated that in the year prior to this study, he did not assign homework in any of his classes, but due to pressure from the school district, he assigned some homework in his Advanced Placement Statistics and Discrete Mathematics classes. However, he did not assign homework in any of his Mathematics III classes. I focused only on the four Mathematics III classes for this study.

George

George was a White male in his 35th year of teaching mathematics as a certified teacher. He taught at both the middle and high school levels. He had a Bachelor of Science degree in Mathematics Education from a small southern university, and a master’s degree and specialist’s degree in mathematics education from a large southeastern university. At the time of this study, he was working on his doctoral degree in mathematics education at that same southeastern university.

He was in his first year teaching part time at a small Christian school in the south, Absalom Christian School. Absalom served approximately 340 students in grades preKindergarten–12. George taught three mathematics classes each week: AP Calculus, Geometry, and Pre-Calculus. His AP Calculus class met for approximately 90 minutes on Tuesday, 45 minutes on Wednesday, and 90 minutes on Friday. His Geometry and Pre-Calculus classes met for approximately 45 minutes every day.

Claire

Claire was a White female in her 12th year of teaching. She taught middle school for seven years as a resource teacher and inclusion teacher for science, mathematics, and
language arts. As a resource teacher, she helped special education students in any subject where they needed assistance, and as an inclusion teacher, she co-taught science, mathematics, and language arts with general education teachers. Claire was also a high school resource teacher for two years where she helped students with any class in which they needed support. She had a Bachelor’s Degree in Elementary Education from a small southeastern university. After this program, she was certified to teach grades PreK–8 and special education. She also held a Master’s Degree in Special Education from another southeastern college.

She was in the third year of teaching at Cainesville Academy, a privately owned Montessori middle school located in the southeastern portion of the United States. At the time of this study, there were eleven students in the middle school. These students would be considered grades 7 and 8. Claire was responsible for teaching language arts and mathematics. Claire offered the students pre-algebra, algebra, and geometry coursework. All of the students were taking at least one of the courses, but several students were taking two, and students could sit in on any lesson if they wanted. Lessons took place on Monday and Wednesday for approximately 40 minutes for each subject. On Tuesdays and Thursdays, the students had time to work on assignments and ask Claire and other students questions. On Fridays, students were assessed on the week’s lessons with a quiz. The assessment consisted of approximately 20 questions covering the material from that week. Students also spent half of the day on Fridays working in a local business as interns to learn skills in a real-life context.
Data Sources

Data sources for this study consisted of classroom observations, lesson plans, and individual interviews. All interviews were audiotaped and transcribed by the researcher for analysis. Each data source is discussed below.

Classroom Observations

I observed two consecutive days of mathematics classes for each teacher. The purpose of the observations was to determine the structure of a typical lesson. During the observations, I kept detailed notes of the time, activities, and questions asked by both the teacher and students. For example, at the beginning of class, I wrote down what time the class started, what the teacher said to start the day, the problem students were expected to work on, how the students were engaging with the problem (alone or in groups), and what the teacher was doing while the students worked. After the observations, I typed these notes and used them to map out the lesson structure and to design questions for the post-observation interview.

Lesson Plans

Prior to the observations, I collected lesson plans from the teachers for the dates of observation. I used the lesson plans to supplement my notes from the observations and to help me describe the lesson structure. George did not write lesson plans for his mathematics classes. He offered to write some for me, but rather than have him create data that would normally not be available, I chose to probe him during the interviews about how he planned his lessons. Because Claire’s schedule consisted of only two days of lessons each week with workdays in between, I felt that I needed additional
information to determine her lesson structure. I asked for additional lesson plans, which she gladly provided, and therefore, I analyzed three lesson days’ worth of plans for her.

**Individual Interviews**

Each participant took part in three semi-structured interviews. Interviews are essential sources of case study information (Yin, 1989) and were the main data source for this study. The interviews allowed me to probe the mathematics teachers’ beliefs, practices surrounding their no-homework policy, and reasons for not assigning homework. The interviews did not build on each other so the order of the interviews was unimportant, with the exception of the Post-Observation Interview. All three interviews were audiotaped and transcribed by me.

The Post-Observation Interview (see Appendix A) was designed to answer the third research question on the challenges and concerns the teachers faced because of their no-homework policy and to gather feedback on my observations. Questions included “What accommodations do you make for not giving homework?,” “How do you ensure your students are successful in mathematics?,” and “If another teacher wanted to try to teach mathematics without assigning homework, what advice would you give them?”

This interview lasted 60 minutes, 53 minutes, and 58 minutes for Thomas, George and Claire, respectively. During the Post-Observation Interview, I described the different portions of the lesson and the lesson structure and asked the teacher questions such as “Does this represent a typical day for your classes?,” “What might be different?,” and “If I had visited on another day, how might the lesson differ in structure?” In addition, I described some teacher moves and activities and probed these actions. For example, I noticed that Thomas kept track of the number of people working on the warm-up
problems and posted this percentage on the board at the front of the classroom. I questioned him on his actions to determine if this was connected to his no-homework policy in any way.

Interview A (see Appendix B) was designed to answer the first research question about teacher’s beliefs about mathematics and the teaching and learning of mathematics. I asked such questions as “What do you like most about mathematics?,” “When it comes to learning mathematics, would you argue more for nature or nurture?,” “What does it mean to know mathematics?,” and “How do you think your students best learn mathematics?” This interview also helped me answer the second research question because it allowed the teachers to express their ideas on homework, its influence on teaching and learning mathematics, and their rationales for not assigning it. I asked questions such as “Have you ever assigned homework or have you always taught mathematics without it?,” “Tell me about your decision to teach mathematics without homework.,” “What are the educational benefits of not assigning homework?,” and “How has your decision to not assign homework influenced the way you teach mathematics?” This interview lasted 68 minutes, 81 minutes, and 70 minutes for Thomas, George, and Claire, respectively.

The third interview, Interview B, (see Appendix C) was designed to help me answer the first and third research questions. To answer the first research question, I asked questions such as “Is mathematics a creative subject? If so, what does it mean to be creative in mathematics?,” “How do you feel about cooperative learning in mathematics?,” and “Is it okay for students to feel uncomfortable during your mathematics class? If so, when/under what circumstances?” To answer the third research
question, I asked questions such as “What challenges do you face because of your no-homework policy?,” “What concerns do you have about teaching mathematics without homework?,” “How do you overcome these challenges and concerns?,” and “How do you make sure students have mastered prior concepts needed for future lessons?” This interview lasted 68 minutes, 81 minutes, and 46 minutes for Thomas, George, and Claire, respectively.

Data Collection

Data collection began in early November 2010 and continued until the end of January 2011. Thomas lived too far away to meet in person for the interviews, so the Post-Observation Interview was conducted via Skype (a program that allows video chat), and Interviews A and B were conducted over the phone. All of George’s interviews were conducted in a quiet office at the University of Georgia, and all of Claire’s interviews were conducted in a quiet corner of her classroom during class time. As I interviewed her, the students were either working on their own or with her co-teacher in another section of the room. All interviews were recorded using a digital audio recorder.

The data were collected in the same order for Thomas and George. The classroom observations occurred first, in early November. After the observations, I typed my notes, mapped out the lesson structure, and designed questions for the Post-Observation Interview. They then participated in the Post-Observation Interview in mid-November. Interview A occurred in December and Interview B occurred in January.

Claire’s students participated in a schedule where they had five weeks of work then one elective week. During the elective week, students were allowed to learn about areas of interest, go on fieldtrips, or do arts and crafts. This was a week where the
students were not participating in typical lessons. Due to this, the Thanksgiving holiday, and other scheduling complications, Claire participated in Interview A first. At the end of this interview, we scheduled classroom observations for a couple weeks later. In early December, I observed her mathematics classes and we scheduled the Post-Observation Interview for the following week. At the end of the Post-Observation Interview, we scheduled her final interview for the middle of December. A synopsis of the data collection process and the dates of occurrence is given in Table 3.

Table 3

Data Collection Process

<table>
<thead>
<tr>
<th>Participant</th>
<th>Activity and Date</th>
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<tbody>
<tr>
<td>Thomas</td>
<td>1. Classroom observations – November 2–3, 2010</td>
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<td>2. Post-Observation Interview – November 12, 2010</td>
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<td>3. Interview A – December 23, 2010</td>
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<td>4. Interview B – January 16, 2011</td>
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<tr>
<td>George</td>
<td>1. Classroom observations – November 9–10, 2010</td>
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<td></td>
<td>2. Post-Observation Interview – November 18, 2010</td>
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<td></td>
<td>3. Interview A – December 9, 2010</td>
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<td>4. Interview B – January 24, 2011</td>
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<tr>
<td>Claire</td>
<td>1. Interview A – November 16, 2010</td>
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<td></td>
<td>2. Classroom Observations – December 8–9, 2010</td>
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<td></td>
<td>3. Post-Observation Interview – December 15, 2010</td>
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<td>4. Interview B – December 17, 2010</td>
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Data Analysis

All of the interviews were transcribed and analyzed using thematic analysis. Thematic analysis “involves the searching across a data set – be that a number of interviews or focus groups, or a range of texts – to find repeated patterns of meaning” (Braun & Clarke, 2006, p.86). Braun and Clarke (2010) describe six phases of thematic analysis that were used as a guide in this study: (1) Familiarization with the data, (2)
Generation of initial codes, (3) Search for themes, (4) Review the themes, (5) Define and name the themes, and (6) Production of the report. This process was completed for each of the individual cases.

I worked on only one participant at a time and began by reading through the participant’s transcripts while listening to the interview audiotape. I then reread the transcripts and color coded the text according to the topic of discussion. I used the interview questions as a guide to determine whether the teacher was talking about mathematics, teaching mathematics, learning mathematics, or homework. Throughout this process, I made notes of my thoughts on what the teacher said, connections to other pieces of the transcript data, and any recurring ideas or beliefs. For instance, if the teacher discussed practice as being important to learning in response to different questions and in different interviews, I made note of this as a recurring theme. After categorizing the topic of discussion, I focused on the topics of mathematics, teaching mathematics, and learning mathematics. I placed all of the transcript data for each of the categories into separate documents.

Through repeated readings of each of the categories of mathematics, teaching mathematics, and learning mathematics, I categorized the teacher’s beliefs according to Ernest (1988) to answer my first research question. I began with the category of beliefs about mathematics. I compiled all the teacher’s statements that included some aspect of their beliefs about mathematics. I then wrote initial codes for each statement. I reread through the data several times to ensure that each piece of data was coded. I then searched for themes within the data by grouping the initial codes into larger chunks of similar concepts. I reviewed the themes and compared the theme with the transcript data.
to ensure that the data fit under the theme. During this phase, if changes were needed, I adjusted the themes accordingly. I then defined and named each theme according to the data within the theme. This was repeated for all areas of beliefs. While the teachers often expressed beliefs that could belong to more than one of Ernest’s categories, I placed the teachers into categories based on the areas they stressed the most. If the teacher had a particular goal and emphasized this goal through his/her actions, I marked this as an important aspect of the teacher’s belief. For example, Claire referred to mathematics as a toolbox but she often spoke of the connections among mathematical ideas. She wanted students to connect mathematical concepts to each other and liked how her lessons helped students do that. Since she stressed making connections across different mathematical areas and expressed this as a goal of hers, I categorized her as having a Platonist view of mathematics rather than as an Instrumentalist.

Then, I focused on the homework category for the teacher. I read through the transcript data on homework and highlighted any pieces of data related to homework that would help me answer my research questions. Through repeated reading of the text, themes began to emerge that helped me answer the second and third research questions. More specifically, the teacher discussed issues and beliefs about homework that led him/her to decide to not assign it and specific concerns and challenges he/she had to overcome because of their decision. I separated the text according to two categories: rationales and challenges and concerns. After separating the data into the two categories, I placed text from the transcripts into separate documents for each of the categories. As I divided the text into the categories, I took additional notes about the sections of text if I had any ideas on possible themes within the category and connections among the
teacher’s beliefs and rationales. This analysis was used to answer the second research question.

I then worked within the challenges and concerns. I grouped the challenges and concerns that were similar. I also noted areas in the transcripts where the teacher talked about methods and practices that they employed to overcome specific challenges or concerns. This analysis was used to answer the third research question.

The description of each case is presented in the next chapter with the teacher’s beliefs about mathematics, learning and teaching mathematics, followed by the teacher’s rationales for not assigning homework and the challenges that arose from that decision. The beliefs that impacted the teacher’s decision to not assign homework are also discussed.
CHAPTER 4
THREE CASES

The chapter is divided into each teacher’s case. Within each case, I first discuss the teacher’s beliefs about mathematics, learning mathematics, and teaching mathematics. I then describe the teacher’s rationale for not assigning homework. Finally, I describe the challenges teachers faced from their no-homework policy and the methods they used to address these challenges, including how they organized their classes.

The Case of Thomas

Beliefs about Mathematics

Thomas’ beliefs about mathematics centered around his view that mathematics is a study of patterns. He believed that by investigating patterns, a person could discover relationships and consequently solve problems. When talking about patterns and doing mathematics, Thomas often used words such as “look for,” “notice,” “finding,” and “discovering,” all words that describe a view of mathematics that is discovered rather than created. For him, noticing and exploring patterns indicated an interest in mathematics. He believed that mathematics was creative because it was open to the exploration of patterns.

Whenever you are looking for patterns I feel like you are kind of having an interest in something. You are looking at your, you’re creating a problem essentially whenever you look for patterns and when you create a problem then you start exploring some things, I think you are being creative at it.
Thomas liked patterns and felt successful when he could investigate a pattern. He believed that finding patterns enabled a person to see relationships among mathematical concepts.

… looking for and finding patterns and noticing relationships would be a successful math activity … I feel successful whenever I am working through a problem or just working through some interesting patterns that I’ve noticed. So I’ll look for the pattern and I want to establish a relationship there and if I learn something about the relationship, I feel successful.

He extended his belief about success to his students as well, who “have been very good at noticing certain patterns.” He thought his successful students “are very interested in finding patterns and looking for patterns” and are “up and looking for relationships.” On the other hand, his less successful students could not solve problems because they did not engage in finding patterns and, therefore, could not see relationships: “They’re not really looking for anything and they’re not noticing relationships because of it.”

Thomas believed that patterns derived from the laws and axioms of a domain. In his words,

We are studying patterns, looking for patterns. Patterns already exist so we are kind of discovering patterns that exist, but we formulate a lot of how we approach it… With axioms, we decide what axioms we are able to use and then that creates patterns that we then discover.

He stated that properties, laws, and axioms did not necessarily have a conceptual basis and that there might be times in which a person could repeal some of them. He believed that once the properties, laws, and axioms of a mathematical domain are known and
understood, a person would be able to solve problems. They would be able to investigate resulting patterns, find relationships, and make connections. In his words,

knowing mathematics really is knowing what kind of assumptions you use and like whatever kinds of conditions you are working under, what kind of operations are allowed, know why. I mean, if you know those things, everything else kind of falls from there. Like, it’s just natural.

According to Ernest (1988), Thomas held a Platonist view of mathematics. The Platonist view of mathematics holds that mathematics is a static and connected body of knowledge. Teachers with this view believe that mathematics is discovered, not created. For Thomas, mathematics consisted of a set of axioms and properties that create patterns. Studying patterns allows a person to make connections and understand relationships, which can then be used to solve problems.

Beliefs about Learning Mathematics

Thomas believed that students needed to collaborate, try different ideas, evaluate whether those ideas helped solve the problem, and solve problems in mathematics. He believed that students learn mathematics when they work together. In his words, “they learn pretty well when they are given opportunities to kind of discuss with each other how things work.” He wanted his students to help each other and to ask each other questions rather than looking to him for answers. He explained,

I really like having students work in pairs, which I have liked the best. You know, I like to kind of match up kids with similar level where they can kind of work side-by-side thinking about things. One kid will figure out something and then the other one will be like “Hey, how’d you do that?” and they will all talk to each
other and explain. And I feel like that’s a good way to reason and to bounce ideas off with somebody with a similar skill when you are at a particular area.

In order to help students collaborate, Thomas arranged his rows of student desks in pairs or sets of three. He believed that, in many ways, students learned best from their peers. However, he also recognized that care had to be given when assigning peers to work together.

I know that sometimes it helps to have someone above you that you can kind of bounce ideas off of but I feel like that person is almost always more likely to tell you how to do it rather than to throw you back in. Because I’ll have some of my top students help out my weakest students and oftentimes, they’ll end up just telling them this is what you do, look at what you do here. And I’m like, “I can easily do that myself.”

For Thomas, it was important for students to explore with peers rather than with him because it was a more authentic situation.

They gotta think is this possible, is there anything that goes against my theory, how can we explain that it actually worked, and they usually have to discuss with their peers. If they are discussing it with me, I already know all the answers so it’s kind of hard for me to do a genuine discovery, as like what really happens when they actually encounter a problem on their own.

Thomas believed that creating an authentic situation where students had to rely on themselves and each other was a way of helping them become independent learners.

Thomas wanted his students to develop autonomy with mathematics. He wanted them to be able to reason about mathematics problems and determine whether their
answers were correct or not. He felt that “no matter what, people run into problems. They’ve got to look for patterns and they’ve got to optimize based off those patterns.” When students would ask him if their solution was correct, he would explain “you know, in real-life situations, like in real life when you are running into a problem you have to deal with, you’re not going to ask someone whether you are wrong. You’re going to have to figure this out yourself.” He believed it was important for students to learn to reason and think about mathematics because they will encounter problems outside of the mathematics classroom that they will have to solve.

Thomas felt that students needed to be actively engaged in exploring problems. He believed actively engaging with problems helped his students understand mathematical concepts and retain information.

I could tell them and they would be like “Oh that makes sense” but they are not going to remember it. But if they explore a situation and they come across the meaning of why certain things happen or don’t happen then I think they will remember longer.

He believed that when engaging with a problem, students needed to analyze patterns, discover relationships, and make connections. For example, he described a lesson on graph theory that illustrated how he wanted students to analyze patterns and relationships to understand paths and circuits.

…they had to determine “Can I find a path?” so I just kind of explained to them what we are looking for, and then I can have them just go with different situations to kind of look for patterns. And so there were a lot of them working on things,
discussing. “Can I do this? No you can’t because of that” and so on. Or “If you think you can’t do it… why do you think that might be impossible?”

Thomas stated that he believed learning mathematics was like “putting together a jigsaw puzzle” or “creating a clay sculpture” in the sense that you are trying different ideas and making connections to get to an end result.

[Y]ou have to reason out what you are looking for, because you also have a particular puzzle in mind, something that you want to complete… You have to kind of work through which [pieces] go with what and when you can use certain pieces.

His description indicates that learning mathematics means reasoning through which steps can be used and how the concepts fit together. It also indicates his belief that a person goes through a process to finish a problem. According to Thomas, with a clay sculpture, “you kind of have an idea of what you want in mind but there may be a lot of different ways you get there.” For example, if students are working on a finding a circuit in a graph, they know what the goal is and they have to figure out a method of achieving that goal. Or if they are working on a word problem, he wanted them to be aware of what they are looking for, the meaning of the answer they will find, and they can use different methods of finding the solution.

Struggle was an important part of learning, both for himself and for his students. Thomas believed that the experience of struggling through and working problems was instrumental to his knowledge of mathematics.

I would definitely say that I learn best by working through problems that are just out of my reach… I think the strong thing is to just work through problems, almost
like a hands-on type of thing. That’s how I’ve learned most of the things that I’ve learned.

He believed that struggle was part of being actively engaged with and experiencing problems, which was important for students’ understanding. In addition, he felt that engagement with a problem led to a sense of enjoyment in learning for his students.

[They learn pretty well] when I give them problems and allow them to kind of struggle with them…A lot of times, when I lecture and I work problems I find for them, sometimes I think they get it but they really don’t because they don’t really have the experience. And when I let them struggle with it they seem to actually enjoy it more.

Thomas’ beliefs about learning mathematics was one in which students had to be actively engaged in finding patterns, making connections, and reasoning about their solution strategies. He believed that if students were not engaging in, struggling with, and experiencing mathematics, they were less likely to understand and remember the concepts. It was important that his students learned to find ways of determining whether they were correct or not because they would need those skills in their personal lives.

**Beliefs about Teaching Mathematics**

Thomas believed that mathematics teachers needed to teach students how to solve problems by modeling mathematical thinking and encouraging student-to-student discussion in the mathematics classroom. He believed that students learned by solving problems and as a teacher, his job was to help them learn how to approach and think about mathematical situations: “I need to help them learn how to reason and how to test themselves and how to think about their problems.” He believed that by modeling his
thinking and the questions he asked himself as he solved a problem, he could teach students how to solve problems: “I try to show them different patterns that I notice… I try to ask them questions that they should start asking themselves.” He wanted students to continually ask themselves questions related to the operations they were doing and the connections they were finding.

I try to ask them questions like “What are we trying to solve for?” consistently and then, “What do we know about the problem? Why can we take this step?” Whenever we go through any step, I ask them “Why are we doing it? What’s the point?”

His emphasis is on students understanding the reasoning behind the operations and the steps for solving problems.

For Thomas, it was important for students to have conceptual understanding of mathematics in order for them to be able to solve problems. He believed that if teachers spend most of their time teaching concepts, then students would be able to solve problems. He felt an emphasis on teaching the skills and algorithms would not translate into an ability to solve problems. When asked, he stated that he believed teaching should emphasize concepts about three-fourths of the time. He explained his reasoning,

I feel like if you only have skills, obviously you really can’t do anything because you don’t know when to apply the skill without understanding, you just follow when you see a situation you do exactly what you are supposed to do. When you follow the rules, maybe very well, and then you see a certain situation like $x + 3 = 5$, I just subtract 3. But if you run into another situation where you have to step that up, if you don’t have a concept, you’re not gonna be able to do it.
Thomas believed that to learn how to solve problems, students needed to talk and discuss strategies, and his job as a teacher was to encourage student-to-student discussion. When asked, Thomas stated that he viewed his role as that of a coach. He believed that as a teacher, one of his roles was to support students’ thinking and discussion by pairing them up with a peer. He explained his view of a coach:

They let the kids do their own thing, their own play. And the kids have to play and the coach is just kind of guiding them when they get stuck. They kind of encourage them when things aren’t working out very well, pairs them up with different kids that can help them out…. [T]he coach kind of gives them some pointers along the way… They just kind of tell them “Hey, you should be doing these types of operations, give this a try, what if you run into this situation, what do you think you would do?”

Thomas also felt that his students could learn through the experience of sharing ideas with the class and discussing problems with peers as a large group. He believed that his role should be as a facilitator who encourages students to discuss with each other.

A lot of the times I try to get students to go up and explain what they have found and learn from each other to explain what they [think], and then a student will ask a question and another student will answer it. I’ll be like “Okay. Can you explain this further or whatever?” and I’ll try to have them dialog rather than it be between me and them.

Thomas felt that students were more likely to understand each other: “It’s a lot easier for me to say things but that doesn’t necessarily line up with what they understand.” Sharing ideas with the class offered opportunities for students to learn from their mistakes as well.
For instance, he gave an example of when a couple of students thought they had a counterexample to Euler’s formula.

I had them, you know, put their counterexample up because I know there’s not one but they said they had one and then several students kind of like commented on it and it helped them see why it wasn’t a counterexample.

In addition to helping students learn, Thomas believed that encouraging students’ discussion was a teaching practice that could help him assess how students were thinking about mathematics and what students understood. When asked how he knew his students were learning, he explained, “I try to listen to their conversations and think about what they notice. But sometimes I try to get them to expand upon an idea they’ve found and try to see what they really understand about it.” Thomas believed that asking questions and listening to students’ responses was a good way for teachers to formatively assess students’ understanding.

I oftentimes use a questioning-type thing. I try to question what they understand and I’ll give them some situations, like “What happens if I do this, how would that apply?” and see if they can adapt. If they are able to adapt their idea, then I feel like they have a really good grasp of it.

According to Ernest (1988), the explainer view of teaching held that students were expected to have conceptual understanding with connected knowledge, something that Thomas felt was important in order to be able to solve problems. Thomas emphasized students’ understanding of the operations, how those operations helped solve the problems, and the connections among the different strategies and problems.

Additionally, Thomas also held views of the teacher as a facilitator in the classroom. He
believed that he needed to facilitate student-to-student discussion and interaction when he gave students the opportunity to investigate mathematical situations and solve problems.

**Homework Rationale**

Thomas used to assign homework to his Math III students but decided against it because he did not trust his students to complete the work. He had difficulty motivating his students to do the homework and when the students turned in homework, he did not trust that they had personally completed it.

I used to assign tons of problems and then very, very, very few of my students would do them. And would have time to do them. And a lot of times they would just copy each other and not do it at all.

This belief that students could not be trusted to do the work was not uncommon in Thomas’ school. During the days of observation, he introduced me to his colleagues and explained my purpose for being there. It was then that I learned that many of the mathematics teachers did not assign homework because “students did not do it.”

Thomas’ belief that students could not be trusted to complete the work did not extend to all his students. He tied success in mathematics with an interest in “looking for patterns” and extended this to outside of the classroom as well. He believed that his better mathematics students were thinking about his class and mathematics on their own because they were interested. He trusted that these students were completing the homework because of their interest in mathematics.

A lot of my top students, I would have thought, if I had asked them to think about, just think about [mathematics] would have just thought about it. Like when I ask
them to do the problems, they do the problems. They just felt like they needed to
do them because they like to.

However, he did not extend his trust to those students he considered to be weaker in
mathematics. He continued,

I felt like that [assigning homework] wasn’t really helping my weaker students
and really a lot of times my best students, they would think about it anyway. Like,
a lot of times when I am teaching, for example, the additional principle to my
students in Discrete, a lot of them would come back and be like “Oh, I was
thinking about it.” I didn’t assign them to think about it. They thought about it
anyway. So my top students were thinking about it anyway and my weaker
students weren’t doing anything.

He believed that his weaker students were more likely to cheat when they had to do
homework. He felt that if students were not doing the work themselves, then they were
not likely to gain any mathematical understanding.

They obviously copy from each other. They also copy from the back of the book.
Like, if I assign any odd problems whatsoever, people will just do the odd
problems. And I’m like “Oh, hey. You just did the odd problems. That’s
interesting.” And they’re like, “Yeah. Those were the only ones I understood.”
And I’m like, right… It just doesn’t seem to be adding anything to their
understanding.

Thomas used the phrase “tons of problems” to describe what used to be his typical
homework assignments for his Math III classes. In his first year of teaching, he assigned
problems for homework using the model that his teachers used when he was in school,
such as assigning all of the even-numbered problems between 2 and 40. However, even in cases when he considered assigning some homework problems different than the type of assignment he experienced as a student, his trust issues with students limited him. He explained,

I think I would be more likely to give them some skills based practice with some conceptual exploration. But it’s hard to grade those things because it’s more like, did you do it or not? You know, if they are exploring and they didn’t find anything, how can I penalize them for that if they made an effort? And then how do I know if they made an effort?

He seemed to be under the impression that many of his students would not explore a mathematical situation when asked. He continued to ask students to think about mathematical situations outside of class, but he did not believe them when they said they did so. He shared his experiences with this type of exploratory homework assignment.

I still sometimes will try to get students to do things at home and to think further about what they learned. But a lot of times, they’ll be like “Oh, really. That’s all our assignment is, to just think about it?” Then they’ll come back and be like, “Well, I thought about it but nothing happened.” And I’m like, okay. You really thought about it. Sure you did. Or some of them will go home and they’ll be like “I’ll think about it on the computer while I look it up.” So that’s kind of annoying. His annoyance with students looking up solutions to problems suggests that he did not believe students could gain any understanding from investigating a problem on the internet. Instead, he wanted to be assured that they had personally investigated the situation and he did not trust that they would do so.
For Thomas, his rationale for why he chose to not assign homework centered on his trust issues with his students. He simply did not trust that his students would complete the homework for a variety of reasons. Some students would not do the homework and for those that did, he did not trust them to have done so themselves. Even in cases where he saw possibilities for homework that went beyond assigning a large amount of practice problems, he still had issues with trust.

**Challenges.** Thomas felt he had two challenges as a result of his no-homework policy. His first challenge was finding a way of helping students remember the concepts and skills between classes, especially because his classes were on a block schedule and he did not see them every day. He saw homework as a way of helping students remember concepts through practice but because he did not assign homework, he allowed them more time to explore during class time. He felt that his 90-minute class periods helped him in this regard.

I have a lot of time in class. We have block schedules so I try to spend a lot of time having them actually explore through things and discuss things, work on things… I try to get them to kind of explore things a lot on their own and come up with things.

In addition to having students explore ideas, he also made sure to include some time in class for them to practice. He described how he included practice problems into their work time.

I allow them to explore. Once they come up with an idea, I’ll stress that idea. Like, if a student comes up with it, I’ll have them explain it and students will decide if it’s true or not. And then we’ll go through some counterexamples if
possible or come up with some or not. But once we have established that it seems to be really true or is true depending if we have proved it or not or we just have a lot of really good evidence, then I will give them skill-based questions to kind of extend that knowledge or to practice.

For instance, when students had generated Euler’s formula, he asked students to apply that formula to different situations, “What do we do … if we know how many vertices and edges there are?” He also extended these types of questions to include cases that required further reasoning.

Sometimes I’ll try to extend it a little bit. They’ll end up with a situation where I give them the number of vertices and edges and it turns out that there are no faces. So, how’s it possible there is no faces? If they, if everything matches in the formula, does that mean that the graph is possible? … Or like, one is zero, how can you draw something like that? And they have to think about that too or if they get a negative number of edges. Well, that’s supposed to work if the formula were true but what does that mean? Can you draw a graph like that?

Thomas allowed a large portion of his day for students’ work and discussion. For instance, he typically began class with a 10 to 15 minute warm-up. During this time, students were expected to begin working on the warm-up problems as soon as they came into class and these problems typically were review problems that the day’s lesson built upon. Then, he had about an hour for the lesson and work period. During the observations, about 40 minutes of this hour was spent letting students work on problems. The first couple of problems were generally a review of previous material. Then he would give them a problem to introduce a new concept. He would introduce a new term
or let students discuss findings from their explorations, which generally took about 20 minutes of class time. Then, the following problems used and built upon the new concept. The 90-minute class periods allowed him to incorporate practice into lessons as well as include time for students to explore and discuss their methods for solving the problems.

The second challenge that Thomas had with his no-homework policy was encouraging students’ interest in mathematics. He believed that students needed to consider mathematical ideas and work on problems outside of class, and he tried to encourage them to do so through the problems he asked them to consider.

I feel like they should continue to engage at home, especially if it’s an every other day class that I normally teach. I feel like they should always have it in their minds, but I’m not really sure how to do that other than giving them challenging problems in class that we haven’t solved yet.

However, Thomas did not give his students additional problems or show them where they could find other problems unless they asked for more practice. Instead, he encouraged them to think about mathematics and work additional problems by increasing their interest in the subject. He believed that posing problems he found interesting and applicable would encourage students to think about mathematics outside of the classroom. He gave an example of a problem that he used to encourage students to work on mathematics on their own.

When I was doing graph theory problems, I gave them a situation. I was like, hey, is it possible to cross all the Konigsberg bridges? I didn’t assign it for homework. I was just like, “We are going to talk about the big theme.” And several of my students, well, all of them went home and started thinking “Is this possible?”
When they were bored, they were trying. [They would] come in, be like, “I should work on the bridge problem.” So trying to make my problems interesting enough. At least an overlying problem that kids could keep thinking about afterwards…

They just need to have a desire to be interested it in.

Thomas thought that students would work on mathematics on their own if they were interested and if they felt there was a connection between the mathematics and real life. He looked for problems where they could make connections between the mathematical topic and their life outside of the classroom to encourage and motivate students’ interest in mathematics. He explained how moving to a no-homework policy has influenced his teaching.

I have to find ways that will engage them on their own at home that they’ll actually be interested in doing… I want them to actually be interested in the problems and to see things where they are like, “Ooo, we read this with Mr. R.” So I actually try to come up with a lot of real life situations they can think about and recognize. Like when we were thinking about logarithms, I talked about earthquakes and different feelings of earthquakes and stuff like that and how they compare and how they’re related to exponential problems and stuff like that. And I ran into problems with money and things like that where they are thinking about investing, things they can actually apply. Also, interesting puzzles where they are like, “I wanna figure out how to solve that.” And they’ll actually want to go home and do it rather than me telling them they have to. I feel like they are more likely to do it if they are encouraged on their own.
While Thomas tried to encourage students to take an interest in mathematics and work on mathematics outside of the classroom, he still felt as though he did not have much success. Sometimes he felt there was some success, such as with the bridges problem in which he saw students engaging with the problem on their own, but he stated that this is something he continues to struggle with. In his words, “I want them to continue to think about the ideas, but I just don’t know how to do that successfully yet.” He wanted students to want to engage with mathematics, and for him, homework was not a good method to increase that interest: “I think they just need the desire. And I can’t really instill it by myself by just saying do these problems.”

Thomas chose to stop assigning homework because of his trust issues with his students. He did not trust most of his students to complete the assigned homework. He wanted students to take an interest in mathematics enough that they would choose to think about and work on mathematical problems outside of the classroom, and he tried to pose problems that would be interesting to the students to encourage that exploration. He also believed that he could help students remember the material longer if he allowed them to investigate and explore their ideas in class so he structured his lessons to include a lot of work time and practice. When asked what advice he would offer to teachers who wanted to try a no-homework policy, he stated,

I would say that they definitely need to take a lot of time allowing the students to work problems… They need time thinking, trying to balance in their minds “What is my goal state? And what are the different things I can try to do to get there? And how do I analyze that I’m not getting there and need to try something else?” So they need a lot of time to do that.
The Case of George

Beliefs about Mathematics

George believed that mathematics was a human creation rather than something that exists in the world waiting to be discovered. In his words, “Mathematics is constructed. It’s built.” To George, that construction was a personal one; each student constructed his/her mathematical understanding on a personal level as a result of his/her engagement with a problem. For him, mathematics “should be created by each individual student.” George’s views about mathematics have changed over the course of his career and his experiences in college. Where he used to feel that mathematics was a closed subject in which there was only one correct solution, he now believes that it is an expanding field in which problems are open for exploration and interpretation. George believed that mathematics is always expanding and changing as new mathematics is created so no amount of scholarship or experiences would allow a person to know mathematics fully.

For me, if I were to say I know mathematics, what it would mean was that I wasn’t being quite truthful… If anyone says that they know mathematics, they’re being disingenuous to a certain extent. They may know some mathematics that they’ve experienced or that they’ve been taught, but there so much more that they don’t know than what they do.

George believed that mathematics is a fun subject to engage in and he wanted his students to feel similarly. He believed that mathematics was something people should explore and study because it is enjoyable, not because they might need it in the future. In
the following excerpt, George explains his attitude toward mathematics when he was in school and how he hopes his students will have the same experience in his class.

I wasn’t searching for it [mathematics] to have some sort of higher purpose. And I still don’t search for that and I don’t search for that with my kids that I’m teaching now. I try to have a classroom where I feel like they can enjoy what they’re doing strictly for the sake of the mathematics. Not because it has some sort of meaning or something.

He believed that higher mathematics should be studied simply because it is pleasurable, not because of any extrinsic motivation for the subject. He did not want students to worry about when they would need a certain concept, and he did not want to have to try to convince them that it was something they would need. He wanted them to engage in mathematics simply because they found it fun and interesting. In his words, “Don’t worry about whether you are going to be doing this or not when you are 28 years old. Chances are 99.8% that you’re not. That’s not the question. That’s not what we’re trying to do here.”

George’s beliefs aligned with Ernest’s (1988) category of a problem solving view of mathematics. He felt that mathematics was something humans have created and continue to create, including his own students. Mathematics to him was ever expanding and evolving and open to exploration in different ways on different problems and by different people. He thought that mathematics was fun and should be done simply because it was enjoyable.
Beliefs about Learning Mathematics

George believed that learning mathematics required students to actively engage in exploring and solving problems. Problem solving required students to explore problems, try different ideas, connect mathematics and collaborate and talk with other students. George believed that for students to learn, they needed to be engaged with a problem, which included some level of struggle and discomfort. In his words, “We’ve got to have a problem. I mean, in the definition of problem is, there’s some discomfort. If there were no discomfort, it wouldn’t be a problem.” In his mind, students experienced discomfort when they were asked to think for themselves rather than following the teacher’s directions. He continued the above statement, “If they just marched in and did whatever I told them to do like automatons or something like that then geez, what is that? Yeah, I want them to be uncomfortable.” He wanted students to explore problems that required them to create a mathematical idea that they could then prove was true. He gave an example of a problem that he asked students to think about.

I just sort of gave them a problem and said now I want you to think about this. I want you to do this so now draw a triangle. Construct the midpoints of two sides of the triangle and draw the segment connecting them and tell me what you think. I mean, that was the direction. And they did it and I said, now if you were going to write a theorem about this, what would you write? “Parallel.” Yeah. Looks like it, doesn’t it? So, you think that is something that should be able to be proven. That’s what theorem means.

George believed learning mathematics meant that students needed to generate their own understanding and ideas as they explored and solved problems. He believed
that exploration and experimentation are essential processes to learning mathematics.

Parroting statements and mimicking procedures was not learning in his mind. He explained, “You best learn by doing it…Even if they can repeat what I did, that’s not learning. They can only learn by being generative and by doing and by having lots of opportunities to do.” George believed that, if given opportunities to explore and experiment, students could generate almost all mathematical ideas.

If they’re taught mathematics from the point of view of like a scientific experiment or an exploration, then they can tell you what the theorems are. They don’t have to write them out of the book. They study the picture and they study what’s happening in the picture and they’ll write out the theorem on their own… Ninety percent of what we tell them, they would tell us if we gave them the chance.

The use of the computer was an important tool for learning to George. He believed that all students benefitted from using the computer and other tools, such as calculators and books, in their exploration and problem solving. In George’s classes, students used laptop computers on a regular basis. During the observations, students generally went into the closet to get laptops at the beginning of the class period on their own. Most of them made the assumption that they would be using some form of technology during class. He felt that these tools helped students conceptually understand mathematics and make connections across the different subjects. For example, in the following excerpt, George describes a recent event in class in which he was teaching a lesson on the equations of conic sections. In this lesson, he encouraged the students to use dynamic geometry software called Geometer’s Sketchpad (GSP) to explore the
relationship between the equations they were studying and the associated geometric constructions of the conic sections.

In my pre-calculus class, I’ve had kids studying conic sections and they’re learning about the forms of conic sections that the equations take and everything. So this is a hyperbola because the square terms are subtracted or something like that. So I was like let’s think about the geometry. Let’s construct a hyperbola. Let’s build one geometrically. And they were like, “We don’t know what you’re talking about.” But we got on GSP [Geometer’s Sketchpad] and we did it and they were just beside themselves. I mean they were captivated….They were tying algebraic thinking into geometric thinking and seeing some sort of relationship.

He believed that using the computers and technology made mathematics interesting and fun for students because they could explore their ideas more easily. In the above example of how the students were using GSP to investigate the relationship between the equation of a hyperbola and its graph, he went on to describe how the students were so interested in the investigation that they did not want to leave.

It was a great day. The bell rang and I literally couldn’t get them to leave. They were still exploring what happens when I move these points further apart, what does that do to the hyperbola. I didn’t give them that direction to do that. They just decided to investigate it and the bell rang. I said, you all have to go to your next class. “No, we want to figure this out.” It was ten minutes before I could get them out of there…this was a great day.

George also believed that students learn mathematics by working together and talking about their mathematical ideas. He explained, “I think when kids are able to
converse and collaborate and sort of score on a type of problem, I think learning has
taken place.” He thought students shared a common language that could help them learn
from each other. He stated,

My kids work in pairs every day and then they work in groups as least once every
other week, groups of four or five or half the class or whatever. And the reason
for that is because I think that they can help each other. See, they can express
themselves in ways that their peers understand sometimes better than I can.

He believed that part of talking mathematically included debating ideas, which was
important for students’ understanding of mathematics. He gave an example of the type of
discussion he saw as important to learning.

They got in a fight today over something. What was it? Oh, they had drawn a
figure and some of them were claiming it was a rhombus and some of them were
claiming it was just a parallelogram. Just a parallelogram. Do you hear that
inference? “No it’s not a rhombus, it’s just a parallelogram.” “Well, a rhombus is
a parallelogram, okay, but that’s not what I’m saying. Just because it’s a
parallelogram doesn’t…” okay so they got in a conversation with each other. And
other kids were listening.

This debate about whether the shape was a rhombus or a parallelogram was one that took
place between the students and was allowed to progress to a conclusion with very little
interference from George. He felt that he needed to stay out of these discussions as much
as possible to help students become more autonomous in their mathematical thinking.

George wanted his students to become autonomous in mathematics. He believed
that when students are autonomous and can create and discuss mathematical ideas on
their own, they create and demonstrate their understanding. For instance, George shared an example in which he expected students to feel uncomfortable in his class, and he talked about how he wanted the students to solve the problem and create their understanding without him.

I said, draw a trapezoid, take the midpoints of the legs. Okay, connect those. What’s the relationship?... In about four or five minutes, about half of them had their hand raised, said the length of the median is always the average of the two bases. Why would I tell them that when they can tell me?...I mean, is it mathematical understanding to be able to look at you and say the median of a trapezoid is the average of the lengths of the bases. Is that understanding? Or is it understanding to be able to take the problem and work it out and come up with that statement? Which of those is understanding? That may be what we’re talking about here. And for me, it’s the last thing. I want to throw something at kids and have them be able to operate on it and argue about it and miss it and stuff like that and talk about it and make a conclusion without me saying anything at all.

He stressed that students needed to be the ones doing as much of the work in class as possible. He wanted them to discuss their ideas and try to convince their peers of the appropriateness of their theories with very little input from him. In his words, “What I want them to do is, I want them to play the music… I just kind of want to wave my arms and I want them to play.”

George believed that students needed to be autonomous, not only with respect to solving problems, but in other areas of life in general. While George wanted students to learn to think critically and problem solve with respect to mathematics, he also wanted
them to be responsible, independent thinkers. He believed that students learn responsibility when they are given choices.

I’ve got three kids that are failing. And I’ve tried various things with them. Come in, get extra help. “Well, my other teacher assigns me a time and I have to be there.” No, I’m not going to do that. Uh uh. I’m going to leave it up to you to come see me. It’s that same notion, that thread is weaving its way all through this.

What I’m trying to do is get them to be accountable for themselves.

He thought that when students are given choices, they will learn how to become independent and responsible and will then make better choices. He shared a case in which he overheard a student talking during lunch about how she was doing more at home to increase her grade in his class.

I had a little girl that’s failing Calculus. She made a 92 on the test the other day. I spent five minutes talking about her. It’s just fabulous. She got her a tutor. She went to work. She started working on problems at night… Did I assign her more problems? No. Did she begin to work some problems on her own? Yes. Same theme. Personal accountability. She decided of her own volition, I need to work some more problems. I’m going to work some more problems because that’s what I have to do.

Overhearing this conversation led George to believe that he was correct in his decision to push students to be more responsible. He felt that this student and others in his class were more autonomous as a result.

According to Ernest (1988), teachers who believe that students need to be active in the mathematics classroom try to build students’ interest in mathematics. Building
students’ interest in mathematics was important to George, and he believed that learning mathematics was an active endeavor. He stressed that students needed to be engaged in problem solving and exploration together, and his goal was to increase student interest in mathematics and to help them become autonomous with respect to their learning.

Beliefs about Teaching

George believed that the teacher needed to provide opportunities for students to engage in problem solving and discussion to increase students’ confidence and critical thinking skills. He believed his role was to push students in their mathematical exploration during class discussions and help students by asking questions rather than giving them answers to their problems. This can be seen in his description of a case in which students were discussing their ideas about whether a shape created by connecting the midpoints of the sides of a triangle was a parallelogram or a rhombus. See Figure 1 for a diagram of the drawing.

![Figure 1](image)

*Figure 1. Diagram of connected midpoints of triangle and resulting parallelogram.*
They’re talking to each other and I’m sort of over there, sort of like, and then they look at me, see, because I’m supposed to know. That’s the typical role. You’re the arbiter of all knowledge. If we get into a fight, you’ll settle it. They did finally conclude that it was not a rhombus even though it looked like one. I said, and you know sometimes I shoot them a line like “How can you check?” Well, it looks like a rhombus. “Okay, what’s the next thing to do?” Measure, see.

In this example, George’s role was to remind students of how they can go about investigating the situation to come to a conclusion. George believed the teacher should be there to bring everyone together and to push the conversation along rather than leading the discussion. He wanted students to discuss their ideas with him saying very little.

During our discussion of what the best learning environment is like, he explained his belief about the role a teacher as a conductor.

Waving their arms and talking loud and sort of trying to maintain contact with the kids, very much like the white-haired gentleman that used to conduct the New York Symphony. Just sort of, the music was beautiful and everything but if you looked at him, you thought well this guy is sort of deranged, you know. He’s sort of, but the music was beautiful. And he knew when to bring in an instrument and he knew at what tone or pitch he wanted that instrument and he knew when to quiet that section off and bring another section in and that kind of stuff… To me, a mathematics teacher is like an orchestra conductor.

George believed that teachers needed to have high expectations of students by asking questions that go beyond fill-in-the-blank answers. George believed that having high expectations of students increased their confidence in their problem-solving
abilities. He believed that when students are required to think critically in the classroom, they become better problem-solvers. Asking them questions was a way of relaying to students that they can do mathematics and they have quality ideas to contribute in the classroom.

I think one of the things that defines how successful we can be is our conceptions of our students’ abilities. So if I think that they’re smart and I treat them as if they’re smart and I ask them questions that require them to be smart, not just fill in the blank type stuff, I think they see that. I think they understand that. ..

George believed that teachers needed to listen to and respond to students’ ideas. He believed that when a teacher valued students’ ideas, those students became more confident in their abilities. In his words,

I think it’s important that kids develop confidence but I think that in some ways, it’s more a function of what’s happening in [the classroom]. How do I value what you’re saying to me? Do I show that I’m listening to you and I’m responding on the same level that you’re talking to me? See, I develop confidence by responding to them in the terminology that they’re using to me so that they’re not scared.

Responding to students meant that George had to be flexible with his planning. He needed to be able to take up students’ ideas without worrying about staying on a strict timeline. He explained his ideas about planning when he described what was involved in doing the best job he could:

Being ready, being prepared, knowing what your goal is for the day or the hour or the minute. Preparation. Always preparation. Now, by that I don’t mean writing out a four-page lesson plan. That’s the most detrimental thing to mathematical
learning that I can think of because, you see, if I have that thing, I have a tendency to want to abide by it and I don’t hear my kids. All I hear is, what does the next sentence say on the lesson plan?

Because George wanted to plan around his students’ ideas and conceptions, he spent time thinking about the types of problems he could pose students for their consideration and the adjustments he would make according to how they engaged with the problem. He believed that each student had different needs and ways of thinking, so he needed to be able to respond accordingly. He felt that being flexible with his plans allowed him to differentiate his teaching and responses according to the students’ needs.

Even in the same day with two classes of Geometry, how could I possibly teach them exactly the same way? It’s different kids. How could I do that? How could I make one lesson plan for both classes?

George believed teachers need to understand how their students think. He believed that when teachers have an accurate assessment of students, they can pose problems that are engaging and increase students’ confidence in their problem solving skills.

We have to formulate a conception of our students that allows us to determine something that while not too easy is not too hard too. Something that they can attach themselves to and feel successful in.

His statement, “something that they can attach themselves to,” suggests that he saw student interest as important in students’ learning. He also wanted to increase students’ confidence in their problem-solving abilities by making sure that he posed problems that they could engage with. To George, formative assessment of students’ thinking was one
of the most important activities a teacher could do because it allowed teachers to interact with students and pose problems based on students’ actions. He mentioned this when asked how students best learn mathematics.

By doing. And by having someone that cares enough about them to watch them do. And someone that can assess where the point of difficulty lays. And that’s very individual with kids… You need to give them the opportunity to do, observe them, and see what you can determine about them. And they best learn when they have a teacher that is able to make those assessments.

He later elaborated on the importance of assessing students’ thinking.

The best math learning occurs when you have a gifted professional in the classroom assessing what they see the child doing. We talked about that today so that’s when learning takes place it seems to me. Let that kid do something and observe and watch and see what they’re doing and react against that.

George fell into the facilitator view of the mathematics teacher, which views the role of the teacher as helping facilitate student discussion with the purpose of creating confident problem posers and solvers (Ernest, 1988). To George, teachers should help the students in their mathematical discussions, assess students’ thinking, and pose problems that build students’ confidence and problem-solving skills. He believed that teachers needed to help students become confident problem-solvers and wanted his students to pose questions and follow their interests.

**Rationale for Homework Policy**

When George first taught, he assigned some homework for his students to do. However, after a few years, he decided against it for two reasons. First, George felt that
homework was a poor assessment tool. For George, it was important that he gain a good understanding of his students’ abilities. He felt that homework was a poor assessment tool because he could not assess how his students were thinking and engaging with the problems.

The whole game is my drawing a notion of my students’ abilities. I mean, that is everything, is my ability to wisely assess the abilities of my students. I can’t do that unless they are working in my presence so I can see what they’re doing. See what they ask me, see what they ask each other, listen, hear what they’re saying. I can’t do that if they’re at home. I’m not going to Skype with them while they do their homework.

Homework is often seen as an opportunity for students to practice the material they learn in class. George felt practice was necessary for students’ learning, but he wanted them to practice in class. He believed that when they worked in class, he could use that time to assess how each individual student was thinking about the concepts.

I certainly want [them] to practice too, but I always want them to practice where I can see…I don’t refute the idea that practice is important but I refute the idea that I can gain everything from it that I need to gain if it’s being done outside my presence.

George relied heavily on his informal assessments to understand his students’ thinking. His class time was instrumental in his ability to assess his students’ reasoning, and most of his time was spent listening to students and watching students work. He began lessons with an 8 to 10 minute introduction. This could include a review of the previous day’s lesson in which he asked students to share what they remembered, a short discussion of
the mathematical ideas, or a review of the previous day’s practice problems in which students shared their solution strategies and discussed difficulties. This was followed by a lesson period where students worked and discussed problems, either in groups or as a whole class. Finally, the last 10 to 15 minutes were spent having students practice a few problems, generally only two or three. During the observations, a large majority of class time was spent with students either working or talking with George listening and watching students’ interactions.

I’ve got about 40 in three classes total. I like to feel like, though, that if you called out a kid’s name, I could tell you what they did today. From memory. Informal, continuous informal assessment. Tell me what you’re understanding of this thing that we’re talking about is? What do you hear?... That’s precisely what I do with them, what I just did with you. Tell me how you’re thinking about this and I’ll listen.

The second reason why George decided to move to a no-homework policy was because he wanted to encourage students to take responsibility for their learning. George believed in self-directed homework, rather than assigning homework. While he encouraged them to be responsible and personally accountable in the classroom, he felt that a no-homework policy was an extension of that philosophy. He believed it was better for students to personally decide to do more practice than for him to tell them what to do. In his words, “It’s not so much that I’m against home work as it is that I am against the assignment of it… If I can get kids to do it outside of my having assigned it, then I win.” George made a distinction between homework that is teacher assigned and work students decide they need to do at home. When students chose to work more problems at home,
they were showing an interest and engagement with mathematics, something he wanted students to do in the classroom. He believed that when students took responsibility for their learning, they would begin to see the value of working at home and would choose to work hard to reach their learning goals. The example earlier of when he had a Calculus student decide to work on problems on her own is continued,

Did I assign her more problems? No. Did she begin to work some problems on her own? Yes. Same theme. Personal accountability. She decided of her own volition, I need to work some more problems. I’m going to work some more problems because that’s what I have to do. That’s really where I’m headed. That’s where I’m trying to get to. I’m not trying to make a stand against homework. What I’m trying to make a stand against is the assignment of it. Kids don’t value it because they don’t see the use in it but they can. They can see the use in it. They really can.

George wanted to make clear that he was not against students working on mathematics problems at home, but the students had to make that decision. To George, when students saw the need to work problems and practice on their own, they were able to differentiate their practice according to what they felt they needed.

It’s the student’s compulsion to do it on their own that’s the most important thing…And how much of it to do. So I went home and I worked these four problems and I got them all right so I feel okay. Fine. Why would I give a kid 20 problems that doesn’t need but 4? Why would I give a kid 2 problems that’s going to go home and work on math all night so they can make an A on the test? How can I be the judge of that? I absolutely can’t. And across 20 kids, why would I
give everyone the same assignment when they have such varying levels of

necessity?

George believed that each student had different needs for learning, which is why it was so important for him to learn about his students and plan around their ideas. His last sentence in this quote suggests that his belief on the various needs of students influenced his desire to have students self-direct their homework practices.

When students worked at home, George would look over their practice if they wanted him to and he encouraged them to bring in their work so he could.

When they go home and do work on their own, I’ll go over it carefully and respond to them, so they know to hand it to me. “Would you look at these? I worked these last night.” Yeah, I will. So, it’s not like, “No, I don’t give homework. I’m not going to be bothered with that.” If they’re working problems, then you know they did it at home. I mean, shouldn’t I be willing to take a look at it? I reckon, yeah.

George wanted to watch his students practice mathematics in class and encouraged them to keep working at home if they felt they needed more practice. His decision not to assign homework was not because of a desire to have less work for himself. Instead, he felt that this policy was best for his students and himself. He felt that his teaching was better because he was better able to assess his students’ thinking.

I’m the doctor in my classroom and what I’m trying to do is assess. And I’m looking for weaknesses and I’m looking for strengths and everything. It all ties in together. What’s best for the child is actually what’s best for me, too. So I’m not seeking to put something off for my own convenience. I’m not assigning 25
homework problems so that tomorrow I really don’t have to think for the first 20 minutes of class, we can just go over the homework. It’s really what’s best for me. It allows me to be a professional person. It allows me to feel like a professional person.

**Challenges.** George mentioned a couple challenges that arose because of his no-homework policy. First, he felt that he had to help parents, administrators, and students understand his no-homework policy. He knew that most teachers in the U.S. assign homework and, in his experiences, homework is expected by parents, administrators, and students. Therefore, there was an expectation that he would assign homework also. He explained,

I would define homework as being something that parents expect. I would define it as sort of a traditional norm. Kids have always done homework. My kids ought to be doing homework because that is what kids do, is homework.

George mentioned that parents ask him why their child is not doing any homework for his class. He understands how parents feel with respect to homework and their desire for their child to learn mathematics well, so he finds ways to share his ideas and discuss his philosophy with them.

They think that if the children are doing work at home that that means that they are really thinking about their school and stuff like that. And they see it as an all day long thing and such. So I have parents that I have conversations about that with, but I don’t make any apologies or any accommodations for the fact that I don’t give homework.
Another challenge for George’s decision to not assign homework was the support of his principals. While he felt that he was now supported by his principal and had been supported by several principals in the past, this was not always the case. George mentioned how a former principal met with him to discuss his no-homework policy and pressured him to assign homework. George believed parents were pressuring the principal.

“You know, Mr. W., we really value you here. You’ve done a great job teaching at this school, but you’re going to have to give these kids homework.” Well, why is that exactly? “Well, that’s what we do. That’s our philosophy of education, you know. These parents expect that their kids will have homework.” …

“George, why are you doing this to yourself?” I said, “I’m not sure what you mean.” He said, “Well, you got parents complaining.” I said, “I don’t care. I don’t care that parents are complaining. I care about what my kids think.” I said, “Let’s bring 10 of my kids in here. You ask them whether they’re learning math or not and whether or not they enjoy math class.” I said, “I don’t give a crap what their parents think.”

George felt that his discussions with parents and his principal decreased the amount of pressure that he received to assign homework. He was, however, unsure whether or not they were actually convinced that what he was doing was okay or whether they just left him alone because they saw he was unwilling to budge from his position. In his words,

I’m not sure I’ve ever convinced anyone. I’ve talked to people about it. I’m talking to you about it and as I talk about it, you’re drawing your own
conclusions. I don’t know if I’m convincing you or not. I don’t know if I’ve convinced them. They let me alone.

George learned to reduce some of the pressure he feels about his no-homework policy by discussing his philosophy with his principal beforehand. He does not want to put himself and the principal in a position where they are stressed about his policy. He shared how he felt supported by his principals when they understood how he taught and his philosophy on homework.

I’ve been blessed to have principals for the most part that saw the way that I was doing things and allowed me to do that. And I’ve worked in 5 or 6 different schools and I always ask [if it’s okay not to assign homework]. Because I could never work for anybody that would require me to do it [assign homework]. I just wouldn’t put myself in that situation… I just wouldn’t work somewhere that would get me in some sort of stressful situation with my boss. I mean, why do that? They have their reasons. I have mine. Both of our reasons work for us.

George believed that students also have an expectation with respect to homework. He felt that they are used to being instructed on what they needed to do to learn mathematics and succeed in school, and he had to overcome those expectations. When he mentioned that older students will take on more responsibility for self-directed work than younger students, I asked why he thought that was. He explained, “I think to a certain extent that’s a maturity thing. That’s sort of, but it’s also a culture. There’s sort of the culture of expectation that permeates without regard to grade.”

George’s second challenge was related to his belief that students expect teachers to assign homework. His second challenge was teaching students responsibility so they
would practice on their own. He wanted to teach them the value of doing work outside of school, and he felt he could do this during class. He wanted to help students understand his position, and when asked if he told them about his reasons for not assigning homework and the goal of getting them to self-direct their work, he stated, “I do tell them that. Yeah. That’s fair. I shouldn’t have an objective in mind that I don’t share. Why would I hide it from them?” He then shared how he hinted to them that they needed to practice at home.

I’ll talk with them about this…Sometimes we begin class just by talking and I’ll talk to them about that and I’ll say “Now, you didn’t do too well yesterday on this. How many of you worked an extra problem last night or an extra two problems?” Two or three people will raise their hand. “That’s not enough.” So I’ll try to encourage them. He believed that small hints were enough for most students to begin to see what they needed to do to succeed. However, he understood that some students needed a stronger push to work on their own.

As kids struggle more and more and more, I’ll get more and more and more suggestive to them. Even up to handing them a sheet. Say, here, work these five. “When?” Whenever. “Do I have to take them home?” No, I didn’t say that. Work these five and bring them back to me. I want to see them. I’ll get more and more suggestive when I see that kids need it. I stop short of making an assignment. I’m not going to do that.

While some students found problems on their own or asked him where they could find some additional problems, if he felt some students needed to do more, he pressured them
by giving them problems to do. However, he left the decision to do them up to the student.

George’s challenges resulting from his no-homework policy centered on the fact that very few teachers did not assign homework so he had to help others understand his position. Parents and principals questioned his homework decision so he had to explain his thinking. When asked what advice he would offer for other teachers who might want to move to a no-homework policy, he stated,

Have a very clear-cut defense of what you are doing and believe it because you are going to be challenged on it. And if you don’t believe it, you don’t really believe it, then you are going to give up. You are going to say, “Nope. If this is going to get me in trouble, I’m going to go to a different way of operating because I don’t want trouble.” So, what you’ve got to do is, you’ve got to read what some of the research says about mathematical ability given levels of homework, you’ve got to think about the reasons why you are saying “I don’t want to do it” and you’ve got to be willing to state those to people who are in opposition to you.

He felt that the decision to not assign homework had to be one that the teacher strongly believed in order to be able to explain the position and stand against criticism.

The Case of Claire

Beliefs about Mathematics

Claire described mathematics as a bunch of tools, and she believed that having an understanding of mathematical concepts allowed people to create a “toolbox” of different methods and strategies they could use to solve problems. She referenced her “toolbox of
math” several times during the interviews to indicate her view of mathematics as a
collection of facts and skills.

Claire believed that mathematics was a connected field of ideas. The fact that
mathematics is a connected field allowed people to be creative and solve problems in
many different ways. In her words, “I think it [creativity] just means kind of having a big
toolbox to pull from and being able to get an answer from a variety of viewpoints.” She
wanted students to be creative when solving problems and judged success based upon
whether a student had conceptual understanding and unified knowledge of mathematics.

A great math student to me is a student who’s always trying to make connections
between something else they learned in math and to kind of see what a web it is.
Some student who’s really open minded. They don’t look at a problem and go
“Well this is the one way I know to solve it and this way isn’t working here, what
do I do?”

She explained further,

I think [success] means that you have kind of a toolbox of things that you can turn
to to solve everyday problems or math problems. That you’ve got a lot of skills
and ways to approach a problem that you can look at a problem in different ways.

Claire recognized that knowing mathematics was more than just being able to
work mathematics problems or having a collection of tools to use. She believed that a
person needed to have the conceptual understanding behind the mathematical tools to be
able to apply mathematical methods and facts to new situations. In the following excerpt,
Claire describes a student who could complete a problem but did not understand the
underlying concept of her actions. She felt that this student would not be able to transfer
this idea to a new situation because the student did not conceptually understand the mathematics.

We were solving systems of inequalities and she could do that. She did her shading and if we had stopped there, we would have been good to go… I asked her what does the shading mean? She had no clue. She knew that you shaded the direction of a certain part and that was it. She had no idea that the shaded area was all of the possible answers to that problem and no way to check her work and all that… It didn’t have meaning for her. It wasn’t something she could use later because she knew what it meant to use that.

Applying mathematics to real-life situations was important to Claire. She believed that mathematics was an instrumental part of people’s lives and felt that students needed to be able to apply facts and skills to their problems, something that required an understanding of mathematics beyond knowing algorithms and having skills. In her words, a person knows “mathematics if you can successfully get through your everyday life and solve any kind of problem that you want to, pulling from your toolbox of math.”

To Claire, if a person understood the mathematical concepts and knew the connections among the different strategies and facts, then s/he would be able to solve everyday problems. This “toolbox” of knowledge allowed people to try different strategies when faced with a mathematical problem or situation. Claire held a Platonist view of mathematics, which, according to Ernest (1988), is a view of mathematics as a connected collection of facts and skills. While she saw mathematics as a collection of facts and skills, she stressed that these facts and skills were part of a connected field and
that the ability to use the tools in mathematics came from understanding the conceptual ideas and connections among the different concepts.

**Beliefs about Mathematics Learning**

Claire believed that in order for students to learn mathematics, they needed to have a relaxed learning environment where they had the freedom to make choices and to follow their own interests. She believed that humor kept students interested in mathematics. She explained,

> I think there has to be humor involved. I think there’s kind of this misconception that it [mathematics] has to be, that it has to be serious. And too, we’ll even try to be goofy with the problems just to sustain their attention on them. Word problems can be funny.

While she believed learning needed to be a relaxing endeavor, she still felt that she had to overcome her own personal educational experiences. She described her experiences in mathematics classes as more traditional in nature, which she felt was not necessarily the best for learning. She explained some of the struggles she encountered in her classroom.

Sometimes I feel uncomfortable when they’re working together, even though I can tell that they’re talking about math and working on math. The noise level and things like that, I always like – Because I come from a traditional background where the students sit in desks and all that. So I get this feeling like, are they really learning it? Are they being serious about it? Are they being goofy about it? And all that. And then I remember how important laughter and all of that is to learning and humor and how it’s them being relaxed while they do math, which is a good thing…The alternative structure is a little uncomfortable for me.
Her classroom environment was designed to be a very relaxing place, with a living room style set up in the middle of the room (i.e., a couch, some cushioned chairs, and some tables), a kitchen on one end, a small area with an interactive whiteboard where the lessons were conducted, and an area where classroom pets were placed. Bookshelves and work stations were also placed throughout the classroom and the students had personal desks along the walls. In addition, students were allowed to use their time however they saw fit, so long as they did not keep others from working. When students were not in a lesson, I observed them hanging out in the living room area, chatting and working.

Claire felt that she had a strong influence on how students perceived mathematics and their interest to keep learning mathematics. In her words, “My tone and the mood I create in a math situation is going to affect what they decide.” The mathematics classroom was a space that she felt should be a positive and fun environment because some mathematical problems can be difficult to solve and some concepts can be difficult to understand. In her mind, if students have difficulty with mathematics and are in an environment that does not offer positive affect, they lose interest.

[Mathematics] should be something that they kind of look forward to, the challenge. It’s something they can tackle. It should, there should only be positive things associated with it because there will be some difficult things that come up naturally. They’ll have trouble with a concept and that’ll bring its own little bit of negativity… you don’t see it right away but later on it’s like, “Augh, math,” and the eye roll.

Claire believed that students needed to have choice in their learning. In her words, “The power of choice is a really, really big thing to me.” She believed the learning
environment needed to be open so that students could pursue their interests and felt that when students were given choice in their learning, they were more likely to enjoy school and want to work.

I think any time you give someone control and choice over their learning and their time and their setting, you get huge benefits. I don’t want every minute of my day dictated to me, including my time when I leave my job. I don’t want that dictated to me and if it was, I think it would affect my attitude about my job. Whereas when I am given the choice and freedom, I’m like “Oh I really like that place.”

This type of environment is typically part of the Montessori philosophy and was something she felt strongly about. She expected that all students would engage in at least one of the courses she offered, but she wanted students to feel free to choose to study additional mathematics if they so desired.

Any student is allowed to observe any other lesson. That’s a Montessori element that we bring in and they’re welcome to participate in the assessment. And I do have some students who are working on both Algebra and Geometry credit this year because they did a lot of Algebra work last year based on being able to come into the groups and they’re doing well… We have an open door policy on any lesson.

The freedom of choice also helped students cater to their learning needs. She believed that each student had different needs and learned best in different ways. She felt that since the environment was open and students could work however they wanted, each individual could cater to his/her learning style. In the following excerpt, she explained how her students learned best and how they chose to engage in mathematics learning.
It seems to be different for different ones of them. I have a few this year who really like to talk about it … They’re kind of almost debating it but that seems to be their strength or their style with anything … I’ve got a student who is a drawer … They all have their different ways. Some of them like to take the dry erase boards and solve some problems on them and then wipe it clean… It’s kind of different for all of them.

During the work periods, Claire let students decide how they wanted to work. They could use any available materials, work alone, or work with others. The students decided what worked best for their learning.

Claire believed that students needed to be active in the classroom in order to remember and understand mathematical concepts, learn how to apply the concepts to problems, and make connections among the different ideas. She shared some of her favorite activities in class and how she felt they improved students’ memory of facts.

I love, love, love when we’re teaching geometry to take the patty paper and see how when you slide angles together how they overlap. Or when you’re learning how a triangle has 180 degrees when you add its interior angles to actually take a triangle, sloppily cut it apart and flip them so that you make a straight angle out of it. We did that last year and they almost never forget that a triangle when you add the interior angles equals 180 degrees.

Another activity had students measure the circumference and diameter of several different circular objects to understand the relationship between the two measurements and to discover pi in the relationship. These activities were a way to show students where
the irrational number comes from. Claire explained her view of learning as students being
given the facts and vocabulary then figuring out how to solve problems with those ideas.

Claire gave students the background information she felt they needed to solve
problems. Her lesson plans and the observations suggested that the background
information she gave students typically consisted of definitions, facts (such as the sum of
the angle measures in a triangle), theorems that will be useful (such as the Side-Side-Side
Theorem), and figures that might come in handy (such as a stair model to remember
different measurement relationships). In her lessons she generally covered several topics
or sections of the mathematics textbook, although the topics were not necessarily directly
related. For example, during my observation of the algebra lesson, she covered solving
equations and the metric system. She explained how she determined what to teach and
how she adjusted her plans.

I go through the book but I try to, instead of having a math lesson each day, it’s
kind of like, I guess in another school setting it might be Monday’s lesson was
one of those [topics] and Tuesday’s lesson was one of those [topics]. But we just
kind of put them together, give them a lot of that background information and
then they have the Tuesday to do follow up work and ask questions … Usually I
just kind of go in order of our textbook… Sometimes I’ll switch them around if I
feel like two concepts are just too, two new concepts are just too much for them to
do in one lesson. I felt like the metric system would come to them pretty easily so
I felt like I could kind of combine that with something that might have been a
little more difficult like solving equations.
Claire believed that the students needed to actively engage in solving problems. Once students were given the “background information,” she believed they needed to try to find different ways of using those pieces of information and to make connections among them. She used the follow-up assignment for students to take the information given, try to apply it to problems and make connections among the different facts.

I think of the students I’ve had in the past who were poor math students who were like “You didn’t give us a problem like this.” And I’m like, “But I gave you every tool you need to figure out a problem like that. We did all these other things, now assimilate them.”

She said that learning mathematics was like working a jigsaw puzzle; people learn mathematics from trying to piece together given information.

[Learning is] like working a jigsaw puzzle because you’re looking for clues and pieces. You’re looking for this color that matches this color and then you try them and sometimes they fit and sometimes they don’t. You have to try something else.

The process of trying different ideas using the facts given was what Claire considered problem solving. She believed that when students make connections among the different pieces of information, they could solve problems because they have multiple ways of approaching a situation.

[A] great math student to me is a student who’s always trying to make connections between something else they learned in math and to kind of see what a web it is. Some student who’s really open minded. They don’t look at a problem and go “Well, this is the one way I know to solve it and this way isn’t working
here, what do I do?” … Someone who’s a risk taker and who’s willing to be open minded and problem solve with it.

One of the philosophies of Montessori schools is to educate the whole child. For example, in the elementary grades, students are often expected to clean up their messes and work outside in the garden to help build motor skills. As part of teaching students life skills, the curriculum tries to teach students how to be accountable and independent in all aspects of their lives. Students have classroom chores that they are expected to complete each day, such as feeding the pets, cleaning the kitchen area, or taking out trash. Claire believed that students needed to learn how to take initiative and be autonomous because they will need those skills in the work force. As part of their education, the students engage in work internships each week. For half a day on Friday, each student goes to a local business to work and learn the skills associated with having a job. She believed that these work internships were instrumental in teaching students how to be responsible and described how she wanted students to learn to take initiative and become independent.

Our students go on internships every Friday and the feedback we get from that, the biggest thing that the internship coordinators say is that the student was great, did everything asked for them to do, [but] didn’t think of things they needed to do themselves. So if you ask them to sweep, they’ll sweep but they don’t look around and go “Oh I could sweep for you. Do you have a broom? I’ll take care of this.” And so that’s kind of what we’re going for here, is not just can you do what I tell you to do but can you assess where you stand with what needs to be done and do it?
She believed that by learning how to take initiative in the workplace, the students would become responsible and autonomous. Additionally, her atmosphere of choice is designed to encourage students to learn how to make appropriate decisions with respect to their needs by allowing them flexibility in the classroom. Claire extended this belief about students’ need of autonomy and independence into her mathematics classroom as well.

Claire wanted her students to be autonomous in their mathematics learning. She believed that students needed to know how to find and use resources other than the teacher because they would need to in their future classes. In her words, “In high school, they’re only going to have that teacher for 50 minutes. I think they can get used to having me all day every day and I want them to have other resources they turn to.” The students had books and computers with internet access they could use to research their questions or find additional problems to work, if needed. Claire also wanted students to ask each other for help and view their peers as a resource. For her, learning where to find other resources besides the teacher was part of being autonomous. During the interviews and observations, she suggested that students with questions ask peers for help and explained, “I kind of want them to start do more of their relying on each other too. They all have different strengths of it and they can learn a lot from each other.” She believed that having students help each other increased both students’ learning. When students share their ideas, they remember more and can incorporate different strategies into their “toolbox.”

Sometimes a different person will have a better way of explaining something they’re really good at. I think it boosts their confidence when they can help and there’s always opportunities where one of them knows something and then the
other one needs helps with it and they can swap off… I think the act of talking things out and working it out helps them to remember it better and helps them … be more creative in their approach to things.

It is important to note that her description of students getting help from each other is not the same as cooperative learning, in which students solve problems together. Students can choose to work together if they want to, but she does not dictate that they do so. She allowed them to decide whether or not to work together. However, if they had questions, she encouraged them to ask their peers who have already completed those problems.

According to Ernest (1988), teachers with the active construction of knowledge view about learning believe that learning is an active construction in which the teacher’s role is to develop autonomy and student interests. Claire believed that students learned by constructing their understanding of mathematical connections and exploring their interests. Her beliefs about mathematics learning focused on students piecing information together within an environment that she felt was conducive for learning. She wanted students to be autonomous with respect to all areas of their lives and extended this into the mathematics classroom as well, where she expected students to find resources other than her when they had questions.

**Beliefs about Teaching**

Claire believed that teachers needed to limit the amount of guidance given to students when teaching. She felt that teachers should not tell students how to solve problems but should instead give and clarify information and encourage their exploration. During mathematics lessons, Claire saw herself as a resource. She believed that she needed to provide the pieces of information, or the “tools,” students would need to
complete the follow-up assignment. Like a textbook, she gave the students definitions, facts, and theorems that could be used in the follow-up assignment.

My lessons tend to be a little more like giving out some background information and like a few example problems but then the questions tend to come up more when we’re doing individual practice.

The example problems mentioned here were not samples that she completed and showed to the students but were problems that students would try to solve during the lesson to see if they had any immediate questions. Students’ solution strategies for these problems were shared and discussed before the lesson period ended. Once the lesson was finished, Claire assigned follow-up problems that she felt were an opportunity for students to make connections among the pieces of information and to solve problems. She felt that this follow-up assignment and the corresponding work days were the reason that students were so successful in their learning. The value of the work days was evident when she offered some advice for teachers who wanted to teach without assigning homework. “I would say that the work days are essential… If you’re not going to have them [students] take the work home, you’ve got to have the work days built in.” Claire mentioned that, if she were to ever decide to work in another school, she would continue her no-homework policy and structure her lessons the same way to keep from having to assign homework. During this free work time, Claire believed the teacher needed to be a resource to clarify assignments and answer questions.

I’ll assign some problems that aren’t exactly like the ones I gave. They’ve got all the information to solve them but the challenge comes with the follow-up assignment and so the questions come up usually then. And they usually come up
from the students. They’ll say “I don’t know how to approach a problem like this.” And I’ll say okay well, start stating what you know about it. And so it’s more of, there’s less of me asking them specific questions.

During the work time, Claire wanted students to rely on themselves and others as much as possible to help them become more independent. She often had to fight her desire to do more because helping students too much would interfere with their learning.

The hardest part of my job is being as hands-off as I can possibly be. And there are times when I really want to jump in and just bleh [spit] out the answer or just say it for them or something. And so I feel some discomfort then… Because otherwise, I’d just be taking the easy route and doing everything for them.

Claire typically asked students to be more specific with their questions during this period. For example, when a student came for help and said “I don’t know how to do this problem,” Claire mentioned that was not a question and to be more specific about where she was stuck. When a student did ask a specific question, Claire asked questions to help him/her figure out a method that would work. Every once in a while, she would collaborate with them to figure out a way of solving the problem, but she tried not to tell them what to do. She wanted to help students learn how to ask questions that got to the heart of their difficulties and to help them reason through the information and possible ideas that could work to solve the problem.

Claire believed there were times when teachers needed to show and explain to students how and why certain actions needed to be taken. By sharing how and why she does certain actions, she believes that students will increase their learning and become
independent. For example, she wanted students to learn skills such as how to study or take notes. She described how she mentored students so they would learn how to study.

I show them how I would study. I show them where they can pull problems from that they can access the answers to so that they could see if they are getting it correct as they practice. I show them how you can pull practice problems from online.

Learning to be independent was important for Claire, but she realized that students sometimes needed to have someone to show them how. She believed it was her responsibility to share her thoughts and actions to teach students how to be responsible and more independent. She wanted to try to keep from telling students what to do and when, and instead, wanted them to understand that they are responsible for themselves.

For instance, during the work days, the students are given freedom to choose how they want to spend their day. The expectation is that students use this time wisely, and mistakes are seen as teaching moments. Claire believed that she needed to help students reflect on the reasons why they might be struggling with a particular issue, such as time management.

We have students who it [time management] just naturally comes to them. They’re great at managing their time and getting their stuff done and we have some that’s absolutely not the case. And in the extreme cases, we’ll sit down with them at first and make like a daily schedule. Like if it was me, I would do these two things on Monday because I’ve got this coming up on Wednesday and I’ll need to make sure I know that information. And we’ll kind of go through their week and they post it in their cubicle that they sit in or at their desk. A lot of times
kind of check in with them during the week, how are you on track? Asking them to reflect on how their weeks are going at the beginning of the year. And a lot of times they’re like “I freak out on Thursdays.” I’m like, why are you freaking out on Thursdays? “Well I have all this stuff due.” What did you do on Monday and Tuesday? “Well I didn’t do so much then. I was kind of visiting.” Just kind of talking about it a lot of times will help them clear up a lot of that.

Claire believed that a large part of a teacher’s job was making sure the students knew the mathematics so they would succeed in their future courses.

I guess I’m kind of the air traffic controller, trying to kind of keep things, keep them on schedule but also not just run through and my responsibility is to make sure that I give them everything they’ll need to successfully succeed in the next math.

She worried about students’ future success as they moved into high school because she expected the high school environment to be very different from the environment at her Montessori school. In order to make sure that all of the topics were covered that the students needed for their future classes, she combined several sections or topics into each lesson. To Claire, when a teacher combined several sections into one lesson, the students were able to make connections across the different topics more easily. In her words, “I’ll teach three or four sections at once… We’ll kind of see how things connect to each other more than if we’re just learning these isolated skills. You’ll learn three or four concepts and see patterns at once.” She felt that a teacher needed to make sure students mastered the concepts and understood the material and did this in her classroom with an assessment each Friday, which consisted of around twenty problems similar to the
problems they did on the follow-up assignments. To Claire, the assessment was a way of
determining if students were autonomous with the mathematics or whether they needed
more individual tutoring.

If a student takes an assessment and we realize that they were able to do it with a
peer but not perform on their own, we have time where we can work with them
one-on-one. We have time during Friday internship time where we can work with
them and just do some kind of one-on-one after-school lessons.

Claire’s weekly assessment was designed to make sure each student had made
connections among the information given and had created some strategies to solve
problems.

Ernest classified teachers’ beliefs about teaching according to the outcomes they
expected students to have. For Claire, her emphasis was on students making connections
among the different pieces of mathematics and information as well as having an
understanding of how mathematical facts were derived. These beliefs would place Claire
in the explainer category of beliefs about mathematics teaching, which according to
Ernest, has an emphasis on students’ “conceptual understanding with unified knowledge”
(p. 150). Claire saw herself as a resource in the classroom to give the students
information and model how to manage their time and work. She believed teachers needed
to make sure students knew the mathematical concepts needed for future courses and her
role was to encourage student learning by giving them information and problems that
would help that development.
Homework Rationale

Claire discussed two reasons for why she chose not to assign homework to her students. First, she wanted students to be well-rounded individuals. She felt that students needed to have time to follow their own personal interests, whether that was spending quality time with family or engaging in hobbies that were exciting to them.

I made the decision about trying not to assign homework the summer before the middle school even opened. It wasn’t based on the needs of the particular students but it was based on what I felt like this age group needed across the board. They need their time at home to be time at home. They need to be connected with their families and not talking about school work. They need to be talking about what interests them and they need to be pursuing their outside interests.

Taking a break from school work and allowing students to decide when they wanted to complete assignments allowed students the chance to decompress, which Claire believed would increase their attitudes about mathematics, in particular, and school, in general. All of her students were involved in outside activities that they really enjoyed, such as competitive ice skating, helping parents run a business, and working with technology.

She believed that when students are allowed to choose what interests they want to follow, their learning is increased in the classroom as well.

There are days that I want to go home and have a life outside of my job and I suspect the same for them, that they want to do something aside from school and that sometimes it makes you more ready to come back to it when you’ve allowed yourself a break from it.
For Claire, part of being well rounded meant that the students were responsible for themselves and their learning. She wanted students to be autonomous, not only with mathematics but with their other decisions as well. She believed that homework involved telling students what and when to study, and therefore, did not help students learn responsibility and independence.

A second reason I made that decision was I want them to learn to effectively manage their time. When you’re in college, your professors don’t say to you, sometimes they do but oftentimes it’s not, this is your specific assignment and it’s due then. It’s like there will be a test on such and such and you decide at what pace you’re going to do things. You decide what problems you’re going to do. You decide whether you fully understood it or not. Your professor doesn’t check your homework and give it back to you. They might go over it in class but then it’s your responsibility to know whether you had really understood it or not. And so I wanted them to learn those kinds of skills in middle school. I wanted them to know when they’ve got something on their own and they could do it at home if they chose to or when to, when they needed help and they needed to ask for it. So to manage their time and to manage their comprehension.

Claire emphasized that allowing students to make choices could help them become more responsible. Her statement “you decide whether you fully understood it or not” also suggests that she believed letting students choose when to do their work and make decisions about whether or not they need additional practice could help them learn when they needed to ask for help. She emphasized in her class that students needed to decide when they needed more practice and they should find additional problems. She helped
them learn those skills in her class by explaining to students how she studied and found additional exercises to work.

**Challenges.** Claire had two challenges with her no-homework policy: (1) responding to parents’ concerns about her no-homework policy and (2) making sure students had the resources they needed to succeed. Parents’ concerns and questions were especially a challenge at the beginning of the year. Claire thought that parents believed homework was essential to learning everything in school but were open to changing those ideas.

Questions from families… I think there’s this idea that if they don’t have this intense course load, they’re not learning a lot. It doesn’t take too long for [the parents] to figure out just from hearing their children talk about what they’re learning during the day that it [clears up].

Claire understood that parents worried about how much their child learned in school without being assigned homework. To address their concerns, she encouraged parents to talk and ask their children questions about school. She also showed parents their child’s Measures of Academic Progress (MAP) scores at the beginning and end of the school year. The MAP test is a standardized assessment designed by the Northwest Evaluation Association to give detailed information about what a student knows about the different subject areas. It adjusts to each individual student based upon how the child answers the questions to give a more accurate measure of where the child is academically. She found that over the school year, parents became less worried about their child’s learning.

[I tell them] that we still get everything in that they get in other schools. Our MAP scores show significant improvement between fall and spring so they’re obviously
learning. I say give [the no-homework policy] some time and see what your child’s coming home and talking about and you can even ask them some questions yourself and see how their math behaviors are growing and changing. That usually pretty much solves it.

In addition, Claire’s students kept portfolios of their work to show parents during parent-teacher conferences. These measures helped parents understand what their children were learning without assigned homework. It should be noted, however, that parents who send their children to Montessori schools are more likely to be open to the alternative policies and beliefs about learning than most parents.

While parents were concerned about the no-homework policy at the beginning of the year, Claire was more concerned with making sure her students had the resources they needed to succeed with mathematics. In her words, “My biggest concern is, as my class gets bigger, making sure I have time to clarify details if they’re not asking someone else outside of school and making sure that they learn to find those other resources, other than me.” Claire believed that the teacher’s role was to be a resource and to teach students how to find other resources. She worried that she would not have enough time to answer all students’ questions and to help all students individually once her class got larger. This was one of the reasons she encouraged students to ask each other for help. She wanted them to learn that they could help each other so if she did not have time to get to them right away, they could still get their questions answered. Claire also felt it was essential for students to have plenty of class time to work on mathematics tasks, practice and ask questions because they were not assigned homework. In her words, “If you’re not going to have them take the work home, you’ve got to have the work days...
built in and time to help them.” To make sure students had enough time to work, Claire organized her class time so that they would have plenty of time to work. On Mondays and Wednesdays, she had a short lesson, about 30 to 40 minutes, in which she gave students information over 2-3 textbook sections. On these days, students had several hours to work on their assignments. She also scheduled Tuesdays and Thursdays as work days so students would have plenty of opportunities to ask questions and work problems.

Claire’s belief that students need to become well-rounded, independent individuals is seen in her rationale for not assigning homework. She believed that students needed to pursue their interests outside of school and develop personal responsibility, and she believed her no-homework policy allowed students to do both. However, she also believed that students needed time for practice and time to ask others for help. Her lesson structure emphasized long periods of time where students worked problems and got help, either from her or from peers. While she mentioned parents’ questions and concerns as a challenge, this was typically only encountered at the beginning of the year and dissipated once parents could see their children learning without homework. Her other concern, making sure that students’ needs and questions were answered, was increasing each year due to higher classroom enrollment. To help meet this demand, she helped students learn how to find additional resources and to ask each other for help.

Summary of Findings

Much like Nisbet and Warren (2000) and Wilson, Cooney, and Stinson (2005), this study found that Claire and Thomas held views that would be classified by Ernest as more Platonist than problem solving. Claire viewed mathematics as a connected
collection of tools that people used to solve problems. For her, mathematics held conceptual meaning and was a field that people needed to solve their everyday problems. Thomas’ beliefs about mathematics centered more around mathematics as patterns. In his mind, these patterns were something that people discovered and that people used to make predictions and solve problems. In contrast, George, held a problem solving view of mathematics. He felt strongly that mathematics was something that people created through exploration and experimentation.

While all three teachers believed that mathematics learning was an active process, they conceptualized the process differently. Claire felt that students needed to work problems and apply mathematical facts in order to understand how the concepts were connected and worked. She felt that students needed to be given mathematical facts that they then used in problem solving to develop methods that would work for many different mathematical problems. George believed that students needed to explore, experiment, debate and discuss their ideas with peers in order to create mathematical concepts and understanding. He felt that for students to understand mathematical concepts, they needed to generate their own ideas and theories. Finally, Thomas believed that students needed to work together to try different ideas or understand concepts and exploring mathematical concepts helped students remember material.

The teachers’ beliefs about the roles of the teacher in the classroom also varied. Claire believed that she was largely a resource and mentor in the mathematics classroom. She spoke often of giving students the information they needed, such as definitions and theorems. She was also a resource for students to come to when they were working problems. She wanted to keep students on track with their mathematical learning and
wanted to help them learn how to find ways of managing outside of her classroom, such as teaching students how to study and find additional resources. George believed his role was that of facilitator. He wanted students to create mathematics and discuss their ideas with each other, and saw his role as keeping the group together and facilitating the discussion and exploration. He believed teachers needed to ask questions that required students to think about how to solve problems and discuss theories. Thomas believed that teachers should often play the role of facilitator and explainer. He thought he needed to teach students how to solve problems and emphasized that students needed to consistently ask themselves about the steps they were using in their exercises. He also believed that students needed to learn from and talk with each other and teachers needed to facilitate this discussion.

These three teachers had different reasons for why they chose not to assign homework. Unlike Norton, McRobbie, and Cooper (2000) and Quinn and Wilson (1997), the teachers’ beliefs about mathematics and its teaching and learning did not appear to influence the teachers’ decisions to teach without assigning homework. Similar to some teachers in Atkin (2001), Claire’s rationale for a no-homework policy related to her beliefs about what her students needed, namely time to pursue personal interests outside of school and opportunities to learn responsibility. Perhaps her rationale is not surprising considering the fact that she chose to work at a Montessori school and these schools are very progressive with respect to developing the whole child. George and Thomas shared reasons for not giving homework that were not discovered in Atkin (2001). George believed that homework hindered his ability to assess his students’ thinking. He believed that in order to teach in the most effective manner, he had to have a strong understanding
of his students’ thinking and capabilities, and he felt that homework was not a good assessment tool. He felt that his class time was better spent letting the students work problems and practice for a bit in class where he could listen and observe them. Thomas’ rationale for not assigning homework took students into consideration in a different manner than Claire. Thomas felt that homework could be beneficial for students, but much like the teachers in Quinn and Wilson (1997), he perceived outside factors kept him from implementing this teaching practice. For Thomas, he believed that he could not trust his students to complete the homework, something that others in his school also expressed. This belief is very different than Claire’s because he views students in a negative manner rather than as individuals with needs that must be met outside of the classroom.

While many teachers assign homework for the purpose of practice (Epstein and Van Voorhis, 2001; Murphy and Decker, 1989), this study found that teachers who choose not to assign homework felt practice was important for students to learn mathematics. However, they used different ways to engage students in that practice. Claire let students work and practice during two of her class periods and encouraged students to find additional problems if they needed more practice. Thomas felt that his long class periods allowed plenty of time for students to work and incorporated practice into his class period. George also had students practice for a few minutes in class where he could observe their work and encouraged them to practice on their own as a way of increasing their responsibility. Both Claire and George acknowledged that every student had different needs when it came to practice and that the student was best equipped to decide what they needed. This belief was part of the reason why they decided to help
students learn responsibility and served as a way of helping students differentiate their practice according to their needs. One important note is that the concept of practice did not come up in the interviews until we discussed the definition of homework, uses for homework, and methods of teaching without it.

Claire and George expressed a belief that students need to learn responsibility and they viewed their no-homework policy as a way of helping students achieve this. This is an interesting concept considering that Xu and Yuan (2003) found that teachers often believe homework builds responsibility. Teachers who want to build this responsibility in students often assign homework for that purpose. While Claire and George held a belief that learning responsibility is important, they chose to implement this belief in the opposite way, by not assigning homework, than those teachers who assign homework for that purpose. This study suggests that teachers who assign homework and those that do not might have several beliefs in common, such as believing that students need to learn responsibility or need to practice.
CHAPTER 5

DISCUSSION

My interest in homework issues began several years ago as a result of reading Chazan’s (2000) book, Beyond Formulas in Mathematics and Teaching: Dynamics of the High School Algebra Classroom. In his study of a high school Algebra class, the topic of homework came up in one of the interviews with his students. They considered homework as unpaid work time, a concept they were unfamiliar with in their own job situations. This short excerpt began my reflection on how I viewed homework compared to how these students perceived homework. During my schooling years, I completed homework because it was expected of me. I felt pressure to do the work so I did not disappoint my teachers and parents. It generally did not take me very long, and although I would not say I enjoyed homework, it did not take away the enjoyment I had of learning and of school in general. However, this was not the case for my brother, who struggled to complete his homework each night. He would often work on homework long into the night, and when our parents would try to help, a fight would often ensue. This reflection began a long journey of reading literature and research about homework, which only increased my desire to learn more. Even now, I often wonder about the role that homework played in my brother’s decisions with respect to education. For as long as I can remember, he disliked school and did everything he could to limit his exposure. In high school, he chose to take courses in welding so that he could get out of the classroom and not have homework. Once he graduated, he went directly into the work force rather
than pursuing a college or technical degree. Thus, I embarked on a study of three teachers who chose not to assign homework to understand their decisions. To this end, I investigated their beliefs about mathematics as a discipline and the teaching and learning of mathematics as well as their philosophies about homework. Three descriptive case studies were conducted to help me explore the beliefs and rationales underlying the teachers’ decision to teach without the instructional practice of assigning homework.

This study found that the teachers held varying beliefs about mathematics and its teaching and learning. They emphasized different aspects of mathematics, such as the discovery of patterns, the connections among mathematics, and the creation of mathematics. Two of the teachers held Platonist views of mathematics and one believed in the problem solving view of mathematics. While they all believed that students needed to be active in the learning process, there were varying roles for the students. Students could create mathematical theorems and prove their ideas or could solve problems by trying to apply different mathematical facts and theorems. The teachers also viewed their roles in the classroom differently by seeing their role as a facilitator, a resource and explainer, and as a facilitator and explainer. The teachers chose not to assign homework for many reasons. One teacher did not believe that his students were doing the homework and did not trust them to complete the work assigned. Another teacher believed that students needed to have time to pursue their interests and wanted to help students learn how to manage themselves and their time and learning. Finally, the last teacher felt that homework was not an accurate assessment tool. He wanted students to work in his presence and then take on responsibility for their learning by working outside of class if they felt they needed more practice. The challenges they faced from their decision to not
assign homework varied from helping parents, students, and administrators understand their rationale to making sure students had the resources they needed to succeed to creating enough interest in students so they would want to continue learning and problem solving on their own.

There was no apparent link between the teachers’ beliefs about mathematics and teaching and learning mathematics, and their homework policy. The teachers’ beliefs varied within Ernest’s (1988) categories, and each teacher stressed different aspects of what they felt was important to learning mathematics. These teachers’ homework practices stemmed from their beliefs about adolescents’ needs and/or learning in general. Because of these beliefs, the teachers likely would not assign homework in other courses either, as was the case with one of the teachers who taught multiple subjects. However, the teachers’ beliefs about mathematics and its teaching and learning did seem to influence how they perceived the challenges that arose from their no-homework policy as well as the practices they used to overcome them. Teachers have complex interacting beliefs which make it difficult to define which beliefs are stronger and which impact certain decisions. This study reaffirms the existing literature on beliefs, which has found that it is difficult to see teachers’ beliefs in practice.

The teachers in this study adjusted their class time because of their no-homework policy. All of the teachers used class time to allow students to practice concepts, although the time allotted differed for each teacher. While one teacher allowed students whole class periods for work, another incorporated practice into the lesson so students were applying concepts after their exploration, and the third used a few minutes at the end of each class for student practice. Two of the teachers felt that their freedom to adjust their
class schedule and lesson time was instrumental to students’ learning. They felt that
students’ learning would have been severely limited if they were not given this discretion.

The results of this study showed that the teachers made an important distinction
between not assigning homework and expecting students to do work at home if the
students felt it was necessary. Two of the teachers expected students to take initiative and
work on mathematics outside of the classroom when they needed it. These teachers
stressed that students had to make the decision to do more practice. They believed
students were best equipped to know whether they understood the concepts and to decide
what type of and how much additional practice they would need to remember the
mathematical ideas. The other teacher’s focus was on intriguing students and building
students’ interest so they would want to engage in mathematical thinking outside of class.
He placed less emphasis on helping students learn how to find additional practice and
rarely discussed with students how they might need to work extra problems on their own
to learn the material.

**Implications**

This study found that Ernest’s categories of beliefs are too broad to clearly define
teachers’ beliefs. This finding is important because it suggests that Ernest’s categories of
beliefs would benefit from subcategories that better explain teachers’ philosophies about
mathematics and its teaching and learning. For instance, teachers who view the student’s
role in learning as that of piecing a puzzle together once he/she has been given definitions
and theorems sees active learning very differently than another teacher who expects
students to create and prove mathematical theorems and statements. Teachers’ beliefs
about the role of the teacher can also vary within the same category of beliefs about
teaching. The types of conversations students have when the teacher facilitates a discussion around students’ ideas and the generation of those ideas is different from discussions that occur when students discuss how they used rules to solve a problem. While the teacher facilitates the discussion in both cases, the emphasis is different: in one, the teacher is trying to get students to create and prove their theories while the other is trying to get students to explain why they do and can use certain operations. I would argue that the second role places the student into the role of an explainer in the classroom. Finally, even within Ernest’s categories of mathematics, teachers can fall into the same category and hold vastly different views. For example, within the problem solving view of mathematics, teachers could emphasize the cultural aspect of the creation of mathematics or they could believe that each individual student creates mathematics from their personal experiences. Both of these views see mathematics as a human creation, but in different ways since they consider the collective group differently. Thus, each of Ernest’s (1988) categories of beliefs has several different aspects about mathematics and mathematics teaching and learning.

Mathematics teachers’ classroom practices are often influenced by their beliefs about mathematics and teaching and learning mathematics. While the teachers in this study felt they met students’ mathematical learning needs, they also felt that they were able to meet other learning and teaching needs through their no-homework policies. These teachers provide evidence that there are alternative methods for helping students learn mathematics that do not rely on assigned homework and that teachers use their class time differently when they do not give homework. A better understanding of these teachers’ goals can help others value different ways of teaching and helping students
learn. These cases can help teachers, administrators, parents, and students understand how learning can occur without the teacher assigning homework and can offer the foundation for a dialogue about the role of homework, the type of homework that could be or is assigned, and the desired results from homework. This requires everyone to reflect on how homework is or is not meeting the needs of students and whether there are alternative methods to achieve the same ends.

Future Research

Research that examines student achievement by comparing teachers who assign homework versus those who do not assign homework has flaws because it assumes that teachers are constant in the classroom. These studies measure whether or not additional work outside of the classroom improves student achievement, but they fail to consider whether there are other practices that teachers use to ensure student learning. To have a discussion about the role of homework in student learning, it is imperative to understand how the classroom and teaching practices change when no homework is assigned. This study found that the teachers changed the way they managed their classroom time due to their no-homework policy and that they believed this time management had an impact on student learning. One limitation of this study was that I did not investigate student learning within these classrooms. Teachers’ management of time, coupled with their teaching and classroom practices, has an influence on student learning. Future research needs to investigate the student learning that occurs within these classrooms as well as how the teachers adjust their teaching and classroom practices to influence students’ mathematical learning.
REFERENCES


APPENDIX A

POST-OBSERVATION INTERVIEW PROTOCOL

1. How long have you been teaching? And what have you taught?

2. What is your mathematical background?

3. Have you attended any professional development? If so, which ones?

4. Recap of today’s observation. Does this represent a typical day for your classes?
   What might be different between the classes?

5. If I had visited another day, how might the lesson differ (in structure)?

6. How would the lesson look before a test? How do you prepare for a test?

7. How does the lesson proceed after a test?

8. Do you think your students are successful in mathematics? What does that mean to you? How do you know?

9. How do you ensure they are successful? What accommodations do you make for not giving homework?

10. Tell me about how the math topic might influence your classroom practices? Do you find some topics easier to teach without assigning homework? Which ones?

11. If another teacher wanted to try to teach mathematics without assigning homework, what advice would you give them?

12. Tell me about your students.

13. How do your students influence your classroom practices?

14. How do your students influence your decisions on homework?
APPENDIX B

INTERVIEW A PROTOCOL

Views about mathematics

1. What do you like most about mathematics? Least?

2. Would you say mathematics was discovered or invented?

3. What does it mean to know mathematics? When someone says “I know mathematics,” what does that mean to you?

Views about learning mathematics

4. Describe a good math student? A poor math student?

5. Consider the following similes. Learning mathematics is like:

   Working on an assembly line. Watching a movie.
   Cooking with a recipe. Picking fruit from a tree.
   Working a jigsaw puzzle. Conducting an experiment.
   Building a house. Creating a clay sculpture.
   Working as an apprentice. Working on a corporate team project.

   Choose the simile that you believe best describes learning mathematics and explain your choice.

6. When it comes to learning mathematics, would you argue more for nature or nurture?

7. How do you best learn mathematics?

8. How do you think your students best learn mathematics?
9. Describe the best environment for mathematical learning. Why? (What would students be doing? What would the teacher be doing? What would the room look like? What materials would be present in the room?)

Views about teaching mathematics

10. Consider the following similes. A mathematics teacher is like:

   News broadcaster   Entertainer
   Doctor             Orchestra conductor
   Gardener           Coach
   Missionary         Social worker

   Choose the simile that you believe best describes a mathematics teacher and explain your choice.

11. What is your ultimate responsibility as a mathematics teacher?

12. What is the most important thing you could tell me about your belief about mathematics teaching?

13. Is there a right way to teach mathematics? If so, describe it.

Views about homework and its role in learning mathematics

14. How do you define homework?

15. Have you ever assigned homework or have you always taught mathematics without it?

16. Tell me about your decision to teach mathematics without homework. (Why did you choose to not assign homework? How do you feel the students benefited from that decision? Do you think the students miss out on anything? Why or why not?)

17. What are the educational benefits of not assigning homework? Please explain.
18. What other benefits are there to not assigning homework?

19. What do you think are the educational benefits of assigning homework? Please explain.

20. What other benefits are there to assigning homework?


22. How has your decision to not assign homework influenced the way you teach mathematics? Please explain.

23. What activities would you like for your students to do outside of school? What activities do you think they are engaged in outside of school?
APPENDIX C

INTERVIEW B PROTOCOL

Views about mathematics

1. Is mathematics a creative subject? If so, what does it mean to be creative in mathematics?

Views about learning

2. How do you feel about cooperative learning in mathematics? Why?

3. How do you know when learning has occurred?

Views about teaching

4. Consider the following continuum. As far as mathematical importance, put an X on the continuum where you believe the importance or emphasis should be in mathematics teaching.

| __________________________________________________________________________|
| skills                                                                 | concepts |

5. Whose responsibility is it to decide what is taught in your mathematics classroom?

6. Is it okay for students to feel uncomfortable during your mathematics class?


7. Is it okay for you to feel uncomfortable during your mathematics class?

   When/under what circumstances? If so, can you think of an example? Do you avoid feeling uncomfortable? Elaborate.
Aspects of homework

8. What challenges do you face because of your homework policy?

9. What concerns do you have about teaching mathematics without homework?

10. How do you overcome these challenges and concerns?

11. Many teachers assign homework to give students additional practice with mathematical ideas outside of class. How do you address practice in your class?

12. How do you make sure that students have mastered prior concepts needed for future lessons?

13. Some teachers assign homework to increase student participation for those students who might not fully participate in class. How do you make sure that all students get a chance to participate?

14. Some teachers assign homework to help students develop personal responsibility. How do you address this? Perseverence? Self-confidence?

15. Some teachers use homework as a form of punishment. How do you address behavior problems in the classroom?

16. Some homework is used to introduce new material. How do you do this?

17. How do you help students prepare for exams? Do you worry about students having difficulty knowing how to study for exams in the future?

18. How do you monitor your students’ progress?

19. Many parents feel that students need to do homework in order to master mathematics. How do you address those parents’ concerns? (How would you address those concerns?)
20. How do you promote communication between school and home? Between students and parents?

21. How do you see your teaching as different from others’ who do assign homework?