STUDENT PERCEPTIONS OF THE DEVELOPMENT OF MATHEMATICAL SELF-EFFICACY IN THE CONTEXT OF THE INSTRUCTIONAL SETTING AND PROBLEM SOLVING ACTIVITIES

Christine M. Salon  
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Christine M. Salon

B.S., Education, University of Maine, 1974

A Dissertation
Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Education in Instructional Leadership in the Department of Education and Educational Psychology at Western Connecticut State University
2008
STUDENT PERCEPTIONS OF THE DEVELOPMENT OF MATHEMATICAL SELF-EFFICACY IN THE CONTEXT OF THE INSTRUCTIONAL SETTING AND PROBLEM SOLVING ACTIVITIES

Christine M. Salon, Ed.D.

Western Connecticut State University

ABSTRACT

This multi-case qualitative study, conducted in two elementary schools, observed the self-efficacy experiences of 67 5th grade mathematics students in daily lessons. Four classrooms were observed a total of 40 times for 30 minutes each. Two classrooms each used traditional instructional materials and standards-based instructional materials. Problem solving activity, interviews, a self-efficacy survey, and analysis of student work samples and teacher instruction materials were used to confirm information gathered through observation.

Analysis of information sources resulted in the development of four major constructs: social learning, feedback, modeling, and strategy use. Both groups experienced each construct however, students in standards-based classrooms were exposed to higher levels of each.

Recommendations for future research include the following: similar research with a more diverse socio-economic sample, research committed to detecting the background forces which promoted the site differences in social learning readiness, and inquiry into problem solving.
Doctor of Education Dissertation

Student Perceptions of the Development of Mathematical Self-Efficacy in the Context of the Instructional Setting and Problem Solving Activities

Presented by

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2008
ACKNOWLEDGEMENTS

The first profound thought of my doctoral process came during my first class: there is no way to survive this alone. Over the ensuing five years I relied heavily on Dr. Marcia Delcourt, my professor, program director, and eventually dissertation advisor. Her vision guided our program and her calm demeanor has guided my research through the triumphs and tribulations that all projects face.

Dr. Karen Burke, also central to the growth of our program took on my project as a secondary advisor when busy with many other projects. Thank you for your frankness, kindness, and wisdom. Drs. Cronin and Hibbard were very busy practicing educators when they agreed to serve as a secondary advisor and reader on my committee. Thank you for making room in your extraordinary lives and bringing the perspective of active practitioners to my study.

The four classroom teachers and rooms of students who opened their mathematical lives to me have my gratitude and my profound awe. First, your sense of professional practice was inspiring. Second, I was constantly impressed with your openness and welcoming natures. Without you none of this would have been possible.

Finally, self-efficacy is the product of many externally driven influences. The feedback we receive from the people we trust and admire and the models we see in those we believe in and want to emulate, powerfully affect our personal sense of ability. To say it took a great deal of self-efficacy to complete this project is being mild. Among all the people who have affected my sense of personal capability, especially when challenged, there are two people to whom I most owe my own self-efficacy. They are my own most powerful sources of feedback and modeling. First, my mother who provided me with the strongest model of “can-do” ever created. Her sense of perseverance and ability to organize are two of the best things I inherited with from her. I
deeply regret she will not be there when I graduate as she would have absolutely loved to have a “doctor” in the family. It would have meant the world to her. Second, my husband, who for no particular reason has loved me from the very beginning for the person I was, and am. He promised me in the mania of writing the middle of chapter 4 that if there was a fire in the house he would carry me and my computer to safety. He cooked, cleaned, and laughed alone for a long time. But, he always believed in me and believed that what I was doing was worth it.

My own children, Jena, Abbey, and Brad are the future of the world. Now adults, I am immensely proud of all they do on their own. Each in their own way have found their path to the world of teaching and are affecting the efficacy of adults and children throughout our country. Although they do not need this model I hope that perhaps in some small way my accomplishments will help them go forward in their own endeavors.
DEDICATION

This work is dedicated to the children who are our future. My dearest Grayson, my third graders who have counted down finished chapters with me, and all those who fill the hearts of teachers everywhere. It is my hope that through research like this we will learn to raise children who know how to go forward with strength and independence in the face of the challenges of our changing world.
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CHAPTER ONE

“I think I can, I think I can, I think I can!” The little blue train chanted as it approached a seemingly impossible task (Piper, 1954). In one of America’s most well-known childhood tales a train full of goodies for waiting boys and girls proved that believing in oneself could make the difference when faced with a challenging situation. This story of self-efficacy has since been confirmed over time in research (Bandura, 1982; Phan & Walker, 2000). Student self-efficacy, the belief that one was capable of succeeding at a given task, was an important piece in understanding motivation and performance, both in and out of the classroom (Bandura, 1982; Zimmerman, 2001). While self-efficacy had been studied extensively through quantitative research, much remained to be discovered about the relationship between this important phenomenon between students and their classrooms (Lent, Brown & Larkin, 1986; Pajares, 1995; Pajares & Johnson, 1994; Parjares & Miller, 1994; 1995; Schunk, 1981, 1982, 1989, 1994, 1995; Schunk & Gunn, 1986; Schunk & Hanson, 1989; Schunk & Rice, 1992; Schunk & Swartz, 1993; Sewell & St. George, 2000).

Due to the large body of quantitative research that had been undertaken since the theory was first introduced by Albert Bandura (2002), the conclusions of self-efficacy’s academic benefits for students had come to be judged as stable across ages from elementary school through college (Linninbrick & Pintrinch, 2003). Research indicated that students were likely to experience a wide range of direct and indirect academic benefits when they had high self-efficacy toward a specific task. Indeed, students with higher levels of self-efficacy were more likely to persevere at challenging tasks than students with lower levels of self-efficacy (Lent, Brown & Larkin, 1986; Schunk, 1981, 1994; Sewell & St. George, 2000). According to Harter (1992), students with higher levels of self-efficacy than their peers were more likely to express
positive feelings toward academics and report academic pride. Schunk found higher levels of self-efficacy also resulted in greater use of learning and metacognitive strategies (Schunk, 1999; Schunk & Gunn, 1986; Schunk & Rice, 1992).

Student development of self-efficacy was associated with four factors: enactive experience, social models, feedback, and physiological state (Bandura, 2002; Phan & Walker 2000). Prior experience, or enactive mastery experience, encompassed the relevant tasks and activities the individual could build upon when approaching new learning. Social models, vicarious experiences, included adult and peer models used as examples when attempting tasks. Feedback, or verbal persuasion, was the information a person received from influential others while working toward a task. Physiological and affective states were the emotional and physical cues, such as increased heart rate, or a feeling of well-being, that an individual received when attempting or performing new learning. Within a classroom setting, the development of each of these factors was complex. Although some research had specifically addressed the connection between self-efficacy in the classroom setting and these factors, some relationships were clearer than others. For example, Schunk conducted a series of studies connecting feedback and strategy use with academic progress in elementary school aged students (Schunk, 1981,1982; Schunk & Rice, 1992; Schunk & Swartz, 1993). Educational links to self-efficacy have also been built through motivation theories and classroom environmental studies (Schweinle, Meyer, Turner, 2006; Eshel & Kohavi. 2003). The purpose of this research study was to further broaden this body of research to include the student perspective.

Rationale

“Given that teachers at all levels want[ed] more student engagement and learning, fostering positive self-efficacy beliefs [was] one pathway for all teachers to experience success
in their classrooms” (Bandura, 1984, p136). In recent years self-efficacy, and its effects across various domains, has been examined through quantitative studies with high school and college students (Parjares & Miller, 1994). Additionally, Dale Schunk and others, pursued research focused on quantitative studies in elementary classes (Schunk, 1994; Schunk & Swartz, 1993; Sewell & St. George, 2000). These studies supported the initial theorization that student development of self-efficacy could lead to increased benefits for the student (Pajares & Graham, 1999; Pajares & Miller, 1994; Phan, & Walker, 2000) and, students with increased self-efficacy benefited from increased persistence in problem solving (Pajares & Kranzler, 1995; Schunk, 1994). It was further shown that teachers could make direct efforts to improve self-efficacy through such methods as goal setting and self-regulation techniques that, in turn, improved self-efficacy (Schunk, 1994).

In all of these cases, treatments were imposed on the regular classroom environment where the goal was for students to use their self-efficacy to increase persistence in everyday classroom tasks. While it was known that students benefited academically from higher self-efficacy, it would be an oversimplification to think that if students believed they could accomplish a task, they would happily engage in all classroom activities. As Margolis and McCabe (2003) pointed out, students would invest in an environment that provided them with the physiological and affective needs for building self-efficacy, that is, one that was interesting, safe and rewarding. What was the connection between the development of self-efficacy and the life students experience in the everyday classroom environment? To answer this question, researchers began to create links between self-efficacy, motivation, attribution, and classroom instruction. Already there were hints at these connections (Miller, Greene, Montalvo, Ravindran, & Nichols, 1999).
Self-efficacy was built upon student experiences. These included enactive mastery experiences, vicarious learning experiences, feedback, and their physiological input. These experiences occurred within the context of the classroom setting. How these experiences were interpreted and integrated by students were unique to the situation and student (Paris & Turner, 1994). Students could be affected by a variety of environmental factors. Therefore, it was important to understand the context of the classroom if we were to understand the development of self-efficacy in individual students.

Existing research has sought to establish the influences and effects of self-efficacy. However, since 1991 researchers noted the lack of qualitative research in the area of self-efficacy (Phan & Walker, 2000; Schunk, 1991). Qualitative research, such as this study, will allow the observer to go into the classroom and study the phenomenon from the student perspective, under the most natural conditions possible. The present research will augment the already robust body of quantitative research, mentioned earlier in this chapter, and lend direct observational information to the data gathered to this point. In addition, observation of students in their environment enables the researcher to observe the interaction between the student and his or her environment. This is an important feature of a qualitative approach in that three of the four conditions for the development of self-efficacy (modeling, feedback, social/emotional state) are dependent on environmental conditions.

Problem

According to self-efficacy theory, students became self-efficacious as a result of four influences. These conditions included: prior experiences, feedback, social models, and psychological state (Bandura, 1986, 2002). Students who were more self-efficacious were shown to demonstrate higher levels of effort and persistence (Schunk, 1981, 1991). They were also
more likely to make desirable academic decisions, experience higher achievement, and experience increased motivated (Bandura, 2002).

Connected to these four conditions that promoted self-efficacy was a developing body of research that was linked to the instructional environment in the classroom (Miller, et al, 1996; Pajares & Graham, 1999). Research connected student self-efficacy with various forms of feedback, modeling, and physiological states (Bandura, 1982, Schunk & Rice, 1992). The development of the conditions that promoted self-efficacy in the mathematics classroom environment had yet to be fully explored in research, although some meaningful and purposeful connections had been made (Miller, et al., 1996; Pajares & Graham 1999; Turner, Cox, DiCintio, Meyer, Logan, Thomas, 1998).

Instructional programs designed for elementary school students in mathematics provided a wealth of opportunities for the development and use of self-efficacy and its consequent behaviors such as perseverance. Through these programs students encountered an array of various mathematical experiences on which to build their understanding. In some programs, students were afforded daily opportunities to problem-solve and encounter challenging new information in which students must engage in risk taking. Frequently, strategies for problem solving were emphasized and balanced with a need for accuracy that provided students with the opportunities they needed for frequent feedback from their teachers and peers. Mathematics work lent itself to group analysis and higher-level thinking. Many of these opportunities were ripe for the building of self-efficacy.

The development of mathematics self-efficacy depended on students’ specific experiences with mathematics within each classroom (Linnenbrink & Pintrich, 2003). The influences that build self-efficacy were environment specific (amount of prior experience,
modeling, feedback, and physiological state) and relative to classroom environments which differed for many reasons (student population, instructional program, teacher, student perception). Given these circumstances, it was reasonable to expect a degree of variability in the conditions for building self-efficacy for mathematics students. The point of this study was to investigate experiences students perceive as those that build self-efficacy in mathematics and mathematical problem-solving.

Different types of mathematics programs potentially promoted varied avenues of student access to the skills that appeared to build self-efficacy and self-regulation, the ability to regulate the behaviors that influenced and managed learning. Traditional, or teacher-centered, mathematics programs were based on the . . . “transmission, or absorption, view of teaching and learning. In this view, students passively absorbed mathematical structures invented by others and recorded in texts, or known by authoritative adults” (Clements & Battista, 2002, p. 6). On the other hand, constructivist or student-centered mathematics programs, stressed student independence in construction of personal understanding of mathematical knowledge (Clements & Battista).

Students developed self-efficacy in many different mathematics classrooms (Pajares & Kranzler, 1995, Phan & Walker, 2000) and within the same classroom some students developed more self-efficacy in mathematics than other students. Since self-efficacy promoted consequences that were beneficial for students’ futures as previously stated, it would be desirable for teachers to develop mathematics classroom environments that facilitated the growth of self-efficacy. The problem addressed by this study was: how the mathematics classroom environment, as experienced by the student mathematician, fostered, mathematics self-efficacy.
Significance

Teachers at all levels, from elementary through postsecondary classrooms, are always concerned with increasing student engagement and learning. They often wonder why some students are involved, engaged and motivated for schoolwork and others are disengaged and apathetic, even when these students are in the same classroom (Linnenbrink & Pintrich, 2003, p. 119).

Although there was no one simple solution to solve this issue for the classroom teacher, the positive academic effects of self-efficacy for learners were widely supported through research (Lent, Brown & Larkin, 1986; Pajares & Johnson, 1995; Pajares & Kranzler, 1995; Pajares & Miller, 1994; Schunk, 1982, 1994; Schunk & Rice, 1992; Schunk & Swartz, 1993).

Finally, there was the opportunity to inform mathematics instruction to better develop student self-efficacy. With better understanding and information, teachers could potentially build instructional practices that seamlessly nurture the self-efficacy of their students.

Related Research

Self-efficacy Theory

The theory of self-efficacy was first advanced in its current form by Albert Bandura (2002). According to Bandura, self-efficacy was an individual’s sense of ability to be successful which could and did “touch, at least to some extent, most everything [one does]” (Bandura, 1984, p. 251). Self-efficacy was built in relationship to specific tasks. In other words, individuals build the capacity to feel the potential to be successful in task specific areas, rather than broad ones. For students in a mathematics classroom this meant that a student may have developed high self-efficacy for problem solving, but low self-efficacy for recognizing geometric figures.
Self-efficacy beliefs were based on four conditions (Bandura, 2002). These conditions included enactive mastery experiences; vicarious experience; verbal persuasion; and physiological and affective states. The greater the degree to which these conditions were present in relationship to a specific task, the greater the likelihood that the individual had a high degree of self-efficacy toward that task. In other words, if a student was asked to complete addition problems with which he or she had strong previous experience, has received meaningful feedback from his or her teacher, saw his or her peers being successful, and was in a positive emotional state, he or she was likely to confront that task with a high confidence that she would be successful.

Many benefits for students with high self-efficacy were theorized by Bandura (2002). Among these were increased self-regulation skills and strategies which include increased persistence and enhanced cognitive and behavioral performance. Academic performance was also positively affected through increased levels of self-efficacy, as well as the use of metacognitive skills. Finally, students with higher self-efficacy were more likely to face challenges with aplomb and choose challenges willingly (Bandura, 2002; Pajares, 1995; Schunk, 1994). It was therefore, the purpose of this study to explore the influences that develop self-efficacy from the student perspective within the mathematics classroom environment.

Mathematics Learning In the Classroom

When the National Council of Teacher of Mathematics issued its first set of standards in 1989 (NCTM) it set into motion a series of changes in the way mathematics is taught in classrooms across America. Parents, teachers, and students strove to deal with increased expectations (Mervis, 2006; Remillard & Jackson, 2006; Sherin, 2002) ever since. Learning expectations for students in pre-standards mathematics classrooms centered on rote learning of
mathematics computation goals. Teachers were considered the central holders of mathematical knowledge and students were expected to memorize concepts and perform required skills. With the advent of the NCTM standards the priorities in mathematics classrooms began to change. Although there has been an uneven and controversial history of these changes, the end result has been that today’s mathematics student faces a much different landscape of learning than the learner of 20 years ago (Mervis; Schoenfield, 2004).

Today’s mathematics student is expected to be able to communicate, strategize, problem solve and think critically. Concepts, mathematical reasoning, and deep understanding are held to be the primary goals in standards and research-based classrooms (NCTM, 2000). Teachers are facilitators of student discussions, strategy development, and problem solving activities. Students are expected to be able to work collaboratively and become directly engaged in the process of learning mathematical ideas. Learners are not only exposed to multiple representations of the same concept or strategy, but are expected to conceive of and express multiple representations as solutions to problems (Goldsmith & Mark, 1999). Skills and development of factual knowledge are still valued, but do not weigh as heavily as understanding how and why algorithms and skills work.

The mathematics standards were first issued by the NCTM in 1989. Since being rearticulated and refined in 1991 and 2000, they have been used as the basis for state level mathematics standards and research based mathematics programs for elementary school students (NCTM). In 1998 and 2005 the state of Connecticut reaffirmed its commitment to the standards-based mathematics for Connecticut learners in its curriculum frameworks (Connecticut Board of Education, 2005). These frameworks stated that students will reach mathematical literacy “comprised of understanding major mathematics concepts, having computational facility, and
making the connections which support the application of that understanding in a variety of mathematical situations” (Connecticut Board of Education, 2005, p. 7). Again in 2006, the Connecticut Board of Education issued a position statement reaffirming its commitment to mathematics education for Connecticut students that included deep understanding of concepts across mathematical topic areas, reasoning, communication, strategizing, and application to real-life settings.

Mathematics programs based on the standards and researched for effectiveness were adopted by schools in Connecticut including one of the schools in this study. These programs included *Investigations: Explorations in Numbers, Data, and Space* (Scott Foresman, 2000). Students participating in these programs were asked to actively participate in the development of their own understanding of mathematics principles and concepts. They were required to individually strategize solutions to mathematical problems instead of relying on preset steps, or to strategize multiple solutions to the same problem. Further, students were asked to communicate the thinking that led to their solutions (Taber, 1998).

This was the mathematics environment in which students were working to various degrees at the beginning of this study, although teacher training and program materials affect the level of implementation of standards-based learning (Mervis, Schoenfield, Taber). Students must develop their self-efficacy through their enactive experiences, vicarious experiences, and the feedback they receive related to a wide variety of competencies related to mathematics in a standard-based classroom. While this expanded the role students must play in a mathematics class, increasing the complexity of expectations, it could be argued that they also had more points of entry from which to build competency. It seemed that in traditional classrooms there were narrow terms for success and therefore, fewer pathways on which to the build initial
success that is important for self-efficacy to develop. Through its rich student sample, this study
was able to consider how students in two such programs built their self-efficacy in mathematics
classrooms.

Definition of Key Terms

1. *Self-efficacy* refers to an individual’s beliefs regarding his or her capabilities to
   produce positive effects in relationship to a specific task (Bandura, 2002).

2. *Experience* is the fact or state of having been affected by or gained knowledge
   through direct observation or participation (Webster’s Dictionary, 2006).

3. *Mathematical self-efficacy* involves an individual’s beliefs regarding his or her
   capabilities to produce positive effects in relationship to a specific task in the
   mathematical domain (Hackett & Betz, 1989).

4. *Self-regulation* entails the exercise of influence over one's own motivation, thought
   processes, emotional states and patterns of behavior, including persistence
   (Zimmerman, 2001).

5. The *standards-based instruction* is a model in which mathematical concepts and
   structures are constructed by students under the guidance of the teacher in carefully
   facilitated activities and lessons. Pedagogical basis of instruction lays in the
   mathematics standards adopted by the National Council of Teachers of Mathematics.
   (NCTM, 2000; Senk, & Thompson, 2003).

6. The *transmission model of instruction*, or the *traditional model* of instruction is a
   model in which the teacher is the center of mathematical thinking, concepts and
   structures imparted to students (Clements & Battista, 2002; Schoenfield, 2004).
7. *Perseverance* is an individual’s steady persistence in adhering to a course of action (Bandura, 1993).

8. *Mathematics problem solving* means engaging in a task for which the solution method is not known in advance and for which students use prior knowledge (NCTM, 2004).

9. The *classroom environment* is a combination of conditions in the classroom setting that affect and influence the academic growth and development of students in relationship to mathematics.

**Research Questions**

While qualitative in nature, and therefore open to new paths of thinking, this research study was guided by several overarching questions chosen to provide focus and clarity to the research. These questions were based both on self-efficacy theory and on the observations of classroom life by this, and other researchers (Bandura, 2002; Schunk & Rice 1992). These observations, of the power of self-efficacious behaviors and perseverance as aids to students in their everyday classroom tasks, led this researcher to explore the following questions through this research study:

1. How does a student experience mathematical self-efficacy in the classroom?
2. How do students experience perseverance in problem-solving activities?
3. How do teachers view their role in the classroom in terms of the mathematics self-efficacy of their students?

**Methodology**

*Design*

This qualitative study was based on data collected from four fifth grade classrooms in two separate elementary schools from a medium-sized high socio-economic status suburban
district. These data were collected through 40 classroom observations of 30 minutes each. Introductory and follow-up interviews were conducted in small groups with four students from each school. Solo interviews were conducted with each of the four teachers in the study. Students were also observed completing problem solving activities as a whole class setting (see Appendix A for full problem solving activity). One small group of four students from each site was also observed carrying out the problem solving activity. Work samples from daily instruction on days when students were not observed and teacher instructional program materials were reviewed to verify consistency in instruction. Finally, a Student Mathematics Self-efficacy Survey was administered to students in a whole group setting (see Appendix B for full survey).

Subjects

While the sites were conveniently located and accessible to the researcher students for this study were selected using a purposive sampling techniques. Classrooms were partially selected from on the basis of the mathematics program being used and its fit with the design of this study. Four teachers, from a group of qualified possible participants, volunteered for participation in the study and were asked to meet the research criteria including: willingness to participate, five years teaching experience in the district, use of mathematics programs fitting with the design for the study (Investigations, or D.C. Heath), and willingness to complete requirements of the study. Four classroom groups comprised of mixed ability students whose parents responded to requests for consent for participation in the research project (Site A: n= 18, n=10; Site B: n=19, n=20) comprised the cases for this multi-case study.

Instrumentation

Data used in this research included observations, interviews, document reviews, and surveys. Forty classroom observations of fifth grade mathematics classrooms lasting thirty
minutes were conducted. Observations of large and small group problem solving activities were also completed. Interviews of study participants, including teachers and students were performed. A review of documents including student work samples and instructional mathematics materials for each was conducted. Finally, the Student Mathematics Self-efficacy Survey was administered to all students in the study.

Conclusion

This chapter explored the background and rationale for this research study. Student self-efficacy was defined. The questions which guided the research were explained. Finally, the instrumentation and methodology which were used to explore these questions were briefly detailed. The following chapter reviews the literature which supports this research.
CHAPTER TWO: REVIEW OF THE LITERATURE

As stated in chapter one, the purpose of this study was to explore the experience of students as they developed self-efficacy in the mathematics classroom environment. In four main sections, this chapter was designed to provide an overview of the theoretical and research background which supported this study. To begin, the theory of language and thought as presented by Vygotsky will be reviewed regarding student development in the classroom environment. Next, social cognitive theory and theory of self-efficacy as presented by Albert Bandura will be examined to provide the theoretical framework for the use of self-efficacy as an important contributor to student functioning in the classroom. In the third section, the influences and outcomes of self-efficacy studies are explored with an emphasis on feedback and modeling. In the fourth section, classroom environment research explores the attributes of classrooms as they pertain to self-efficacious students.

_Vygotsky_

Vygotsky's theoretical framework was established around the conjecture that social interaction played a fundamental role in the development of cognition. Vygotsky’s (1978, 1985) position was that every gain in the child's cultural development happened twice: first, on the social level, and later, on the individual level. The social level was interpsychological, or experienced between people. The second was intrapsychological, or experienced inside the child. According to Vygotsky all higher level thinking began as authentic relationships between individuals.

According to Vygotsky (1978, 1985), all basic cognitive activities were formed through interactions of social history. Cognitive skills and thinking were not solely decided by predetermined factors. These were the results of experiences within the social institutions of the
culture of the individual. The history of the society in which a child is reared, and the child's personal history, were crucial determinants of the way in which that individual would think. In this process of cognitive development, language was a crucial tool for determining how the child would learn how to think because advanced modes of thought were transmitted to the child by means of words. Vygostky further stated that there was a fundamental connection between social speech and the development of thought. Language provided children with a tool for self-regulation, problem-solving, and social interaction. As a learning tool, language was a source of knowledge transmission between peer and adult models and the individual.

*Social Cognitive Theory and Self-efficacy*

In this section the theory of Vygotsky was reviewed in order to provide a basis of understanding for the necessity for social interaction in the mathematics classroom setting. In the next section, social cognitive theory as it applies to the mathematics classroom environment is reviewed. This leads to an examination of self-efficacy as defined by Albert Bandura (1986). Both of these theories lend important support and background to this study as they relate to student operations within the classroom environment.

**Social Cognitive Theory**

According to social cognitive theory (Bandura, 1986), individuals are viewed as functioning within a triangle of interacting forces which shape the individual, rather than the individual being driven by external stimuli, as previously proposed by behavioral psychologists. These forces include behavioral, cognitive, and environmental forces. It is said that they interacted and informed one another (see figure 1). Social cognitive theorists also proposed that people anticipated consequences, set goals, and used these goals to motivate themselves.
Social cognitive theory broke with traditional psychological thinking with regard to learning (Bandura, 1986). Where traditionalists believed that learning occurred through performance, social cognitive theory proposed that “virtually all learning experiences phenomena, resulting from direct experience, could occur vicariously by observing other people’s behavior and its consequences for them” (p.19). The human condition, according to Bandura, was comprised of six capabilities that define it. These capabilities included:

1) The ability to use symbols to transform temporary experiences into models for future action,

2) The ability to anticipate consequences of future actions, set goals, and create plans for future courses of action,

3) The ability to learn vicariously through observation of other people engaged in model behavior,

4) The ability to self-regulate behavior through self-monitoring and self-directing behaviors.
5) The ability for self-reflection, which leads to understanding and evaluation.

Social cognitive theory created the basis of thought from which the theoretical frameworks of self-efficacy were developed by Bandura (1986).

**Self-efficacy: Bandura**

At the heart of social cognitive theory are self-efficacy beliefs. Self-efficacy, according to Bandura’s social cognitive theory, is a person’s belief in his or her ability to successfully complete a course of action needed to attain a given performance (1983, 1989, 1997). This differs from response-outcome expectations in which the expectation is a judgment of the possible consequence a given behavior will produce. Bandura stated that an outcome is, in large part, determined by behavior. He believed that humans see outcomes as dependent on their ability to perform, and therefore rely on self-efficacy judgments to guide them when deciding which course of action to pursue.

**Four sources of self-efficacy information**

According to Bandura (1982, 1986, 1997) an individual’s self-efficacy information was based on four sources of information, or influences. These four sources influenced the individual in a hierarchical manner. The sources of influence included: (a) enactive attainment (building prior experience), (b) vicarious experience (modeling), (c) verbal persuasion (feedback), and (d) physiological and affective states. Enactive attainment, or building upon prior experience, influenced self-efficacy positively as a person experienced success at tasks similar to the goal task. If failure was experienced, efficacy was lowered, especially if the individual could not attribute failure to the environment or outside events. However, failures that were overcome raised self-efficacy by building experience in mastering difficult situations. Vicarious experiences, or modeling, were used by persons lacking in skills and dependent on observations
of more competent individuals. In these situations, efficacy was raised through observation of a model’s performance. Verbal persuasion, or feedback, was also thought to contribute to overall sense of self-efficacy. Verbal persuasion became a source of self-efficacy when significant others expressed confidence in a person’s capabilities. Although feedback was a less pronounced source of self-efficacy information, it was seen as possibly leading to prolonged effort and therefore could have a great impact on performance (Bandura, 1997). Physiological and affective states referred to the individual reading of personal fear reactions and emotional states. This was determined by an individual through such factors as heart rate, stomach upsets, fatigue, and personal beliefs in the ability to overcome stressors (Bandura, 1997).

**Bandura’s research**

Bandura’s most prominent research experiments were conducted with snake and spider phobic subjects. The first, performed with snake phobics, was designed to test the level to which subjects would raise their self-efficacy through performance successes, which was hypothesized to depend on how much effort they had expended in overcoming their fear of snakes. Ten subjects (males, n=3; females, n=7) with a mean age of 41, were asked to perform tasks which put them in increasingly closer proximity with snakes, sometimes repeating with performances of others who were not phobics. The analysis of the results of this experiment led Bandura, Reese, and Adams (1982) to conclude that enactive attainment, or prior experience, and modeling were powerful sources of self-efficacy information. A series of three experiments were then conducted with females, who responded to a newspaper ad searching for participants with a “dread” of spiders. These experiments demonstrated that modeling of those who did not have a fear of spiders was a strong source of self-efficacy information. The researchers further related high self-efficacy to the reduction of physiological response to fear in challenging situations.
According to Bandura, “among the different aspects of self-knowledge, perhaps none is more influential in people’s everyday lives than conceptions of their personal efficacy” (1987, p.391). Self-efficacy beliefs led individuals to persevere when challenged, expend effort in the face of difficulties, and become more resilient in situations where failure was possible (Bandura, 1982, 1993, 1997). For students in the mathematics classroom environment the ability to persevere and willingness to expend effort when challenged are necessary skills. The theory of self-efficacy serves as a firm foundation for research into the classroom environment of today’s mathematics student. The theoretical foundation of self-efficacy beliefs was reviewed in this section. In the next section, the research pertaining to the sources of self-efficacy and the potential outcomes of self-efficacious beliefs is examined.

Sources of Self-Efficacy: Influencing student self-efficacy

The four sources of self-efficacy explored by Bandura (1982) in adults have been investigated for connections to self-efficacy in children. In this section, self-efficacy research in elementary school-aged students is reviewed. This research is categorized into the two sources covered in depth in this study: vicarious experience and verbal persuasion. Within each category, research is organized in chronological order.

Vicarious Experiences: Modeling

Social cognitive theorists maintained that four sources of information influence self-efficacy including: enactive experience, vicarious experience, verbal persuasion, and physiological and affective state (Bandura, 1982). Vicarious experience, or modeling, serves as an effective tool for building self-efficacy. Through modeling, individuals judged their capability in relation to others who they observed engaged in similar tasks (Bandura, 1993). Researchers have explored varied means of providing the most effective models to elementary school-aged
students. In research by Schunk (1981), problem solving aided by modeling, rather than didactic instruction, led to greater gains in skill development, persistence, and self-efficacy. Elementary school-age students (n=56, mean age 9.10), in an experimental design research study with random assignment to group, were asked to solve division problems of varying degrees of difficulty. Student’s rated their sense of efficacy after exposure to the task and at the end of the project. Students were trained over three sessions with division problems under three treatment conditions. Adult models, in the form of trained research assistants were provided to students in modeling groups. In the cognitive modeling treatment, students observed adult models and received adult modeling support when attempting to solve division problems. In the didactic treatment, students reviewed explanatory materials and solved problems on their own. When these students encountered difficulties they were directed by trainers to review instructional materials. In the attribution treatment group, success trainers attributed to hard work and difficulties to low effort.

Through this work Schunk (1981), confirmed that modeling promoted significant gains in self-efficacy, especially when coupled with attributional feedback ($p<.01$). Persistence ($p<.01$) and skill development ($p<.01$) were found to be similarly affected by modeling. Additionally, students improved their sense of self-efficacy and persisted longer than their less efficacious peers. Achievement in the form of overall performance on division problems was improved with increased self-efficacy and persistence. The connection between modeling and self-efficacy was further explored by Schunk and Hanson in later research (1989).

Schunk and Hanson investigated if the model type would affect student self-efficacy and skill. Fourth grade students (n=120) observed either mastery models, coping-emotive models, or coping-alone models, as they learned to solve fraction problems. Models were presented in the
form of same-sex peers working with adults on video tape. Mastery models easily grasped problems and verbalized positive achievement feelings. Coping-emotive models initially encountered difficulty in learning and verbalized negative emotions before this, ultimately displayed coping skills and achievement that matched the mastery group. Coping-alone models performed identically to the coping-emotive models without verbalizing feelings related to achievement. At the conclusion of the experiment, the students in the coping-emotive group experienced the highest self-efficacy for learning. This group reported themselves more competent than the model whereas, the students in the other two groups reported themselves as equally competent as the model.

In this pretest-posttest design experiment (Schunk & Hanson, 1989) with random assignment to group, all experimental conditions showed improvement (all ps < .01). The main effect for self-efficacy and type of modeled behavior showed significant difference between the two coping models. Children in the coping-emotive group judged self-efficacy for learning significantly higher than students in the coping alone group.

Schunk and Hanson concluded that different types of models can impact achievement and self-efficacy. However, they noted that caution should be taken when exposing students to coping-emotive models because of the possibility that they could lead students to overestimation of competence. Coping-emotive models could be productive for students with learning difficulties or students who experience low self-efficacy (1989). Competent peers (mastery models) could also lead to higher self-efficacy when a student believed himself to be equally competent. Schunk and Hanson concluded that in the classroom environment student models could be important sources of self-efficacy, but needed to be chosen with care so that the peer viewed the model is accessible. In this section four research studies examining the contribution
of modeling to the development of self-efficacy have been reviewed. In the next section research studying verbal persuasion, or feedback, will be discussed.

**Verbal Persuasion: Feedback**

Verbal persuasion, also known as feedback, followed enactive attainment (prior experience) and vicarious experience (modeling) in the hierarchical order of the four sources of self-efficacy information. Researcher explored verbal persuasion seeking to determine the most effective types of feedback and its relationship to goal iteration and performance. Verbal persuasion, which could be given in the form of spoken praise, or criticism, could also be given in more subtle forms such as frowns, nods, smiles, and unsolicited help (Bandura, 1991). In this section two studies exploring feedback (verbal persuasion) will be examined.

Schunk (1982) has noted that feedback given to students by teachers was frequently accompanied by attributional messages. These messages, such as: “You tried hard,” could potentially affect feedback as a source of self-efficacy (Schunk, 1982). This effect is often greater with younger children who see effort and ability as equal, or view outcome as highly dependent on effort (Nichols, 1979). Schunk studied two types of attributional feedback with 40 elementary-age students (mean age 9.1 years) who were identified by their teacher has having low subtraction skills. All were given the same pretreatment assessment and training. Students were randomly assigned to one of four groups: past attribution, future attribution, monitoring, and control. Subjects in the past-attribution group were asked how much progress they had made and were then told they had been working hard. Children in the future attribution group were also asked how much progress they had made, but were then told, “You need to work hard.” Subjects in the monitoring group were asked about their performance, but given no attributional comment. The control group received initial training and had contact with proctors during the
explanation of the task only. All students worked on packets of subtraction problems and were monitored by adults every eight minutes. Following three sessions a skill test and self-efficacy measure was administered to all students.

Analysis by Schunk (1982) showed significant treatment effect ($p<.0001$) for past attribution and subtraction skill. Self-efficacy scores for feedback with past attribution students was significantly higher ($p<.01$) than for other treatment groups. Past attribution students also made significantly greater progress in completion of treatment materials. These students completed 85% of materials compared to 50% for the next closest group (future attribution). Through this research Schunk concluded that attributional feedback which focused on past effort linked significantly with skill development, task involvement, and self-efficacy.

The relationship between goal and progress feedback (verbal persuasion) and self-efficacy in writing was studied by Schunk and Swartz (1993). This study consisted of two experiments. The first involved 60 fifth grade students from mixed socio-economic backgrounds. After pretesting for self-efficacy in paragraph writing, students were randomly assigned to one of four groups: product goal, process goal, process goal plus progress feedback, and general goal (control). All students received instruction in paragraph writing over five days for each of four types of paragraph for 45 minutes. Product goal subjects were reminded at the beginning of each work period to keep in mind what they were trying to accomplish that day. Children assigned to process goal and process goal plus feedback began the work session with statements such as, “While you are working it helps to keep in mind what you’re trying to do. You’ll be trying to write a descriptive paragraph.” General goal students were told, “While you’re working, do your best.” Students assigned to process goals plus feedback received feedback three to four times
during each session, which gave the message that the student was making progress toward their goal. Monitors were careful not to give performance feedback such as: “That is a great detail.”

Schunk and Swartz found that process goal and process plus feedback subjects demonstrated higher skill (p<.05) than other groups. Self-efficacy (p<.05) scores showed process plus feedback students judged their self-efficacy the highest. Process goal students judged their self-efficacy higher than product goal students. All treatment groups judged their self-efficacy higher than the control group. Schunk and Swartz followed this research studying the maintenance of gains made by students related to the use of feedback (1993).

Using the research and treatment protocol described above, Schunk and Swartz studied a new group of fourth grade students (n=40). Pretests, writing instruction, and posttests were replicated from the previous study. However, six weeks following the study, a maintenance test which included strategy use, self-efficacy, and achievement, was administered. The purpose of this follow-up test was to test the maintenance of the treatment effect. Analysis of maintenance test measures yielded significant treatment effect. Children in the process goal plus feedback group judged their self-efficacy higher than students in any other group. These students judged strategy use higher than other groups and displayed higher maintenance of skill than other groups (Shunk &Swartz, 1993).

Order of Sources of Self-efficacy. The previous two studies focused on feedback, which according to Bandura (1997), was third in hierarchal order of influence as a source of self-efficacy. As previously stated in this review, the order of the sources of self-efficacy were generally accepted in the literature as being enactive experience, vicarious experience, verbal persuasion, and physiological and affective state. However, there has been some research which questions this hierarchal order. An example of such research was conducted by Phan and Walker
(2000) through path analysis in two back-to-back studies. These researchers studied 383, 3rd and 4th grade Australian students with these goals in mind: (a) to examine the meditational role of self-efficacy in mathematics, (b) to research the order of sources of self-efficacy, and (c) to explore over confidence in mathematics students. Subjects in the first study completed instruments to determine overall levels of self-efficacy, isolate the four sources of self-efficacy, and mathematics achievement. The study’s authors predicted that the sources of self-efficacy would follow the order previously established through research. A path analysis was conducted to test the causal order of the variables included in the study. Phan and Walker concluded that, at \( p < .005 \), the variables for the four sources of self-efficacy, mathematics performance, and math self-efficacy were significant (2000). These results were consistent with social cognitive theory.

In a second study 272, 5th and 6th grade Australian students were administered the Four Sources of Self-efficacy Information instrument (FSSEI-Maths), achievement test (15 questions from the NSW Dept of Education Basic Numeracy and Literacy Skills Test), and the Self-efficacy instrument (SEI-Maths). Path analysis of scores showed that, for these students, the most important sources of information had varied between the two studies. The first study had placed the sources in the following order: emotional arousal (physiological and affective state), followed by verbal persuasion and performance accomplishment (enactive attainment). The second study confirmed performance and emotional state in first and last position, respectively, as Bandura originally stated. Further analysis showed that girls were more anxious than boys. Based on prior research, the authors concluded that the age of the participants were relative to the development of self-efficacy and the hierarchal order of the sources of self-efficacy.
This section has reviewed research relevant to the sources of self-efficacy information in elementary school-age children. In the next section research pertaining to strategy use, a factor related to self-efficacy, which may increase self-efficacy will be explored.

**Factor Related to Self-efficacy**

*Strategy Use.* Student strategy use and its relationship to self-efficacy was researched by Schunk and Gunn (1986) with elementary mathematics students (n=50, mean age 10.0 years). Following pretests in division and self-efficacy, students took part in four, 40-minute training sessions. During the training sessions, students were asked to verbalize strategies used to complete division problems aloud. All sessions were taped and later transcribed and coded. Upon completion of training sessions, skill and self-efficacy posttests were administered.

Schunk and Gunn (1986) analyzed their findings using path analysis ($p<.01$). Greater use of effective task strategies was found to be tied to self-efficacy. It was found that strategies affect self-efficacy indirectly through attribution. For example, success in mathematics work led to student beliefs of high ability, and ability attributions exerted strong effect on achievement beliefs.

Strategy use was further explored in relationship to self-efficacy by Schunk and Rice in 1992 in two experiments. First, the effects of strategy information and strategy instruction were explored on a group of 33 fourth grade readers. In both experiments students were given a self-efficacy pretest and placed in random groups. In the first group students received instruction in strategy information, strategy value information with feedback, or instruction only (control). In the second study students in one group received modifications to strategy instructions halfway through the training sessions. Both studies conducted posttests in skills and self-efficacy.
Students in the second experiment were also administered a maintenance posttest six weeks after the last session. Results were analyzed using path analysis by Schunk and Rice.

The most significant effect was strategy value feedback in maintenance test conditions with relation to self-efficacy ($p<.01$). Self-efficacy related most closely to posttest skill ($r=.62$). In experiment two, strategy modification students judged their self-efficacy higher than other groups both on the posttest and maintenance tests. Posttest and maintenance tests consisted of 4 to 25 sentence reading passages from a commercial reading program followed by related questions. Schunk and Rice concluded that providing readers with a source of strategy information enhanced self-efficacy (Schunk & Rice, 1986).

Schunk and Rice explored effective strategy use for a second time in 1993 with 44 fifth grade remedial reading students. Students were pretested in self-efficacy, reading comprehension skills, and reading comprehension strategy use in reading comprehension before being randomly assigned to one of four groups. Self-efficacy pre-test items focused on students’ perceived capabilities to correctly answer questions related to the comprehension of main idea. Students experienced strategy instruction in reading. Strategies presented to students included: (a) read the question, (b) find main idea of passage, (c) find similarities in details, (d) think of a good title, and (e) re-read question. Each group treatment was either: feedback only, fading with feedback, and no feedback or fading. Adult researchers modeled the reading strategies to all students. In the fading group, trainers taught students to read strategies aloud in sessions one through four while working on reading tasks. After session five researchers told students to whisper strategies and after session nine directed students to repeat strategies in their heads. Researchers directed feedback to the subjects in the feedback group three to four times during each session and focused only on the value of the strategy used. Children in the no feedback or fading group
received comprehension instruction only. Student posttests were administered two weeks following the last session. Analysis showed that fading plus feedback students judged their self-efficacy for comprehension higher than other groups ($p<.01$).

This section has reviewed four studies which explored the connection between self-efficacy and strategy use. Through these studies the connection between the use of strategies and increased self-efficacy was established (Schunk & Gunn, 1986). It was also shown that strategy use, strategy value feedback, strategy modification, and fading improve self-efficacy (Schunk & Rice, 1992, 1993). In the next section the research focusing on the benefits of increased self-efficacy will be explored.

Benefits of Increased Self-efficacy

According to Bandura, when faced with challenging tasks, people with increased self-efficacy demonstrated increased persistence, performance skills, achievement levels, use of metacognition strategies, and resiliency (1997). Improved affective state, goal setting, and commitment to task were also related to increased self-efficacy. In this section, research exploring the benefits to students with increased self-efficacy will be reviewed. Studies related to strategy use, metacognition, performance (achievement), and persistence will be explored. As in previous sections, studies in each category will be organized chronologically.

Metacognition

Student use of metacognition, or knowledge of one’s own cognitive processes and the active monitoring of these processes, as a predictor of increased student success was the basis of a study by Landine and Stewart (1998). This study, with Canadian high school students ($n=108$), also explored the relationship between metacognition and self-efficacy. A learning process questionnaire, scale of intrinsic and extrinsic orientation, locus of control instrument, and self-
efficacy scale were administered during mathematics class time. Analysis of results demonstrated a positive correlation ($p<.01$) between the use of metacognition and self-efficacy, as well as, strategy use and self-efficacy. Motivation was also positively related to improved self-efficacy. Ladine and Stewart also found that self-efficacy was related to academic achievement.

**Performance**

Social cognitive theorists have posited that self-efficacy was necessary to achieve desired behaviors, strongly influenced effort expenditure, and increased the likelihood of an individual’s willingness to persist in the face of challenges (Bandura, 1986). Research establishing self-efficacy as a strong predictor of performance, or academic achievement will be reviewed in this section.

Pajares & Miller (1994) studied the predictive role of self-efficacy compared to mathematics background, math anxiety, problem solving performance and mathematics self-concept. Three hundred and fifty college undergraduates were administered instruments measuring mathematics self-efficacy, math anxiety, perceived usefulness of math, math self-concept, math experience, and problem-solving skills. A path analysis was performed ($p<.001$) which showed that self-efficacy had a higher effect on performance than any other variable in the study. Self-efficacy had a significant effect on achievement. Prior mathematics experience appeared to be an effect largely through self-efficacy (Pajares & Miller). Students predictions about their capability to solve problems (perform) were more predictive of actual performance than any other variable.

These findings, related to student performance and self-efficacy, were supported in later work by Pajares and Kranzler (1995). In this later study, with 329 high school students, instruments measuring general math ability, mathematics self-efficacy, math anxiety, math
background, over/underconfidence, and mathematics problem solving performance were administered. Path analysis was again performed ($p<.001$). This study supported earlier research findings. Pajares and Graham reported significant effects between self-efficacy and performance; as well as, and self-efficacy and ability. The study’s authors concluded that self-efficacy beliefs of students directly affected student performance and mediated the affect of ability on anxiety and performance.

Pajares and Johnson (1995) further confirmed the relationship between performance and self-efficacy in a study with ninth grade writing students ($n=181$). Students were asked to write a 30-minute narrative essay, which was holistically scored. Also administered was a self-efficacy scale, writing apprehension scale, writing self-concept scale, and writing aptitude measure. Path analysis was performed ($p<.001$). Analysis of data showed self-efficacy was a strong predictor of writing performance. Researchers also concluded that writing anxiety was mediated by self-efficacy beliefs. These findings confirmed those of earlier studies performed with mathematics students.

This section has reviewed studies which investigated the relationship between increased self-efficacy and performance. Persistence was also noted as a beneficial outcome of improved self-efficacy. The following section explores research in this area.

*Persistence*

Bandura states that self-efficacy aided individuals in two ways. First, as they made choices on a daily basis and second, through increased ability to persist in the face of difficulty when those choices presented challenges (1997). In this section two studies which explore the relationship between self-efficacy and persistence are reviewed. Miller, Greene, Montalvo, Ravindran and Nichols (1996) studied this connection with 297 high school students.
Participants were asked to complete the “Attitude Toward Mathematics Survey” which included questions in five subscales (goals for doing the academic work assigned in the class, self-perceptions of ability for the class, self-regulation and cognitive strategy use in studying for the class, persistence, and effort. Student grades in mathematics were used as a measure of achievement. Factor analysis of the data \( p<.005 \) showed significant two-way interaction between persistence and self-efficacy \( (r=.49) \). A significant two-way interaction between self-efficacy and achievement \( (r=.56) \) was also noted. The following year the same authors completed a follow-up study with 269 students at the same high school. Instrumentation and data analysis procedures were the same. With small differences, analysis of the data for the follow-up study showed similar results to the previous study \( p<.005 \). Significant two-way interactions between effort and perceived self-efficacy \( (r=.35) \) and between persistence and self-efficacy \( (r=.39) \) were noted. Persistence was the only variable related to achievement in the second study.

Persistence was used by Pajares and Graham (1999) as the definition for engagement in an academic environment. In a study with 273 sixth grade students, Pajares and Graham explored the influence of various motivational variables on mathematics performance. Participants were administered instruments to measure mathematics self-efficacy, mathematics self-concept, and self-efficacy for self-regulation learning. Mathematics performance was measured through two end-of-term exams. A multiple regression was performed \( p<.05 \) for analysis of the data. Pajares and Graham determined that self-efficacy made an independent contribution to performance. The authors commented that overall self-efficacy; value for mathematics, and persistence of sixth grade students was shown to drop from the beginning to the end of the sixth grade. No tie was made between individuals with higher self-efficacy and individual persistence levels. Two of the three studies reviewed (Miller, Greene, Montalvo, Ravindran & Nichols 1996;
Pajares & Graham, 1999) above found that increased self-efficacy is positively related to increased persistence, confirming Bandura’s assertion.

In chapter two, social cognitive theory and self-efficacy have been explored. Research investigating the sources and outcomes of self-efficacy were then reviewed. Persistence, performance, strategy use and metacognition were then examined. In this section we have explored research pertaining to some of the benefits associated with increased self-efficacy including improved performance and persistence. In the final two sections of this chapter the mathematics classroom will be the focus of the research. First, the standards for mathematics education will be reviewed. Next, the research pertaining to the classroom environment will be explored.

Mathematics Standards

The mathematics standards

First, this section will describe the national mathematics standards developed by the National Council of Teachers of Mathematics (NCTM, 2000). Next, the local state frameworks will be discussed. Finally, the implications of the standards on classroom instruction will be explored.

National standards. The mid-1970’s saw a strong back to basic’s movement in mathematics instruction (Senk & Thompson, 2003). In this environment classroom instruction was heavily focused on computation, arithmetic, and rote learning. Soon after this movement took hold academic and mathematics educators began seeking changes in mathematics instruction. Calls for a broadening of instruction to include problem solving and application of mathematical skills started. Work began by the NCTM on multiple drafts of national standards that would address these issues. By 1989 the National Council of Teachers of Mathematics
Curriculum and Evaluation Standards for School Mathematics were completed. These recommendations for kindergarten through grade 12 school mathematics curriculum contained five goals for students and four standards for instruction (NCTM, 1989). Recommendations for mathematics curriculums included: students should (a) learn to value math, (b) become confident in their ability to perform mathematics tasks, (c) become mathematics problem solvers, (d) be able to communicate mathematically, and (e) be able to reason mathematically. Standards for instruction included: (a) problem solving, (b) communication, (c) reasoning, and (d) mathematical connections. Underlying both sets of standards was the recommendation that classrooms would now stress both skills and concepts, focus less on memorization and more on active engagement, and increase use of realistic mathematics materials (Senk & Thompson, 2003). The national standards were followed by a companion document, Assessment Standards for Mathematics (1995), which recommended mathematics teachers move away from multiple choice assessment and toward performance tasks. The standards were reviewed and revised in 2000 in The Principles and Standards for School Mathematics (NCTM, 2000).

State frameworks. Soon after the NCTM standards were written California led the list of states developing individual standards, or frameworks, for mathematics education. Like other states, the host state for this study has mathematics frameworks (Connecticut Board of Education, 2000). These frameworks set goals for students educated within the state that included: mathematical literacy that encompassed ease with computation skills, ability to make connections which enabled the student mathematician to apply mathematical understanding in a variety of mathematical situations, and understanding major mathematical concepts. Later in 2006, the state reiterated its commitment to standards-based mathematics education for its students. Included in the list of topic areas noted in this position statement were: deep
understanding of concepts across mathematical topic areas, reasoning, communication, strategizing, and application to real-life settings (Connecticut State Board of Education).

In this section the national and state mathematical standards were examined. In the next section the effect of these standards on classroom instruction will be discussed.

**Effect of Standards on Classroom Instruction**

In the traditional mathematics classroom the teacher has been as a demonstrator of knowledge (Romberg & Kaput, 1999). Mathematics knowledge was seen as a fixed quantity of facts and concepts that were characterized by mechanical manipulation of numbers and symbols. The center of knowledge rested with the teacher whose job was the transmission of information to students (Clements & Batista, 2002). Within the transmission model, or traditional mathematics programs, mathematics was conceived as a set of fixed courses, each designed to feed into the next. Lessons generally followed a standard three-part approach which included homework review, new work introduction and practice, and finished with introduction of daily homework assignments. Mathematics, as a discipline, was isolated from other academic topics, and primarily delivered to students through basic texts, paper and pencil drills (Romberg & Kaput). The NCTM mathematics standards called for changes in the traditional approach to mathematics education.

The implications of the mathematics standards for classroom teachers were significant. Implementation of the standards required a shift away from the teacher as the center of knowledge (Schifter & Twomey Fosnot, 1993). Teachers were expected to actively engage students in mathematic concept development through collaborative investigations. Hands-on explorations were used in order to aid students as they built their understanding and became problem solvers (Goldsmith, & Mark).
Research by Brown, Kresiman, and Noble (1999) investigated the experiences of students in traditional and standards-based classrooms. Mathematics attitudes surveys were administered to 1,176 elementary and secondary students \( (p<.05) \). Eighth grade students in the standards-based classrooms showed significantly higher levels of association with instructional strategies, looking forward to taking more mathematics classes, viewing mathematics as important, and feeling that mathematics does not make them nervous. Fourth grade students in standards-based classrooms were 7 times more likely to enjoy mathematics than their peers in traditional classrooms and more than 10 times more likely to report that they enjoyed mathematics. The effect of standards-based instruction on teachers was also explored by Sherin (2002). Data collected by Sherin included interviews, daily videotaped classroom lessons, and weekly group video debriefing sessions with teachers. Three categories of interaction between content knowledge and teachers were identified: transform, adapt, and negotiate. Sherin theorized that teachers engaged in teaching novel lessons transformed materials from the curriculum design into more traditional-looking lessons. Or, teachers adapted by developing new content knowledge and implemented new content as designed. Finally, teachers negotiated when they developed new content knowledge and made changes as the lessons unfolded in the classroom. However, unlike transforming, the lesson remained true to the pedagogical base of the program.

Sherin (2002) found that teachers who engaged in shifting to standards-based teaching were required to understand and adapt their teaching as they were implementing lessons. This was due to the nature of the way student understanding unfolded, creating new content knowledge as the lesson progressed. Standards-based instruction required that teachers understand the mathematic foundations behind their instruction and that they were able to attend to the ideas students raised in class. Teachers were more likely to focus on discussion than
“teaching by telling.” Teachers became facilitators who helped students explain, analyze, and justify their ideas. Standards-based instruction required a shift in instructional practices for teachers.

In this section, the national and state standards and the implications of their adoption on classroom instruction were reviewed. In the final section, research related to classroom environment and student self-efficacy will be reviewed. First, a study investigating the relationship between the general environment and self-efficacy will be reviewed. Next, studies relating to motivation in the classroom and self-efficacy will be explored. The effects of different types of goal setting in the classroom will be investigated in the next section. Finally, research related to the affects of discussion on students will be reviewed.

Classroom Environment

According to Bandura (1997) there are many ways in which the classroom environment can affect self-efficacy. Opportunities for academic success, effective feedback on effort and performance, effective use of goal setting and strategy use, as well as, effective use of social influences through modeling each have the potential to positively act on self-efficacy. In turn, improved self-efficacy has the potential to improve performance and aid in the cultivation of intrinsic goal setting. The classroom environment holds many potential self-efficacy sources for students. Dorman and Adams (2004) in a study with 2,641 Australian and British high school students explored the connection between classroom environment and self-efficacy through questionnaires administered during class. Questionnaires included 10 scales for classroom environment (teacher support, investigation, cooperation, equity, etc). Academic self-efficacy was measured using a separate scale. Multiple regression analysis showed a positive correlation
(p<.05) between self-efficacy and involvement (r=.19), investigation (r=.12), task orientation (r=.27), equity, and student negotiation (r=.08). The authors concluded a strong correlation was shown between environment and self-efficacy. Dorman and Adams also concluded that teachers should work to ensure that classroom possess high quality environments characterized by cooperation, cohesiveness, teacher support, and task orientation (2004).

Motivation

Within the classroom environment, as in any human environment, students are affected by different motivational forces. Bandura (1997) argued that self-efficacy was central to the three major motivational theories (attribution, goal, and outcome expectancy). While it is outside of the scope of this review to explore all motivational theory, the concept of student motivation as an feature of classroom environments is frequent in the literature. The attributes of classrooms that have been found to increase student motivation and self-efficacy were of interest to this research. Among these were student choice, challenge, and control (Paris & Turner, 1994). Choice provided students with opportunities to attribute positive feelings to a task making it more likely they would choose to pursue it vigorously (Pintrich & DeGroot, 1990). Challenge was found to be beneficial when it was moderate and did not overwhelm students (Shim & Ryan, 2005). Increased student control improved student interest (Ryan & Grolnick, 1986). Student interaction through collaboration motivated children because peers provide models, additional perspectives, and realistic benchmarks for measuring student work (Paris & Turner, 1994). Students frequently considered feedback from peers more reasonable and useful than feedback from teachers. Persistence and strategy use was improved through group goal commitment (Corno, 1989; Paris & Turner).
Motivation in classrooms where the teachers were engaged in teaching standards-based mathematics programs has been shown to be higher than traditional classrooms (Stipek, Givvin, Salmon & MacGyvers, 1998). The environments in these classrooms featured learning with alternative strategies, and student autonomy more often than traditional instruction classrooms. Research conducted with 24 teachers and 624 upper elementary school mathematics students showed that teachers involved in teaching standards-based mathematics classes emphasized performance goals and placed more emphasis on effort than on outcome. Video-taped lessons (2 per teacher) and lesson observations (2 per teacher) revealed that students in these classes benefited from teachers increased use of scaffolding behaviors. Increases in students’ willingness to take risks and increases in student self-confidence demonstrated the benefits of scaffolding. Students in the non-traditional group reported the highest self-efficacy.

The work of Stipek, Gavin, Salmon, and MacGyvers (1998) underscored the importance of teacher practices. The affective climate (teacher enthusiasm, interest in mathematics, supportive environment, risk-taking, respect, and sensitivity) was the most powerful indicator of student motivation. Researchers also studied challenge as a potential contributor to student motivation in the classroom.

Researchers investigated this connection in qualitative study investigating classroom environments. Scheweinle, Meyer, & Turner (2006) studied 42 students from 7 classes and their teachers (n=7). Students and teachers were observed in mathematics class for a two-week period in the fall and spring. At the end of class they were asked to complete surveys generalizing their experience in class (cooperative – competitive, proud – ashamed). A factor analysis was completed to examine data. The analysis showed that above-average challenge was related with below-average self-efficacy and was consistent with feelings of apathy. Average challenge was
related with above-average levels of self-efficacy. Researchers found close relationships between affect and motivation. Efficacy was especially closely tied to social and personal affect. Importance of task to self was more predictive of student’s motivation than was the challenge that it afforded.

In a related study, researchers focused on the teaching practices within the classrooms cited in the previous study. In this study teacher discourse was coded into three categories: (a) affective and social rapport, (b) autonomy, feedback, and evaluation, (c) challenge, competence, support, and task importance. Teachers whose students reported high levels of motivation and self-efficacy were observed to use several, supportive instructional practices in the classroom (Scheweinle, Meyer, & Turner, 2006). Students in these classrooms were encouraged to develop their own strategies and had many opportunities to demonstrate their competence. When mistakes were made the teacher clarified and re-taught. The teachers in these classrooms used challenges selectively to build concepts gradually and provided the support necessary for students to experience success at each level of learning. Scaffolding was a feature of discussions. This was a blending of teacher and student modeling, meaningful feedback, and realistic challenges that lead to new learning. Scheweinle, Meyer & Turner conclude that challenge and self-efficacy are crucial features of classroom instruction and motivation.

In this section the research pertaining to features of classroom environments that can foster motivation has been reviewed. In the next section the research relating to classroom environments and goal setting will be examined.

Goals

Performance and Mastery Goals. Earlier in this review it was established that goal setting can positively act as a source for self-efficacy (Schunk & Swartz, 1993). Achievement goals can
be viewed as performance goals or mastery goals. Performance goals are those focused on right and wrong answers, or grades. Mastery goals are those based on understanding instruction (Shim & Ryan, 2005). Schunk explored the connection between mastery and performance goals with self-efficacy (1995) with 40 fourth grade students. After administering instruments which measured goal orientation, self-efficacy, skill, and persistence, researchers instructed children in fractions for six sessions. Following training, students completed self-evaluation assessments. Posttests in self-efficacy, skill, persistence, and goal orientation were administered. Data were analyzed using a MANCOVA ($p<.001$). Results showed that students in the learning goals group scored higher on task orientation and solved more problems than students in the performance goals group. Students in the performance goals group scored higher in ego orientation and work avoidance. Self-efficacy was correlated with skill, persistence, task orientation, and self-satisfaction. Schunk concluded that emphasizing to students that their goals were to learn to solve the problem could raise self-efficacy and motivation to regulate their task.

Also investigating mastery and performance goals, Shim and Ryan (2005) administered 2 surveys to 361 college students 3-5 weeks apart. Shim and Ryan then measured student achievement goals, preferences to avoid challenging work, self-efficacy, and intrinsic value. Analysis through multiple regression showed that self-efficacy and motivation were correlated ($r=.28$). Self-efficacy showed a positive correlation with mastery goals and a negative correlation with challenge avoidance ($p<.001$). Grades were positively related to intrinsic values. Performance-approach goals predicated an increase in preference to avoid challenging work.

In this section research related to performance and mastery goal setting has been reviewed. Mastery goals have been shown to be positively related to higher self-efficacy and
student motivation. In the next section research relating to goal setting and social comparative information will be reviewed.

*Social Comparative Information and goal setting.* Within the classroom environment students receive a great deal of information from their peers. According to Bandura, student peer groups could have a powerful effect on their self-efficacy in the classroom environment (1986, 1997). Schunk explored that relationship more closely with 40 fourth and fifth grade mathematics students. Subjects were pretested for self-efficacy and division skills and placed in four random groups. These groups included: comparative information with goals, comparative information only, goals only, comparative and goals (control). Comparative groups were told other students had completed 50% of the task they were working on. Goals groups were told they may want to complete at least 25 of the 50 division problems. All groups completed a posttest. Analysis of data through ANCOVA ($p<.01$) showed that self-efficacy was a main effect for goals. Students in the goals and comparative information groups judged self-efficacy higher than any other groups. Schunk concluded that social comparative information was associated with high self-efficacy and performance.

Research related to goals has been reviewed in this section. In the next section research related to classroom discussion will be examined.

*Classroom Discussion*

Feedback and modeling have both been shown in this review to be connected to the development of self-efficacy. Research relating to classroom discussion demonstrates that high quality interactions between teachers and students include both feedback and modeling (Turner, Cox, DiCintio, Meyer, Logan, & Thomas, 1998; O’Connor, 2001). These discussions benefit students through increased motivation and involvement. In a qualitative study focusing on
teachers interactions with students in mathematics class, Turner, et al observed that classrooms in which students reported higher levels of motivation, student interest, and self-efficacy had teachers who were highly effective at weaving feedback, modeling, and student support into lessons. These teachers created positive classroom environments and supported risk-taking. A case study by O’Connor (2002) drew similar conclusions. After observing mathematics classes for two days the researcher noted features of the discussion that appeared to aide student understanding. The teacher helped students to explore clear examples, managed students’ alternate conceptions, used student insights, leveraged new methods, and scaffolded the discussion points toward higher thinking. Students benefited from teacher use of discussion strategies that included scaffolding, feedback, and modeling.

Conclusion

In this chapter the theories of social cognition and self-efficacy, as well as, the work of Vygotsky and Bandura, have been reviewed. Research related to the sources and outcomes of self-efficacy have explored. Finally, research related to school environment was examined.

Relationship to this study

In today’s mathematics classrooms students are faced with one of at least two program models: traditional or standards-based (Clemens & Battista, 2002). Within these mathematics program models they will have differing opportunities for the development of self-efficacy (Dorman & Adams, 2004). These opportunities for self-efficacy are developed through the classroom environment which is fostered through teacher implementation of mathematics programs. Standards-based programs have been shown to offer higher levels of peer feedback and modeling, scaffolding, and support in risk-taking situations (Turner, Cox, DiCintio, Meyer,
Logan, & Thomas, 1998; O’Connor, 2001). Traditional classrooms have been shown to be more consistent and predictable in building prior experience (Staub & Stern, 2002).

There is a compelling connection between self-efficacy and the classroom environment (Dorman & Adams, 2004). This connection is the basis of this research study. The development of self-efficacy is a positive and worthwhile pursuit for teachers (Bandura, 1997, Schunk, 1982). Self-efficacy lies at the center of student achievement (Schunk & Gunn, 1986; Pajares & Kranzler, 1995). However, its benefits go beyond performance and achievement to include persistence, increased use of strategies, and increased sense of intrinsic value (Bandura, Resse, & Adams, 1982; Schunk & Swartz, 1993). A two-way relationship has also been demonstrated between strategy use and self-efficacy (Bandura, 1997; Schunk & Rice, 1992). The strong ties demonstrated through research between self-efficacy and mastery goals, intrinsic value for work, and future value for work, show that it is an important factor in the classroom environment. In order to understand the functioning of student mathematicians it is necessary to understand them as potentially self-efficacious students and determine the environments which can best foster their growth.
CHAPTER THREE: METHODOLOGY

Students with increased self-efficacy show improved perseverance (Lent, Brown & Larkin, 1986), metacognition (Schunk, 1999), strategy use and achievement in the classroom (Schunk, 1981, 1982). These are reason enough for teachers to be interested in increasing the self-efficacy of their students. These influences: feedback, enactive experience, modeling, and physiological and affective information, have been shown to affect the development of self-efficacy in and out of the classroom. However, influences and outcomes of self-efficacy have been confirmed primarily through quantitative research (Pajares, 1995; Parjares & Miller, 1994; 1995; Schunk, 1981, 1989, 1995; Schunk & Gunn, 1986; Schunk & Hanson, 1989; Schunk & Rice, 1992; Schunk & Swartz, 1993; Sewell & St. George, 2000). In order to understand their influence on and the development of self-efficacy from the perspective of the student, it was necessary to observe student in the natural classroom environment.

It was the purpose of this multi-case study to gain insight into self-efficacy development which is domain specific (Bandura, 2002). Therefore, the development of mathematics self-efficacy will depend heavily on students’ specific experiences within the mathematics classroom. Elements in the setting itself can vary greatly, changing the factors that influence self-efficacy. Class composition, teacher, and mathematics program affect the types of feedback, modeling, and enactive attainment a student may experience in the classroom (Leiter, 1983; Stipek, Givvin, Salmon, MacGyvers, Valanne, 1998). This research studied the interaction of some of these factors.

In this chapter, the design, instruments, and procedures for collecting and analyzing data for this research are described in detail. Sample, setting, and methods are illustrated along with study limitations.
Personal Biography

Researchers need to fully examine personal connections to their research. This is especially true for qualitative researchers who needed to consider possible biases toward their work and also uncover hidden predispositions, prejudgments, and prejudices in all aspects of research (Lincoln & Guba, 1985). Lincoln and Guba suggested that it was imperative the researcher examine her own values as they related to the context of the research, going so far as to propose that researchers who refused to understand the impact their own values made on their interpretations, brought the credibility of their research into question. It was in the spirit of self-examination and disclosure that this biography was written.

My career as an educator has spanned 35 years and 3 states. Through this time I have been active in many different capacities from textbook editing to enrichment coordination and classroom teaching. Most relevant to my work as a researcher were my 15 years of classroom experience as an elementary school teacher. These years helped me to be open to the possibilities that exist in the lives of the students in all classrooms. Through these years of practice I became comfortable in the classroom environment and have gained literally thousands of hours of experience observing, questioning, and speaking with elementary school students. During these years in the classroom, I have learned to build a classroom community based on meeting students’ needs on an individual basis. In order to accomplish this goal I have had to develop the ability to observe my students as they were learning in a busy classroom. These skills and attitudes established a high comfort level in the context of the research environment. These skills were needed within the educational context and were positive aspects of my personal history in terms of this research study.
However, as a researcher, it was necessary to guard against predispositions and expectations in the research setting. Entering the classrooms of other teachers, it is always necessary for a teacher to leave personal judgment outside. My role was to observe and record what was happening, not to judge the teacher, students, or the environment. This was true, not only in terms of the research topic, but also in terms of my own values of teaching. As a researcher, it was necessary to leave my own personal teaching life at the door of each classroom as I entered. I found this disposition strengthened over time.

In preparation for this work as a qualitative researcher, I had undertaken a program of study in the Doctor of Education in Instructional Leadership Program at Western Connecticut State University. This research project completed my course of study. During my program, I extended my professional knowledge and understanding of the important questions currently facing our schools. I also completed small scale projects, research practice, and readings in both quantitative and qualitative work in order to prepare for this undertaking. These experiences raised my intellectual curiosity about the topic of self-efficacy in the classroom and prepared me academically to research the questions included in this study.

Statement of Ethics and Confidentiality

Permission to participate in this research was sought from the district’s superintendent, each school's principal, participating teachers, and all parents of students. To assure confidentiality, each participant was assigned a confidential identification number. All data were stored in a locked filing cabinet in the researcher’s home or office and was maintained there, accessible only to other researchers for whom the data will prove useful in further comparative analyses and who are enrolled in Western Connecticut State University’s Doctor of Education in Instructional Leadership Program.
Sample

Setting

The host district was a medium-sized, upper socioeconomic suburban district, located in northeastern United States. The local population was approximately 23,643, at the last census. The school system includes 5,535 students in a single high school, two middle schools, and six elementary schools. The majority of eligible students in the school district, 89.9%, attend district public schools. Free and reduced lunch programs were used by 0.7% of students compared to the state average of 22.2%. Two and eight tenths per cent of the students came from non-English speaking homes, compared to the state average of 12%. Pre-school attendance was 81% compared to the state average of 75%. Race and ethnicity data reveals the district to be less diverse than the average community in the same state. The district office reports 0.1% American Indian students, 3.2% Asian students, 0.6% Black students, 2.7 Hispanic students, and 93.4% White students. The total minority students reported is 6.6%. The district offices reported mastery tests at the elementary and high school level, as well as, Scholastic Aptitude Tests (SAT) that were above the state average and within the average of their reference group. Looking at mathematics scores, as they were the focus of this project, 82% of fourth graders scored at goal compared to 84% of the reference group and 61% of state fourth graders. High school mastery test results showed tenth graders scored at goal 75% of the time, while the state averages 44%. Overall SAT scores showed district students who took the test averaged 582 compared to their reference group who averaged 585, and state peers who averaged 503. Statistical information for the district also revealed that teachers were well educated and experienced. The average teacher had more than 13 years experience in public schools. More than 83% of teachers had at least a Master’s degree in education.
Sample

Sample selection: schools. Two district elementary schools were chosen for this study. Both schools’ histories included being closed and re-opened to new redistricted populations of students due to an increase in elementary school population in the 1990’s. Since reopening, School B had one change in principal leadership. Both schools had similar socioeconomic makeups that were in keeping with that of the town in general. The percentage of students who received free and reduced lunch at school A was 1.4 compared to school B with 0.9. Diversity in both schools was similar to the district profile. School B had a larger percent of students qualifying for special education with 15.5% of students; as compared to 11.4% at School B. Minority populations at the two schools were somewhat dissimilar. School B with a total of 7.7% had 5.6% Asian students while School A had 3.4% minority students, 2.1% of whom were Asian. School B was located in the southwestern corner of the town and had re-opened 11 years ago. With a population of 446 students School A was considered an average size for the district elementary schools. School B, reopened in 2002 presently had a population of 446 students and was located in the north central area of town.

When School B reopened in 1995, it adopted the district-wide curriculum for all major subjects, including mathematics. Teachers in grades K-2 created mathematics materials based on the scope and sequence of a published standards-based mathematics program. In grades 3-5, teachers used a transmission model mathematics basal program. Lessons prescribed direct teaching of traditional algorithms. When School A reopened in 2002, the decision was made to adopt the full district curricular plan for elementary schools with the exception of mathematics. In the area of mathematics, a student-constructed thinking, standards-based program was
adopted. Students in this year’s fifth grade, whose attendance at School B has been continuous, will have used this program for their entire elementary school career.

Similarities in demographics between School A and B provided stability in the sample. However, choice of schools with the different mathematics programs provided this study with a richness and diversity in the sample. Two diverse mathematics programs provided greater opportunities for observing students as they were affected by their mathematics environment.

Sample selection: teachers. Two fifth grade classrooms within each building were selected for observation in a purposive sample. Four teachers, two male and two female, were included in the study. Initial contact was made through the respective building principals at meetings in the early fall of the study. During this meeting principals were informed of the research design and procedures. Authorization to contact teachers and support for conducting research in their school was gained. Teachers at school A were contacted for an informational meeting through e-mail. Three teachers attended the meeting, where the responsibilities and rights of participating teachers were reviewed. Two of three teachers expressed a high degree of interest in participation and one expressed interest but was unable to participate due to obligations in her classroom. Both teachers signed consent forms (see Appendix C). Teachers at School A were also contacted by e-mail. Of four fifth grade teachers at School A, two teachers were first-year teachers, making selection of teachers a given. Teachers were told that other schools could be selected for the study if they were not comfortable with participation. At the information meeting teachers were carefully informed of all rights and responsibilities involved in participation in the research study. Both teachers agreed to participate in the study and signed consent forms.
Sample selection: students. A total of four classrooms were involved in the study. Gender in the four classrooms was closely matched with 36 males and 28 females. The total number of students in each classroom included in the study is shown in Table 1. A focus group of students from each school was also selected for closer study. Students were chosen based on teacher response to a Mathematics Evaluation Checklist which reflected student interest in various classroom mathematics performance indicators (see Appendix D). Two medium to high and two medium to low students were chosen from each classroom. At School A, one extra student was added because he offered the opportunity to study the perspective of a gifted student and add richness to the sample.
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<th>Site</th>
<th>Classroom 1</th>
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<td>Site Total</td>
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Students in all four classrooms were asked to have parents, or guardians, sign and return consent forms as part of regular homework procedures (see Appendix E). Reminders were posted on classroom white boards to encourage students to remember to return forms; however, teachers were carefully informed not to pressure student participation. Return rates were significantly higher in School B. Student forms were collected from teachers after two weeks.

Selection of Focus Groups. In order to study selected students in closer proximity, a focus group was chosen from each school. To facilitate the selection of students, each teacher was supplied with a Mathematics Evaluation Checklist. Teachers were asked to rate students in their class who had returned consent forms on a scale of 1-5, with 1 being a low demonstration of each item on the scale and 5 being a high demonstration of the item. This checklist was designed to rate student performance on a number of activities that are common to standards-based mathematics classrooms (Goldsmith & Mark, 1999). Checklists were returned to the researcher in sealed envelopes via district school mail. Checklists were tallied in the following manner. A total was determined for each student by adding the points given in every category. Ranges of high, high to medium, medium, medium to low, and low were determined within each class. This was done on the class level because no training had taken place for all teachers regarding rating student performance; therefore the only level of consistency was on the class level. Student names were placed on cards for stratified random sampling. First, all high and high to medium students were placed in a pile randomly drawn and listed. Then, all medium to low and low students were placed in a pile and randomly drawn and listed. This procedure was repeated for each of the four classrooms. Focus group consent forms were sent home to the first student in each class on each list (see Appendix F). In some cases, students did not return forms, parents refused to give consent, or students were on vacation. In these instances the next student on the
list was given a consent form. In other cases teachers suggested that selected students would not be comfortable in an interview situation. Again, the next name on the list was chosen. Finally, one student in school A was added to the focus group purposely. This student was a highly gifted mathematics student who demonstrated interesting qualities during early observations. The decision was made to include this student in the focus group in order to gain his perspective on the classroom environment and self-efficacy.

Design

A multi-case study research design with carefully constructed credibility of information through triangulation of data collection methods was established as shown in Figure 2 and again in Table 2 (Lincoln & Guba, 1985). Use of multiple, or collective, cases enabled the researcher to view the environment studied from a wider perspective and draw broader generalizations (Stakes, 2000). In this case, four classrooms presented the chance to study different mathematics classroom environments in which students experienced the development of self-efficacy. In addition to the normal differences inherent in those classrooms, the teachers in two sites use different mathematics programs which may, or may not, affect how students in their classrooms experienced the development of self-efficacy. Using a multi-case study approach, with each classroom defined as a case, allowed this researcher to observe these students in their classroom settings over a period of seven months for the purpose of better understanding their experiences.
Observations:
- Students in classroom setting
- Students in problem solving activity

Interviews:
- Student interview/follow-up interviews
- Teacher interviews

Document Analysis:
- Student self-efficacy survey
- Work sample
- Program analysis

Triangulation of Methods

Figure 2
Table 2

*Data Methods, Sources, Descriptions and Purposes for Data Collection*

<table>
<thead>
<tr>
<th>Methods</th>
<th>Sources</th>
<th>Description</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation: Classroom</td>
<td>Students</td>
<td>10-30 minute sessions</td>
<td>Self-efficacy development in classroom setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Understand student experience</td>
</tr>
<tr>
<td>Whole class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Students</td>
<td>4-30 minute sessions</td>
<td>Persistence or strategy use</td>
</tr>
<tr>
<td>Problem solving activity</td>
<td></td>
<td></td>
<td>Self-efficacy development and use</td>
</tr>
<tr>
<td>Whole class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus groups</td>
<td></td>
<td>2-30 minute sessions</td>
<td></td>
</tr>
<tr>
<td>n=2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview: Focus Group</td>
<td>Students</td>
<td>Initial and follow-up</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2- 30 minute session</td>
<td>Explore student perspective and confirm observation</td>
</tr>
</tbody>
</table>
Table 2, continued

Data Methods, Sources, Descriptions and Purposes for Data Collection

<table>
<thead>
<tr>
<th>Method</th>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview: Teacher</td>
<td>Teachers</td>
<td>Understand teacher perspective</td>
</tr>
<tr>
<td>n=4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Document Review:</td>
<td>Students</td>
<td>Strategy uses and persistence; match instruction with program</td>
</tr>
<tr>
<td>Work Sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Mathematics</td>
<td>Students</td>
<td>Strategy uses and persistence</td>
</tr>
<tr>
<td>Self-efficacy Survey</td>
<td></td>
<td>Measure of mathematical self-efficacy</td>
</tr>
<tr>
<td>n=67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Document Review:</td>
<td>Mathematics</td>
<td>Confirm sources of instruction</td>
</tr>
<tr>
<td>Mathematics programs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=2</td>
<td></td>
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</tr>
</tbody>
</table>
Observations of mathematics classrooms served as the cornerstone of this qualitative research design. Data gained from these observations were designed to yield direct information about student experiences in the classroom environment. This information was validated through multiple methods and sources. Initial and follow-up student interviews, with questions based on previous observations and a review of the literature, confirmed and furthered observational data. Document reviews of student mathematics daily work samples were designed and reviewed to confirm that work observed in the classroom was typical for each case (see Appendix G). Mathematics program instructional materials were reviewed in order to confirm influences on the mathematics environment that were based in the instructional materials, and thus could be considered more consistent from one setting to another (see Appendix H). Teacher interviews further confirmed teacher awareness and understanding of self-efficacy, as well as, classroom environment as observed in the classroom.

Research questions Research Questions

While qualitative in nature, and therefore always open to new paths of thinking, this research study was guided by several overarching questions chosen to provide focus and clarity to the research. These questions were based both on self-efficacy theory and on the observations of classroom life by this, and other researchers (Bandura, 2002; Schunk & Rice, 1992). These observations, in regard to the power of self-efficacious behaviors and perseverance to aid students in their everyday classroom tasks, led this researcher to explore the following questions through this research study:

1. How do students experience the development of mathematical self-efficacy in the classroom?
2. How do students experience perseverance in problem-solving activities?

3. How do teachers view their role in the classroom in terms of developing the mathematics self-efficacy of their students?

Embedded in the design of this study is a rich interaction between the research questions, which drive the research, and the methods, sources and instruments, used for collecting data. Table 3 specifically addresses these interactions. Student interactions within their environments and their self-efficacy are at the core of the research and serve as the basis for questions one and two. Therefore, it logically follows that students are the source for five of seven separate pieces of data collection. Teachers are a part of the classroom environment and serve as a source of confirmation for environmental factors. Their instructional materials and interviews serve as the remaining two sources completing the circle between design and research questions. In the following section each data source will be explained in detail.
### Table 3

**Interaction Between Methods, Data Sources, and Research Questions**

<table>
<thead>
<tr>
<th>Method</th>
<th>Source</th>
<th>Question #1</th>
<th>Question #2</th>
<th>Question #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation: Classroom</td>
<td>Student</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Problem Solving Activity</td>
<td>Student</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Interview: Student</td>
<td>Student</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Survey: Self-efficacy</td>
<td>Student</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Interview: Teacher</td>
<td>Teacher</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Student Work Sample</td>
<td>Student</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Program Review:</td>
<td>Mathematics</td>
<td>X</td>
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<td></td>
</tr>
<tr>
<td>Mathematics Program Material</td>
<td>Program</td>
<td></td>
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</tbody>
</table>

### Instrumentation

**Classroom Observations**

Central to case study research is observing the lives of participants as they are being lived as authentically as possible (Stake, 1998). That was the goal of the observations of this research. These observations were conducted for two reasons: a) to understand the influences of self-efficacy as they evolve in the authentic mathematics classroom setting from the perspective of students and b) to understand the affect of the classroom mathematics environment on the development of student self-efficacy. To achieve these goals 40 classroom observations served as the cornerstone to this study. Observations lasting 30 minutes, with the researcher acting as
both a postmodern observer and an unobtrusive observer (Lichtman, 2006) were conducted over a period of seven months from December through June. Classroom conversations were scripted by the researcher and later transcribed along with fieldnotes in the manner described by Bogdan & Biklen (1982).

Observations focused on mathematics activities, student behaviors, and student-teacher interactions in the mathematics environment. In order to focus observation information the influences leading to self-efficacy, feedback; modeling; enactive experience; and psychological and affective experience (Bandura, 2002), were the primary focus for observations of students. During observations the researcher was initially positioned in the back of the room. At times when the lesson was not focused on whole group activities with direct teaching, the researcher moved amongst the students to observe partner conversations or to engage in questioning with students.

Interviews

Student Interviews. Semi-structured interviews with students in focus groups were conducted in April and June. Two focus groups were used. Site A had a group of five students, Site B had a group of four students. Initial interviews were conducted in order to gain further understanding of student perceptions of the classroom environment and its affect on the development of their self-efficacy. Preliminary lists of questions were developed following a review of relevant literature and then revised following observations and preliminary review of fieldnotes and scripted observations. The final list of questions related to: (a) classroom practices and student use of strategic thinking, (b) feedback received from teachers and student partners, (c) use of modeling, and (d) practices observed in the classroom that were of interest to the researcher (see Appendix I). For example, the researcher asked students asked to explain their
best source for information in mathematics class when learning new ideas. These students were interviewed as a group to accommodate student class schedules. All student interviews lasted 30-45 minutes and were both scripted and audio taped for accuracy. Scripts were transcribed and checked against audio tapes for gaps in wording. Follow-up interviews were conducted at the end of data collection. The questions for follow-up interviews were based on a review of initial analysis of data from classroom observations and student self-efficacy surveys (see Appendix J). For example, after observing effective student feedback and modeling in small groups students were asked to explain how working in groups helped them to be successful in a mathematics class.

Teacher Interviews. Each of the four teachers involved in the study were interviewed in May after 9 of 10 observations had been completed. Teachers were interviewed for 30-40 minutes during a free period or after the school day. Conversations were scripted and audio taped for accuracy. Interviews consisted of six questions (see Appendix K) which were designed to gather three types of information: (a) teacher understanding of his or her role in developing student self-efficacy, (b) teacher understanding of his or her role in creating classroom environment, and (c) teacher understanding of students’ ability to persist in the face of challenge in the classroom. At the conclusion of each interview scripts were typed by the researcher and compared to audio tapes to be certain all transcriptions were complete. Final tapes were coded and analyzed. See the procedures section of this chapter for further information regarding coding of interviews.

Problem Solving Activity: Observations

Problem Solving Activity: Focus Group. In prior research students with increased self-efficacy demonstrate improved use of strategies and greater persistence (Schunk, 1981, 1999). In
order to understand the outcome of self-efficacy in the same students being observed in the classroom and in the focus group interviews an open ended mathematics problem solving activity was presented to students in the focus groups and whole class settings. To permit the researcher to view student work closely from beginning to end, as well as benefit from exposure to large groups of student work, two alternative work situations were observed. Students in the focus groups experienced the problem solving activity first. It was later presented to the whole classes. This offered the researcher the opportunity to observe small groups of students in close proximity and view larger groups of students as well. The purpose of this activity was to: (a) observe strategies students used in problem solving situations, (b) observe student interactions in small group work, c) observe evidence of persistence in mathematics work, and (d) observe student performance in mathematics work. After reviewing many problem solving activities for fifth grade students from instructional texts and the National Council of Teachers of Mathematics (Gawronski, 2005; Stenmark & Bush, 2005), the researcher chose a problem solving activity based on the Puddle Questions; Assessing Mathematical Thinking (Westley, 1994). The problem was adapted to suit the needs of this research. Students were presented with the “TV Tally Estimation” Problem during a typical mathematics class period and given 30 minutes to complete their work (see Appendix A). Students expressed having seen “problems like this before.” Each student received a work packet consisting of a cover sheet detailing the problem, a blank sheet for work space, and a third page containing mathematics puzzles for enrichment work if students finished early. A written protocol including, directions, review of materials, and permitted procedures such as partner discussions, was read to each group by the researcher. The problem directed students to estimate the amount of television they had watched.
in their lifetime. Participants were directed to show all of their work and explain their strategies and thinking in detail.

**Whole Classroom Problem Solving Activity.** Similar to the problem solving activity used with the focus group, the goal of the whole group problem solving activity was to view the outcomes of self-efficacy in the classroom setting with the same student participants as were observed in the daily classroom environment. The same problem solving activity was administered in each of the studies classrooms as was administered to the focus groups. Packets were distributed to each student, the same protocol as read to the focus groups, was read to each of the four classes by the researcher (see Appendix L). Students were given 30 minutes to complete the activity. If students finished early, they were allowed to try a set of mathematics puzzles, or to choose to follow established routines within the classroom for finished work times. Problem solving activities were administered during the regular mathematics class period in May. Students were allowed to work with a partner or table groups to discuss their thinking, but were directed to show the work for their own problem solving.

**Student Self-efficacy Survey**

Students were asked to complete a survey designed to assist the researcher in understanding participant’s perspectives regarding conditions that contribute to the development of self-efficacy in mathematics. The Student Self-Efficacy Survey was first piloted the previous spring with 114 students in grades 3 through 5 from the same school district as the study was conducted. No students in the pilot were in the research study. As a result of the pilot, wording was changed on two questions. After classroom observations progressed, two questions were added for the purpose of understanding student perceptions of classroom environments, feedback, and strategy use (See Appendix B). Changes included adding questions relating to the
classroom environment and self-efficacy such as: \textit{It is important for the teacher to tell me how I am doing in class every day}. Items 1 through 12 were written on a Likert scale of 1 through 4, ranging from strongly disagree to strongly agree. Items 13 through 17 were given specific multiple choice answers in order to gain more specific information regarding the classroom environment. The survey was administered by the researcher during regular mathematics class periods.

\textit{Document reviews}

\textit{Problem solving activity student work.} The researcher collected student work produced during the completion of problem solving activities for scoring and analysis. Students recorded mathematical computations and explanations on plain white paper within a half-hour time limit. Each work packet was scored according to a previously designed rubric. The researcher and an educator familiar with fifth grade work conducted an audit of the rubric indicators and scoring procedures before scoring began (see Appendix M). This procedure resulted in rewording of two indicators and improved scoring accuracy (73\% agreement improved to 88\% agreement).

Review of student work centered on five categories: computation, strategy use, reasoning, communication, and thoroughness (See Appendix 1). The researcher scored each work sample holistically on a scale of 1-4 (1=Low, 4=High) in each category.

Following the holistic scoring each work sample underwent a second review for strategy use and evidence of persistence. Students’ revealed strategy use through their approach to the problem solution. The researcher noted multiple solutions, originality, complexity, and depth of strategies used. Persistence codes included erasures, rethinking, change in strategy, and multiple approaches. Student problem solving work samples were coded for later analysis.
Student work samples. Student work samples were collected by each participating teacher for the purpose of verifying the types of work observed by the researcher during classroom visits and examining student work for strategy use and perseverance. Teachers were directed at the initial teacher meetings to collect one work sample of regular class work from each week for six weeks. They were instructed to collect work in the form of the traditional math log that each teacher used in their classroom with students. Teachers were offered blank logs from the researcher if they desired.

Work samples were reviewed for answers to the following questions: (a) Does the work reflect strategic thinking? (b) Does the work reflect chances for independent thinking? (c) Does the work reflect classroom practice observed by the researcher? (d) Does the work reflect rethinking, or other evidence of perseverance, and (e) Does the work reflect mathematical accuracy? The researcher reviewed work samples holistically and noted examples to answers to each question within each class.

Mathematics Program Materials. Since the National Council of Teachers of Mathematics published the first set of mathematics standards in 1989 (NCTM) the landscape of mathematics education in American classrooms has been slowly shifting (Schoenfeld, 2004). Mathematics instructional materials available for use in elementary classrooms reflected the shift from a pre-standards, transmission model of teaching and learning to more student-constructed model of learning a and teaching (Clements & Battista, 2002). The schools chosen for this study reflected this shift in pedagogy. Teachers in classrooms at School A were given a traditional, transmission model program to use by their administration. Teachers in classrooms at School B were given a standards-based, student constructed thinking model program to use by their administration. A review of teacher mathematics instructional materials was undertaken in order to better
understand the influence of the program materials on the classroom practices of the teachers as observed. During the period of observation, fractions was one of the common instructional units observed in total. Therefore, the fraction unit from both programs was selected for review. Documents were reviewed and coded for three major themes: (a) student opportunities for strategic thinking, explanation, and metacognition (b) structures supporting group work, modeling, problem solving, and (c) teacher support for developing feedback, enactive experiences, and modeling. Program materials were provided by one teacher from each school for review. Each program was holistically reviewed with the three major themes in mind.

Procedures

Preparation for Research

Mini-sabbatical. As the design for this research project began to unfold it became clear that to achieve the goals of the study it would be necessary to observe students in the classroom setting. For the researcher who was an active working elementary educator this posed a dilemma. The design plan required the researcher to be released from classroom duties for 40 observations (10 per classroom), 8 interviews, 4 whole group problem solving activities, and 2 focus group problem solving activities. In order to make that time available, the researcher applied for a grant known as a mini-sabbatical, offered to teachers having at least seven years of service within the district. In March of the year before the study commenced, the application was made to the assistant superintendent of schools and the Professional Development Committee. At their request, follow-up presentations were made to the Curriculum sub-committee of the Board of Education and the full Board of Education in April. The sub-committee offered its support and interest in furthering the study of self-efficacy in the classroom setting. After raising questions regarding use of student time and confidentiality, the full Board of Education approved the mini-
sabbatical by a unanimous vote. The mini-sabbatical provided the researcher with substitute coverage for 20 half, or 10 full days of school. All days taken under this grant had to be used within the next school calendar year and were charged to a specific district account. Periodic accountability to the school and district secretary in charge of this account was required to report days used and days remaining. The final reporting to the district, as agreed in the mini-sabbatical proposal, was in the form of a website presentation including the findings of this study made available to teachers of the district.

*Teacher contact.* Initial formal contact was made via e-mail with the principal of School A and B in late fall of the research study year. Face-to-face meetings confirmed the details, procedures, and the principals’ willingness to have their school included in the study. Next, the potential teachers were contacted. At School A, all three fifth grade teachers were invited to attend an informational meeting. At that meeting, it was determined that one of the three teachers had extraordinary responsibilities during the upcoming school year but, the remaining two teachers were highly interested in participating in the study. At School B, two of four fifth grade teachers were contacted for an informational meeting due to the fact that the remaining two teachers were first year teachers. Both informational meetings covered the same written agenda. Teacher and student consent forms were explained and the processes for obtaining student consent were covered. Observation procedures were reviewed. Teachers’ schedules were obtained for scheduling purposes and teachers noted dates that were inconvenient for observations. Procedures for gathering work samples were reviewed and teachers were given the option of obtaining blank math logs from the researcher. The process for selection of student focus groups was reviewed with teachers and Mathematics Assessment Checklists were provided for each teacher.
**Student and Teacher Consent.** Every student in each of the four participating classrooms was offered a consent form for participation (see Appendix G). Students were given seven days to return the form as part of their regular home/school communication procedures. Student consents were returned to the classroom teachers and collected by the researcher before observations began. Teachers each signed consent forms (see Appendix E) after the initial information meeting. Students from each school chosen to participate in the focus group were given additional consent forms (see Appendix F) containing permission to audio tape interviews and observations. These forms were also sent home through teachers in April. Refer to the sample section for detailed explanation of student focus group selection.

**Observations**

Collection of data through observations of the mathematical lives of students within the typical classroom setting served as the cornerstone of this research. Initial observations were arranged with each teacher via e-mail. Each month the researcher forwarded a schedule of observations to the teachers for approval based on teachers’ school schedules. Teachers at both schools had mathematics at set times that were arranged through a school schedule. School A held mathematics class from 10:00 to 11:00 in the morning following the special for the day (music, art, etc.). School B held mathematics class from 2:00 to 3:00 in the afternoon prior to snack. When at School A, the researcher would visit classroom 1 from 10:00 to 10:30 and classroom 2 from 10:30 to 11:00 the first week. The following week the visitation schedule would reverse to allow the researcher to observe different routines and procedures. Ten observations, of 30 minutes each in each, of the four classrooms, were conducted for a total of 40 observations. During these observations the goal of the observer was to gain an understanding of the environment in which the learners spent their daily mathematical lives, to document the daily
contact students had with those factors that researchers have previously related to self-efficacy, and to observe students’ development and use of perseverance in problem solving situations.

Initial observations included making maps of the classroom to identify students without consent forms and for other note taking purposes. School A teachers had a planning period before mathematics class, therefore the classroom was empty. As an observer the researcher would arrive at the classroom early to check-in with the teacher and observe any changes to the classroom. This researcher highly respected teacher work time and therefore waited in the hallway while teachers worked for the remainder of their planning period. During classroom observations, the researcher began by standing at the back or side of the classroom while the teacher had the focus of the class. With teacher permission, if the class was working in groups or on individual work, the role of the observer changed and became more interactive. During the observation, lessons were scripted, omitting only responses by students without parental consent. Interactions with students focused on what they were doing, how they felt about their work, and clarifications of questions that had arisen in early analysis of data. For example, early on the question of how student feedback compared to adult feedback arose. When students in class were asked to help each other correct homework, the researcher took the opportunity to question students on this practice. Upon completion of the observation fieldnotes and scripted lessons, all handwritten notes were typed and reviewed for later coding. Early patterns and themes that emerged across classroom observations were noted. The use of a professional transcription service was considered, however, the actual typing of fieldnotes, although arduous provided a review of events and solidified impressions that proved meaningful (Lichtman, 2004). Eventually, the researcher decided to continue personal transcription of all data.
It was necessary to break the flow of observations during the month of February and March for February vacation and administration of the state mastery test. All third through eighth graders took mastery tests for two weeks in March. Since test preparations began after February vacation, observations would not have reflected normal classroom mathematics work. In early April observations resumed. Teachers were open and accommodating with their schedules. As observations ended in late May and early June a small celebration was planned for each classroom.

**Problem Solving Activity**

*Focus Group Problem Solving Observation.* After approximately half of the classroom observations were completed, students in the focus groups were asked to participate in a problem solving activity. Teachers were asked to have students meet the researcher during the students’ lunch recess. This was done to avoid using extra mini-sabbatical time. Due to scheduling conflicts between schools, care had to be taken to schedule School A students on a date when there was an observation planned for School B. Students at School B were able to meet the researcher at a mutual lunch break. Students reported enjoying staying indoors at lunch. After welcoming each student, the researcher presented each student with a work packet. Work packets consisted of a problem page which detailed the problem, procedure, and details, a clean sheet of paper for work, and a mathematics puzzle sheet. The researcher read a protocol to students, explaining directions, procedures, and expectations (see Appendix I). Students were then invited to ask questions. The most common questions were procedural questions such as; do we write our whole name? Students were given 30 minutes to complete the problem. If they finished early they were allowed to stop working or work on the mathematics puzzles. Partner work was encouraged, but not required. Not all groups of students chose to work together.
Student conversations and researcher impressions were scripted during the problem solving observation. Audio taped sessions were used for later verification. As students worked quietly the researcher used a standard set of problem solving observation questions, developed by Charles, Lester, and O’Daffer (1987) to encourage students to talk about their work. If students were discussing their work with other students the researcher remained in the observer role and scripted discussions. Students worked at their own rate and remained for the entire lunch recess. All students who finished early chose to do the mathematics puzzles rather than go out to recess or read a book. No student expressed being overwhelmed by the task.

Whole Class Problem Solving. Within a month following the focus group problem solving activities, each classroom was observed completing the TV Tally Estimation problem. Students from the focus group and students without parental consent forms were given an alternate problem and mathematics puzzle to work on. During a regularly scheduled observation, the researcher distributed a packet of problem solving material to each student. Students were instructed to write their student number and class code on the page instead of their name. Then the protocol was read to the students as the students read the directions to themselves. As with the focus groups, students were allowed to ask questions. Students were given 30 minutes to complete their work. When the class period was finished, the researcher collected the packets and moved on to the second class, or left the building.

While students estimated and calculated the amount of time they had watched television in their lives, the observer moved around the classroom scripting conversations taking place between students. When the classroom grew quiet the researcher asked questions such as: (a) Can you tell me what you are doing? and (b) What is the strategy you are using? Observations
focused on student demonstrations of perseverance through behaviors such as rethinking, erasing, and use of multiple strategies.

**Interviews**

Interviews serve as a tool for exploring the shared meanings between members of the same community (Rubin & Rubin, 1995). Therefore, interviews were an important component of triangulated data in this multi-case study. Both student and teacher interviews were conducted.

*Student interviews.* Student interviews were conducted in small focus groups within the school setting. Group interviews were selected to reduce scheduling demands on students, researcher, and teachers. Initial interviews were conducted following the completion of half of the classroom observations. Arrangements for interviews were made with classroom teachers via e-mail and confirmation e-mails were sent one day prior to each session. Interviews were conducted in classrooms during the students’ lunch breaks. Following procedures outlined by Litchman (2006), students were welcomed and made comfortable with the interview process. Audio tape equipment was used to record the conversation between the researcher and students. The interview was also scripted by hand. The interviewer began by posing a warm-up question: what is your favorite subject in school? After the initial question, a routine was established. Each student answered in turn and then the question was discussed by the entire group. Students answered with apparent openness and independence, measured by the confidence and tone of their responses. Students were friendly and appeared interested in answering questions with serious, thoughtful answers. They often asked to add to their answers after thinking about their responses. Interviews lasted approximately 30-45 minutes. Following completion of the interview, students were dismissed to return to their classrooms.
Audio tapes and handwritten scripts were transcribed following each interview. Scripts were typed first. Then the audio taped was compared to the script line by line for missing wording. Interviews were then reviewed for initial impressions and basic coding categorizations. After the completion of the remaining observations and problem solving activity, teachers were again contacted to schedule a follow-up student interviews late in May. Procedures from the initial interview were repeated. Students again met with the researcher for 45 minutes and appeared friendly and comfortable were with the interviewer. Once again audio tape and scripted interview notes provided records of the interview. Transcription was completed within 48 hours following the interview and checked for accuracy by the researcher.

Teacher interviews. Teacher interviews were conducted on an individual basis in late May and June. Teachers were contacted via e-mail and asked to provide the researcher with convenient opportunities for meeting. School A teachers met with the researcher on days that corresponded with a classroom observation in the teacher preparation period prior to the observation. School B teachers met with the researcher after school hours. Interviews varied between 20 and 30 minutes in duration. The format for interviews suggested by Lichtman (2006) was followed in teacher interviews by beginning with a warm-up question (How long have you taught fifth grade?) and moving on to more significant questions dealing with classroom environment and student self-efficacy. Teachers appeared open and interested in talking about their students and their classrooms. All welcomed the researcher warmly. Digital audio tape and written scripting was used for recording interview conversations. Digital recording which is compatible with Dragon Naturally Speaking software (Nuance, 2006) was used for recording and transcription. This software enabled the researcher to transcribe recordings made on a digital recorder with the use of a computer. However, this digital recording and transcription, was
compatible with single voice recording, and therefore applicable to the teacher interview. After the interview, recordings were transferred into the computer and transcribed through software. Written scripts were used to confirm transcriptions and complete missing information. Transcribed materials were then reviewed for initial impressions to determine if any clarification was necessary.

*Student Mathematics Self-efficacy Survey*

Teachers were contacted via e-mail to set-up the administration of the Self-efficacy Survey. All classes were administered the survey within the same week during an observation period. All school A students participated in the survey on the same day and all School B students participated on the same day. At school A, the researcher administered the survey before the regular mathematics observation period in classroom 1. In classroom 2, the mathematics class was underway when the researcher entered. Therefore, the arrangement with the classroom teacher was to administer the survey in the last 15 minutes of class.

Surveys were distributed to students and who were directed to write their specific class number on their papers. The researcher read the protocol to the students and answered any student questions. Students were then told to answer every item on the survey by finding the answer that most closely matched their own. Questions were read aloud for students while the researcher moved throughout the room to be sure that students were on the correct question and ready to move on. Students took approximately 10 minutes to complete the survey. Surveys were collected for analysis. The process was repeated at School B in classroom 3 and 4. Information from surveys was analyzed for use in follow-up interviews. Further information regarding analysis can be found in the analysis section of this chapter.
**Work Sample Review**

It was a common practice for students in these grade five classrooms to record their mathematical thinking in logs, or journals, referred to as math logs. These logs were a vehicle for recording mathematical thinking and problem solving strategies. At the information meeting teachers were asked to collect six samples of student work in the form of log entries, one from each of six different weeks of school. Despite the review of this item at the informational meeting, within the course of the school year, two classroom teachers disclosed that their math logs were used for recording procedural items only (such as the steps for a new strategy). It was determined that this would not meet the goal of the work sample and teachers were then asked via e-mail to save samples of student work in any form from one day a week for six weeks. Teachers were reminded at three points during the seven months to be saving work. Student work samples were sent to the researcher in sealed envelopes via district mail or handed to the researcher before observations.

**Teacher Instructional Materials**

Teacher instructional materials in the form of teacher’s manuals for their respective mathematics programs were collected from teachers for document review during the last week of the school year. Teachers were contacted through e-mail to request instructional materials earlier in June. Teachers delivered materials to the researcher and requested materials would be returned before the beginning of the upcoming school year.

**Analysis**

**Reason for Multi-site Case Study**

The purpose of this research was to attempt to study students in the classroom as they encountered the typical events that influenced their self-efficacy. A case study as a qualitative
paradigm uses multiple methods and sources of data to create a rich understanding of the context being examined (Bogdan & Biklen, 1982; Creswell, 1998). Multiple cases are used to add variability or depth to the study. In this research project, multiple cases were studied in the form of two sites in order to bring richness to the study in the form of mathematical student experiences. In instrumental case studies, such as this one, a particular case, or cases, are chosen in order that such examination might lead to increased insight into a particular phenomenon (Stakes, 1998). In this particular study the researcher examined student experiences of mathematical self-efficacy in the classroom, investigating how students experienced perseverance in problem solving, and explored how teachers perceived their role in the development of self-efficacy. In that self-efficacy is a sense of one’s own ability to complete a task successfully (Bandura, 2002), it is a personal experience. Although generalities can be drawn about the way in which it is developed, its development can differ from task to task and person to person. As stated earlier, a great deal of quantitative research has been conducted in an effort to better understand the forces that form self-efficacy, however a search of EBSCO found no published qualitative research exploring this very personal human trait for elementary school aged students in their classroom environments.

According to Bogdan & Biklen (1982), case studies are designed to examine the context of one’s setting with the purpose of understanding that setting, in this case, the lives of students in classrooms where mathematical self-efficacy is changing due to the classroom instructional environment. It is this search for the essence of everyday occurrences of the mathematical classroom experience of students that was the focus of this research. The answer to the question of how self-efficacy is experienced lies in understanding the everyday classroom experience more clearly. A complete study of self-efficacy needed to examine student experiences in terms
of prior knowledge, the kind of task modeled, feedback from teachers and peers, as well as individuals’ psychological states. This was accomplished through the careful compilation of information gathered through case study methods including: observation, interview, survey, and documents (Stakes, 1998).

Data Analysis

Coding of Observations, Interviews, and Problem Solving Observations. Fieldnotes and transcriptions from classroom observations, interviews and problem solving observations were coded. These were analyzed to build an understanding of the experiences students encounter within the mathematics classrooms that offer opportunities to build self-efficacy. As suggested by Miles and Huberman (1994) a priori codes, guided by research, were created to label and understand the influences of self-efficacy. Broad codes for sites, classrooms, and type of data were also developed. However, it was important that codes not determine the analysis of the data. All data were printed in hard copy and hand coded for initial themes. The initial review of data involved analysis for classroom practices and student activities that would influence the development of self-efficacy. Feedback, enactive experiences, modeling, and physiological and affective status served as cornerstone codes in terms of teacher/student interactions (Bandura, 2002). The fourth influence on self-efficacy, physiological and affective state, was not frequently observable in the four classrooms and was quickly abandoned as a coding theme. Broad coding and categorization of data relating to the basic theory of self-efficacy guided initial review of data. As a basic coding scheme began to emerge from work with the data, themes and categories emerged. For example, student work in partnerships and partner discussion emerged as valued by students. It became clear that this theme interacted with other themes such as feedback and modeling. As research continued themes began to solidify. The development of feedback and
modeling were condensed into scaffolding with work on classroom environment by Turner, et al (2002).

Codes were then recorded on qualitative processing software. NVivo 7 by QSR International was used for this purpose. As codes were entered into the computer, the process of analysis became both inductive and deductive. Pre-existing codes, were confirmed and justified, or found to be redundant and joined with another code or discarded all together. Data given new scrutiny revealed new connections, themes, categories, and codes. Subsequently, a review of all data was necessary for particular themes. Coding grew to include classroom environment and classroom practices that affected the influences on self-efficacy. For example, as teacher modeling was coded, special codes for visual models were developed. This led to an expansion of the review of the literature research. For example, coding schema were developed to identify student feedback and student models. This was a result of both literature (Bandura, 2002; Schunk & Hanson, 1989), which shows that the more students identify with both feedback and models the more effective it will be, and the student interviews which revealed similar data. A sample of codes and definitions is available in Appendix I.

According to Lincoln and Guba (1985) researchers must be mindful of reviewing coding processes for reliability and validity. Therefore a coding audit was conducted early in the coding process. An auditor with previous experience in the procedures of coding audits for doctoral dissertations was selected to review and confirm coding accuracy. A retired Director of Elementary Curriculum Instruction and Assessment for a medium-sized rural regional school district had 30 years of experience in education before recently retiring.

Twelve codes were selected from the code list including codes from various coding themes including environment, students, teachers, problem solving, and classroom strategies.
Eight samples of data were chosen from every category of data for review and confirmation. These included:

1. Classroom observations from classroom 1A, 2A, 3B, 4B
2. Student interview
3. Teacher interview
4. Problem solving observation.

The samples were coded by the researcher prior to being reviewed by the coding auditor. The researcher provided the auditor with the list of codes, titles, definitions, and uncoded contextual examples. The auditor was encouraged to ask clarifying questions and become familiar with coding procedures with the researcher present before working alone with data. Before beginning the definitions for two codes (Teacher/Student Exchange-Feedback, Environment) were clarified.

Following the introduction to coding, the auditor studied each sample of data listed above independently confirming or rejecting each code. Next, the auditor read each coded text sample and marked every code as confirmed if there was agreement that the assigned code matched the text, or rejected if the assigned code did not match the text. Missing codes were inserted. After the confirmation process was completed, the researcher and auditor determined that 86.4% of the coded material was confirmed as accurate. Coding disagreements consisted primarily of missed codes. In an effort to increase the level of accuracy the researcher and auditor discussed the descriptions of codes to clarify misconceptions and rework definitions that were unclear. Definitions for codes ENV (environment), CON (confident), EFFRT (effort), PER (persistence), and PAR (parent) were clarified. One code, TSEF (Teacher/Student Exchange Feedback) was split into two codes TSEDF(Teacher/Student Exchange Direct Feedback) and TSEIF
Rejected codes were discussed and agreed upon. Finally, a ninth piece of text was selected and audited. The confirmation process was repeated and the auditor and researcher determined the accuracy rate to be 98%.

*Student Mathematics Self-efficacy Survey Results.* Self-efficacy surveys were administered at the end of the study to aid in understanding the interaction of self-efficacy and school environment. Surveys were analyzed using multiple sources of data. First, descriptive statistics were used to understand class statistics. Mean scores were determined for items 1-12 which were scaled on a Likert scale of 1-4. A Likert scale score for each class was determined for each item. Responses for items 13-17 were listed independently and examined for themes and categories. Items were then coded using codes developed for observation and interview data. New themes also emerged and codes were developed specific to the survey themes. For example, students indicated interest in work for multiple reasons and the themes developed into intrinsic and extrinsic goals. Mean responses to specific items (1-12) were noted for their differences and patterns. For example, questions dealing with strategic thinking and group work were reviewed. Items 12-17 were analyzed heavily for differences in class attitudes toward independence and understanding of the meaning of mathematical work.

*Document Reviews: Student work samples and teacher instructional materials.* Student work samples and teacher instructional materials were collected for review as sources of triangulated data. Student work samples were reviewed by class. Instructional materials were reviewed at the school level. Using a list of the following five questions, work each work sample was read and reviewed. Based on the questions, notes were collected for each of the six samples. When the six samples were finished, a review was written for the class, seeking to answer each
of the five questions for each class. Work samples were reviewed according to a scale for the following questions:

1. Does the work reflect strategic thinking?

2. Does the work reflect chances for independent thinking?

3. Does the work reflect classroom practice observed by the researcher?

4. Does the work reflect rethinking, or other evidence of perseverance?

5. Does the work reflect mathematical accuracy?

This process was repeated for the instructional program materials with the appropriate questions which included:

1. Does the instructional material provide opportunities for student strategic thinking, explanation, and metacognition?

2. Does the instructional material provide structures which support group work, modeling, and problem solving?

3. Does the instructional material provide teacher support for developing feedback, enactive experiences, and modeling?

Limitations and Delimitations

This research has a number of embedded limitations. To begin with, the researcher’s primary goal was to study students in the most natural classroom learning environment possible. This limits research results to the population that could be observed and triangulated in classroom work samples. Similarly, the conditions of the classrooms and the student population may limit the transferability of any results or conclusions. This includes the diversity and socioeconomic characteristics of the sample. Second, a large portion of the data collected was presented to the researcher verbally from students and represented their personal understanding
of the events in the classroom or perceptions related to their experience with self-efficacy. These reflections may not fully explain the phenomena of self-efficacy in the classroom, nor do they always fully coincide with observations of student behavior and classroom events. Finally, this study is designed to be an exploratory and descriptive study of four classrooms and the experiences of the students and teachers in the observational period.

The study is delimited in a three ways. First, while gender is often considered a factor in the study of mathematics in the classroom and can be related to self-efficacy as students become older, it is not within the focus of this study to compare differences in gender with respect to self-efficacy or to examine only males or females. Second, the use of problem solving within the study was primarily as a vehicle for viewing student’s persistence. The aim was to research persistence as an outcome of self-efficacy in the area of problem solving. Therefore, problem solving itself was not studied in depth. It would have changed the direction of the study, making it too broad and unfocused. Third, there are four influences of self-efficacy: enactive experience, modeling, feedback, and physiological information. Within the classroom setting it proved possible to study the first three, however, physiological information proved more difficult to obtain reliably. This research did not yield enough data to offer useful conclusions about this area of self-efficacy. Fourth, although every effort was made to procure consent for every member of the classrooms observed for the study, it was not possible to yield 100% student consent across the four settings. The result was sample sets within classrooms that were somewhat uneven in number. Finally, classrooms chosen for this study were chosen on the basis of many factors including: type of mathematics program, building site, years of teaching, and teacher willingness to participate. Although it was preferable to include teachers with a minimum of five years of teaching experience, it was not always possible. When this rule was overridden
care was taken to include teachers with compensating life experience and from recommendations from building principals.

Conclusion

This multi-case study of student mathematic self-efficacy in four classrooms examined data through four methods: classroom observations, interviews, problem solving activities, surveys, and document reviews. These data were triangulated for reliability. Themes and categories were identified in both inductive and deductive analysis. Survey data yielded descriptive and qualitative data. Document reviews were analyzed using uniform questioning practices. Research limitations and delimitations included study participants’ diversity.
CHAPTER FOUR

The primary purpose of this research was to answer the research questions which guided this study. These questions included: (a) How do students experience the development of mathematical self-efficacy in the classroom? (b) How do students experience perseverance in problem-solving activities? (c) How do teachers view their roles in the classroom in terms of developing the mathematics self-efficacy of their students? Data were gathered from observations, interviews, problem solving activities, survey, and document analysis. Examination of the responses revealed four overriding themes that included:

1. student social learning,
2. feedback,
3. modeling, and
4. mathematics strategies.

This chapter will include analyses and reports of information from gathered research instruments used in this study, related to these themes in the following six major sections. The first five sections review the results using each of the data sources as the main focus: observation, interview, problem solving activity, Student Mathematics Self-efficacy Survey, and document analysis. In each of these sections the theme will be presented and defined then analyzed in relation to the information gathered through the appropriate data source. In cases where an instrument does not directly relate to a theme it will be omitted from the discussion. Finally, the chapter explores each construct for new understandings that are revealed when cross instrument analysis was conducted.
Classroom Observations

Classroom observations formed the primary data source for this study and were central to answering research questions one and two which focused on student experiences. Observations for this study included four classrooms from two sites. The school administration at each site directed teachers to use specific mathematics instructional materials. Classrooms in Site A implemented standards-based mathematics materials which promoted student-constructed learning (Senk & Thompson, 2003). Classrooms in Site B used traditional basal mathematics materials which promoted a transmission model of instruction (Clements & Batista, 2002). This section will review data from these classroom observations. This first section will include a discussion of the instructional practices within the observed classrooms. It was designed to provide the reader with an analysis of the environments in which students received mathematics instruction. Later sections provide a review of social learning, feedback, modeling, and strategy use as they relate to observed data.

Description of Site A Classroom Structures

Site A was a newly remodeled school, bright and filled with open spaces. The walls in the hall were lined with student work. Open classroom doors revealed spaces of students clustered around reading boxes, gathered at rugs with their teacher, and working quietly on seat work. The children and adults in the hallways and office were warm and friendly.

Teachers in Site A classrooms held mathematics class from 10:00 to 11:00 AM each day according to the school master schedule. Both classrooms used different desk arrangements over the course of the observation period, but desks were always connected in some way, most frequently forming rectangular tables. Teachers returned with their classes from special area classes, such as library or physical education, and began mathematics with a minimum of
Students took snacks from shelves near the classroom door on the way into the classroom and ate during class, without interruption of the lesson. Teachers moved to the front of the class and began mathematics without having to make an announcement or settle students down. Students were focused throughout class, raising their hands to contribute, and working on class assignments without drifting. Students worked in groups and partnerships equally well, transitioning from seatwork to group work at the rug and to partner work without disruption. These students were always friendly and forthcoming when asked questions, although they did not initiate conversation with the researcher.

Class occasionally began with a review of a problem of the day, or with a review of homework. However, on half of the 10 observed days, teachers began instructional time with the introduction of the lesson. Teachers began with homework review three of the remaining five days. On these days students always engaged in checking homework with groups of their peers. When asked to explain if checking homework in peer groups was helpful by the observing researcher, students reported that this method of checking homework was more useful to them than traditional written teacher feedback as explained by the following comments.

Observer: Is this working in a group to check your homework helpful?
Student: We get to share and are checking. If you get it wrong or don’t get it… other people will explain it to you right away. But if you just check it, or the teacher just [checks it]…, you don’t understand it any better.

Instructional time in these classrooms featured lessons which were focused and, skillfully planned, and included students as models for development of concepts. Discussions which characterized scaffolding were common in these classrooms. Scaffolding will be further developed later in this chapter. Choice and realistic challenge were also common in these
classrooms. Choice most often took the form of choice in the use of strategies and work assignments that offered open-ended tasks. For example, during the fraction unit, students were asked to create a poster which would demonstrate real-world examples to express equivalent values of a given fraction. Challenges in these classrooms were carefully modeled and monitored. Teachers supported students through discussions which monitored understanding with partner discussion and frequent checks of student understanding before advancing the concepts. Teachers offered students challenge problems when finished with the daily assignments. Choice and challenge have been shown to be important to the mathematics classroom environment (Paris & Turner, 1994).

Description of Site B Classroom Structures

Site B was reopened approximately 12 years ago. It was well-cared for and friendly. Students worked in the hallways at tables near large, garden courtyards. Open doors to classrooms revealed students seated in various configurations of desk arrangement. Teachers generally stood in the front of the room teaching lessons to students. Student work lined the hallways of this school.

Teachers at Site B held mathematics class from 2:00-3:00 PM each day, as directed by the school master schedule. The instructional routine began with the Problem of the Day one 1 of 10 observations, homework review on 6 of 10 observations, and direct instruction 3 of 10 observations. This instructional pattern was in keeping with typical classroom instructional patterns for traditional mathematics programs (Romberg & Kaput, 1999). Teachers directed homework review by relating answers while students checked their work. During this time, each teacher invited students who found homework difficult, or had incorrect answers, to ask questions. Teachers sometimes included students as models for the class, as in this example:
Teacher: Let’s go over the homework.

Observer: Teacher goes over homework of fractions and mixed numbers.

Teacher: Did anyone not get the correct solution to the puzzle?

Observer: Three students raise their hands.

Teacher: Let’s review. In the denominator it is 10, 100, or 1, 000.

Student: Could you go further?

Teacher: Yes, but in fifth grade you’ll never be asked to go any higher.

Student: Why?

Teacher: To convert it to decimal …Anyone want to come up and do the ones in the box?

Teacher: Show us the whole thing in the box- the two step process of the fraction

Student: \( \frac{3}{5} = 6/10, \) you go 5 x 2 to get to 10, and 3 x 2 to get to 6.

Teacher: Write it as a decimal.

Student: 0.6.

Teacher: Someone want to do the other one in the box? This one is a little bit easier.

9/1,000.

Student: [Writes] 0.0009

Teacher: 0 in the 10\(^\text{th}\) place, 0 in the 100\(^\text{th}\) place, 9 in the 1,000\(^\text{th}\) place

That’s all for the board. Turn to page 286. “Asking Word Problems.”

Direct instruction was then followed by guided practice and independent practice. A homework assignment typically ended the lesson. This pattern was consistent in the majority of the lessons observed at Site B. Teachers in Site B classrooms followed the instructional period with snack as students left the room for instructional band practice. Students in Site B classrooms were
comparatively outspoken in class. They frequently spoke out without raising their hands. These classes contained a large numbers of high energy students. One of the two classes was on a whole classroom behavior modification program designed to meet the needs of a wide range of students. Students in this classroom were friendly and forthcoming when asked questions by the researcher. Group work was more challenging for some students in this class. Students frequently worked side-by-side in groups without interacting in ways that affected the product the group members. This became defined as parallel group work.

Choice and challenge were also features of Site B classrooms. Enrichment worksheets were available as a choice in these classrooms. Students were also allowed choice in strategy use when solving problems. Challenge work primarily consisted of occasional opportunities to choose enrichment worksheets for homework or finish extra challenge problems in the textbook.

Observations and Major Constructs

The previous section reviewed classroom observations in terms of structures pertaining to classroom instruction. The following sections will report the analysis of data gathered through classroom observations as they relate to the four major constructs developed as a result of this research. These constructs were: social learning, feedback, modeling, and strategy use.

Social Learning. Mathematics classroom environments contained many instructional structures as part of their daily routines. For the purpose of this research, structures will mean classroom routines and practices in place to enhance instruction. Over time these practices appeared to enhance student learning and instruction, and therefore, warrant closer study and analysis. Previous research including student observations revealed that shared thinking through speech with peers enhanced children’s understanding and cognition, as well as their self-efficacy (Vygotsky, 1978; Shunk & Hanson, 1989). Social learning also supported students in the
observed classrooms through group and partner learning as well. The family of observed structures categorized as social learning, for the purposes of this analysis, included: partner work, partner discussion, group work, and group support.

Partner work included activities in which students worked with one other student to accomplish a mathematics task. Partner discussions were typically embedded in classroom instruction. Teachers directed students to turn and talk to their partner about a concept, process, or strategy being developed in the lesson as in the following example. “Could this help us to define a fair game? Turn and talk to your [mathematics] partner about this.” Group work included activities in which students worked with at least three other students to complete a mathematical task. Activities assigned to group work typically included checking homework, playing games, and exploring complex mathematical problems. For example, students were asked to work in groups to determine survey questions for different demographic groups. Behaviors which determined the effectiveness of group work included the degree to which group members supported each other. Group support was defined as student behaviors meant to affect the product of other group members. This behavior was opposite the parallel group behavior observed in other groups.

Both standards-based instruction classrooms (Site A) and traditional instruction classrooms (Site B) included social learning structures. Teachers in classrooms at both sites used group work and partner work as instructional practices. Close analysis of observation coding showed differences in the types and frequency of social learning activities. Students in standards-based classroom engaged in social learning much more frequently than their peers in traditional instruction classrooms (See list of coding totals in Appendix A). Social learning structures varied in frequency and quality between site A and B. Closer analysis of social learning revealed that
students in Site A classrooms participated in partner discussions with higher frequency than students in Site B classrooms. Students in standards-based classrooms were also more likely to experience group work than students in traditional instruction classrooms. The frequency of partner work was relatively even at both sites.

The quality of social learning also varied from site to site. Partner discussions in Site A classrooms typically consisted of brief teacher-directed conversations embedded in the instructional framework, as demonstrated in the following comments.

Teacher: The question I am asking is… yesterday we said a fair game is a game where everyone has a fair chance of winning. Could this [points to line plot] help us to define if this is a fair game? Talk with a partner now. How would you know?

[Students turn and talk with their neighbor.]

Student A to Student B: It is a fair game because each had the same chance.

Teacher: Jared [Student B]. What did you and your partner say?

Jared [Student B]: Well, it didn’t seem like it was fair, but it was.

Partner discussions in Site B classrooms characteristically featured student discussion framed by a mutual mathematics assignment. Students in these classrooms frequently worked as partners, or in groups, to complete the guided practice and independent practice portion of the instructional lesson. Each lesson in the textbook assigned to Site B consisted of a two pages of text. The first page contained a direct instruction portion of the lesson which teacher worked through with the class. The second page included guided and independent practice portions of the lesson. Teachers in the traditional instruction classrooms (Site B) would typically assigned these portions to students as partner work. While students worked in on these exercises teachers
worked with small groups of students in need of support. A review of the answers followed the work period.

Although students in both groups had access to partner and group work, the nature of the interactions between peers in social learning situations varied greatly. As stated previously, supportive behaviors benefited the production of all group members. Parallel group work, included groups whose members worked side-by-side without supporting the learning of other group members. Students in standards-based classrooms often engaged in supportive group behavior. For example, groups were observed working with a set of word problems that required answers in mixed numbers. The group was made up of all boys who were seated at a rectangular table. The group carried on in an animated discussion regarding potential strategies and solutions. The three boys participated very evenly. No student dominated the group. One student read the problem aloud and all students worked together to work out the solution. When one student had difficulty the group paused and explained the process until that student understood. The group did not give the answer without explanation or moved ahead leaving one student out. This group was typical of the groups in Site A classrooms. They functioned collaboratively and cooperatively.

Students in traditional instruction classrooms rarely engaged in fully supportive group behaviors. Students at Site B (traditional instruction classrooms) were often participated in parallel behaviors. For example, a group of girls were observed working next to each other seated at desks forming a rectangular table when given a problem to solve. There was not any noticeable pattern for sharing between these girls. The girls were split into smaller groups of two’s. One group attempted to work together while the other two students worked independently. The two students who worked together gave each other answers but did not share their thinking.
or explain their reasoning about the problem to each other. At one point, one of the girls who was working separately, reached out to a student at a second table, “we should do this as a group.” Students at the other table talked with her for a moment about the problem and then returned to working on the problem with each other.

Social learning appeared as a feature of classrooms that also had high frequency of perseverance in students. The researcher observed perseverance, defined for this study as, a steady or continued action, in classrooms at both sites. Perseverance was further sub-categorized as effort, persistence, and rethinking. Persistence included behaviors such as continuing in an effective manner despite challenges. Students exhibited persistence through behaviors such as erasing work, continuing on challenging work, and beginning work again after realizing large errors in thinking had been made. Effort comprised two behaviors; a purposeful attempt to achieve, or completing a task through more sustained work than was typical of students in these classes. Students demonstrated perseverance frequently in their work and in discussions. On occasions when the students worked independently, the researcher was allowed to speak with them about their work and thoughts concerning mathematics class. During one of these discussions, student expressed willingness to persevere in discussions with the researcher. For example, two students from standards-based classrooms explained:

Student: This looks really hard.

Observer: You think this is going to be a hard unit?

Student: Yes

Observer: Do you think you can be successful at this unit?

Student: Yes

Observer: Why?
Student: I’ll keep working at it. I always do.

An example of a student observed demonstrating perseverance included a mathematically talented student. The student worked on a unit preview. As she worked through each new problem in this novel work situation she would often reconsider her response and erase her work often. When she came to a particular question which asked students to put decimals, fractions, and mixed numbers on a numberline, she thought for a long time before beginning to answer. Although students were allowed to skip problems they did not know how to answer, she considered multiple approaches and erased some of her ideas before selecting a final answer this problem. Other students passed in their papers and she continued. She settled on a clear strategy for working through the problem. The researcher suggested a point she may want to reconsider. She said, “Oh, I see,” erased immediately and adjusted her work as she moved forward.

Students in traditional instruction classrooms seldom exhibited behaviors in these categories. When students from these classrooms expended effort they typically focused on completing games and puzzles. During a game day in one traditional instruction classroom a group of students worked at solving a magic square puzzle. These students rated their chances of solving the puzzle at 50% but were willing to work at it “as long as the teacher will let us. We just need enough time.” Both perseverance and social learning occurred often in standards-based classrooms. This section reviewed the construct of social learning as observed in the classrooms in standards-based and traditional instruction classrooms in this study. Social learning was found in both classrooms at both sites; however the frequency and types of social learning varied between the sites. The next section will analyze the data from observations related to the construct of feedback.
Feedback. This section explores the findings from observations related to the construct of feedback. Feedback given directly and indirectly to students by teachers will be reviewed. The section will close with an analysis of student-to-student feedback. Feedback in these forms the classroom was explored as a possible source of self-efficacy. Self-efficacy has four sources which include: enactive attainment (prior experience), vicarious experience (modeling), verbal persuasion (feedback), and physiological and affective states (Bandura, 1997). Three forms of feedback were explored in this study. Feedback entailed information relayed from a trusted source to the individual which is related to an individual’s performance. Observations revealed that students within the mathematics classrooms received feedback from two primary sources; teachers and peers. Teacher feedback was delivered to students in written and oral forms. Due to design limitations, this study only considered oral feedback. Teacher-student interactions in all classrooms consistently featured feedback. Teachers primarily relayed feedback to students through individual and group support, or as part of instructional lessons. Individual and group feedback was typically provided as teachers moved throughout the classroom during work times, supporting students as they attempted to complete assignments. Teachers gave feedback as part of instruction by asking students questions within a lesson. According to observation data, students frequently received feedback from teachers in Site A classrooms frequently. The feedback directed toward these students was often embedded in broader teaching moments. For example:

Student: 5.25%

Teacher: Exactly. Okay,

Let’s look at patterns on the division chart.

See how ¼ can help you with 1/8.
Talk with your neighbor about what patterns you notice.

Students in Site B classrooms also received moderate levels of feedback. Feedback was again embedded within the lesson. Feedback was likely to be focused on the correct answer as demonstrated in this example:

Teacher: Did anyone do [number] 18? Is anyone on prime?

Teacher: Fredrick, you missed a point on that. Sandra, did you remember what a prime number is?

Teacher: You had a composite number in your number. [Teacher puts Fredrick’s answer on the board.]

Teacher: Good.

Student 3: A number only evenly divided by itself and one. [Fredrick’s answer on the board.]

Early observation of feedback during instruction yielded the finding that teacher feedback in these settings could be separated into direct and indirect feedback. In situations where direct feedback was given, teachers told students expressly how they had performed, as the following example demonstrates.

Teacher: Sally, tell everyone what you did.

Sally: I underlined 57 and 10.

Teacher: She underlined the important information – what a great idea!

Okay, Arlene [teacher continues with the problem] wanted to buy... some books.

Is there anything to solve yet? [Teacher indicates student by pointing.]

Student: No

Teacher: Good, now… What next?
Indirect feedback was defined for this study as that feedback which was not overtly delivered to the student either verbally, or in written form. Indirect feedback was less understandable to students. For example, it appeared that when a teacher asked a question and recorded the answer on the board without a negative comment, or reworked the answer, that the student understood, the teacher was supporting the answer. Although there was general understanding that lack of direct negative feedback could be considered a type of positive feedback, children expressed some hesitation at accepting this concept. At these times it was not always clear to students that the teacher was giving feedback, because the feedback was less direct. While working independently, students were available for questions from the researcher. When asked by the researcher during an independent work time to clarify their understanding of indirect feedback, students explained that teachers sometimes used errors to build mathematical concepts in class. This appeared to cast a shadow on student’s willingness to fully accept indirect feedback, as reinforcement, as demonstrated in this interchange between the researcher and a student.

Researcher: If [the teacher] asks a question and she doesn’t tell you if you are right or wrong, but she writes your answer on the board, do you know that you are right?
Student 1: Yes…well…except sometimes, she might write it on the board when it’s new…or if you weren’t quite right… and she says “how did you do that?”
Researcher: How do you feel?
Student 1: Helps you learn…know what you are doing because you know why you were wrong and what to do next time.
Student 2: [Yes], you know…
Student 3: She may ask you to explain, but yes, especially if it’s easy.
Student 4: She says no… if you are wrong a lot, or asks you to explain.

A different group of students responded in this way.

Researcher: If the teacher asks a question and doesn’t tell you if you are right or wrong, but writes your answer on the board. Do you know that you are right?

Student 1: Yes, but not always. Because sometimes he might be writing a wrong answer on the board.

Student 2: Yes, unless he is going to show how to do something and what a better strategy is.

Student 3: Kind of…it’s hard to tell, I think so, but I am not always sure.

Student 4: No, because sometimes he might put a wrong answer up and asks what your thinking was and shows us how to do it.

Due to this hesitancy on the part of students to fully accept indirect feedback from teachers an analysis and of indirect and direct feedback was conducted.

Direct feedback, which students in these classes appeared to feel was a more powerful indicator of success, differed between the two classes. Direct feedback, given to groups or individuals, was offered to students in standards-based classrooms somewhat less frequently than direct feedback provided as a part of the instructional lesson. Students in standards-based classrooms were more likely to be provided with positive feedback than negative feedback, as in this example of positive feedback: “Student: 5/6.” “Teacher: Yes, can you check by estimating? Turn and talk to the person next to you.” Review of positive and negative direct feedback data showed students received frequent positive feedback in Site A classrooms. Analysis of traditional instruction classrooms revealed similar feedback patterns. Students in Site B classrooms were also more likely to receive feedback in large group instructional settings than on
a small group or individual basis. These students rarely received feedback in small group settings. The analysis of trends in positive and negative feedback in these classrooms was nearly even with only one coding occurrence difference between the two categories.

Ideally, to increase outcome behaviors as result of the feedback, the clarity and proximity to the recipient should be maximized feedback effectiveness to be increased, its clarity and proximity to the student should be maximized (Bandura, 1997). In these circumstances proximity for student feedback refers to the degree of closeness to the child in terms of relationship and age. In other words feedback is most believable when the recipient and giver of the feedback are close in age and relationship. Indeed, student comments during observations reinforced the need to examine both constructs of clarity in feedback delivery and the relationship the student has with the teacher in a particular context, i.e., the mathematics classroom. In addition, as with all responses to behaviors, the link between the students’ comments and the teachers’ replies should be examined. Students in Site A, standards-based classrooms, received only some of their feedback indirectly. Their peers in traditional classrooms received a moderate amount of their feedback indirectly. Indirect feedback in traditional instruction classrooms frequently came in a string of feedback events during classroom instructions as in the following example:

Teacher: Go to the board and explain it.

Student 1: \(\frac{1}{4}, \frac{1}{9}, \frac{1}{3}\)

Teacher: Why?

Student 2: There is 1 in all of the numerators. So, if there is a 1 in all of the numerators that is the same. Then you think about it like a pie. For this one you divide the pie into four pieces and you take one of the pieces. For this one you divide the pie into nine
pieces and you take one of the pieces. For this one you divide the pie into three pieces and take one of the pieces.

Teacher: What is the least common multiple?

Student: 36

Teacher: What are the three denominators?

Student1: 8, 2, 4

Teacher: What is the least common multiple?

Student: 24

Teacher: That is a common multiple but not lowest

The proximity of the source of feedback to the students helped to determine its effectiveness. For example, students received feedback from each other in the classroom. Student-to-student feedback occurred in all classrooms during observations. During the following small group and partner work examines, students could be observed providing peers with feedback regarding a mathematics task:

Student 1: How did you get that?

Student 2: (Leaning over to look at the paper) Good…You showed your work. I think you added…look you just miscalculated here.

Student 1: Oh, yeah! I got it. Okay.

Analysis of observation data showed that students in standards-based classrooms appeared to be more comfortable giving such student-to-student feedback. Peer feedback occurred frequently in standards-based classrooms. Students in traditional instructional classrooms were observed giving peer feedback occasionally. It should be noted that some of this difference can be attributed to access to partner and group interaction. As noted previously, students in standards-
based classrooms in these groups frequently meet with peers in small clusters of 2-4 students, increasing the possibilities for student-to-student feedback. When students met in groups and partnerships to work on common mathematical tasks they had many opportunities for sharing feedback at these times. Students in the standard-based classroom felt comfortable offering and seeking feedback from their peers. One student expressed this when he said, “When the work is easier I would rather work alone and then check it with a partner. If you have a different answer then you can find out why.” In these classrooms it was common to see students working side-by-side sharing their work. Most significantly, as students received feedback it was common to see students adjust their approach or answer based on the information gained from their peers.

This section reviewed student experiences with feedback and ways in which these actions may affected student self-efficacy through proximity and clarity (direct and indirect feedback). In the next section modeling (vicarious experience) observed across the multiple cases will be examined.

*Modeling.* In the classroom environment modeling served as a source of information through which students judged their ability to successfully complete a task (Bandura, 1982; Schunk, 1981). The proximity and attitudes of the model affected the judgments made by the student (Bandura, 1997; Schunk & Hanson, 1989). In this context, proximity referred to the relationship of the person delivering the model to the student. In other words, if the model shared a peer relationship with the student, the student was more likely to judge himself or herself as capable of completing a similar task than, if a model shared an adult-student relationship with the child. Even within the confines of peer relationships proximity was important (Schunk & Hanson). If a student judged the model to be within a similar range of ability as himself or
herself, then the model was more likely to be an effective source of efficacy. Conversely, a model with skills too far from what the student perceived as attainable would have less influence.

Considered an important part of observed data for this study, vicarious experiences (modeling) warranted further exploration. Both teachers and peers provided models for students during the course of the observed mathematics classes. Models presented information to students in general class instruction and small group settings. Modeling behaviors included: demonstrations and explanations of concepts, skills, strategies, or processes. For the purposes of analysis these interactions had to have the quality of explanation in order to be considered modeling. For example, in daily classroom instruction, teachers and students routinely displayed blocks of mathematics information without providing supporting explanation. This was demonstrated in the following classroom discussion where the teacher focused on sharing the computation involved in ratios without elaboration or explanation.

Teacher: What are we looking for today? …

Teacher: David?

David: Compare ratio.

Teacher: The ratio is 30:100 [writes on board.] Shanna?

Shanna: 30%

Teacher: 30 out of 50

30/50 make a fraction. You multiply 30 x 2 = ___ and then 50 x 2 = 100.

What about 30/33? Cali?

Cali: (on board) 30 x 3 = 90

33 x 3 = 99

Teacher: Now it is looking better – adjust it-
How can I get closer to 100?

Teachers at both sites regularly provided models for their students. In whole group instruction teachers typically offered models throughout discussions and lessons. At these times models worked through problems or computation with a focus on explaining the processes, strategies, and concepts needed to complete the work successfully. For example, in the following discussion the teacher is working with the class to understand data collected from a series of dice throws on a line plot:

Teacher: [Working at an easel. Looking for the median.] Which 3 should I circle?

Student: The first one.

Teacher: What about the bottom one?

Student: Right- I see.

Teacher: This tells me that some people were unlucky.

Plotting this way shows us that most people ended up about where we expected.

You can use data to back up what you know about probability.

What did you learn about using data?

Talk about it with your neighbor.

Often, as in the previous example, teachers reinforced their demonstrations by writing on the white board. This form of modeling was re-coded as visual support. This modeling was felt to lend extra support to students by offering information through an additional modality (visual) to the auditory information already being presented. Modeling were frequently supported by textual and pictorial representations on white boards at the front of the classrooms. Teachers at Site A frequently used data projectors which projected the lesson page onto the white board.
These teachers would generally begin working on the white board and move to using the data projector when students worked on an assignment. In this way the use of the data projector supported the student work. One teacher at this site frequently took the class to the rug where students sat in a circle to talk. When students were at the rug, the teacher recorded student thinking on chart paper at an easel. At Site B teachers would write on the board and students would follow along. In these classrooms teachers were likely to record the steps for computation problems as they moved through them. One teacher from this site frequently had students write answers to questions from the text on the board for other students to see. Although the two sites had similar practices, analysis revealed some differences. The depth of information sharing practices lead to noted differences in modeling. Students in standards-based classrooms were frequently offered models by their teachers in whole group lessons. Their peers in traditional instruction classrooms were sporadically offered models in whole group lessons. Visual support offered by teachers also differed across classrooms. Visual support often accompanied the modeling in standards-based classrooms, while it very frequently it matched the modeling in traditional instruction classrooms.

As noted, students also provided peer models in the mathematics classrooms observed. Two student information sharing behaviors qualified as student modeling. First, teachers frequently asked students to explain mathematics concepts, skills, processes, or strategies in the context of large class instruction. Explanations qualified as modeling if they extended beyond brief answers, or contained a quality of original thinking within the explanation. Second, students often provided modeling of information in small groups or partnerships through demonstration of skills, concepts, processes, or strategies.
Students in Site A and Site B classrooms frequently provided models for their peers in large group instruction. These peer models afforded proximity to the learner that potentially added authority to the information they conveyed (Schunk & Hanson, 1989). Teachers promoted student as models by asking students questions during their lesson discussions. Following the students answers the teacher asked students to explain their thinking, strategy, or process use. Students also received peer modeling information when working in small groups and partnerships. Analysis of this theme revealed that children in standards-based classrooms were exposed to moderate peer modeling in small groups or partner work. Students in traditional instruction classrooms seldom experienced modeling within these structures. Children in standards-based classrooms frequently worked in small groups and partnerships. Student comfort within these structures has previously been established. Students expressed ease with approaching their peers for help when challenged by mathematics problems. It follows therefore, that opportunities for student modeling in these classrooms would be maximized as student opportunities for interactions with their peers increased.

This section reviewed modeling observed in standards-based and traditional instruction classrooms. Previous sections examined the constructs of social learning and feedback. The next section will examine data related to the construct of instructional strategies.

*Strategy Use.* Students in the observed classroom used various strategies to negotiate mathematics assignments. These observed strategies were analyzed and grouped into the following categories: explanation, deeper strategy use, practice, skill, general computational strategy use, home, and teacher help (see Table 4 for an explanation of each strategy).
Table 4

*Strategies Used by Students - Definitions and Examples*

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative strategy use</td>
<td>Student used computation strategy other than traditional algorithm to solve a mathematical operation.</td>
<td>Used in place of $2,493 - 1,421 = 2,000 + 400 + 90 + 3$ - $1,000 + 400 + 20 + 1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1,000 + 0 + 70 + 2 = 1,072$</td>
</tr>
<tr>
<td>Deeper strategy use</td>
<td>Students used strategies which required more than one problem solving step to complete the solution. Steps increase likelihood of accuracy, level of reasonableness, or level thinking.</td>
<td>Problem: Estimate number of hours of television watched in lifetime Strategy: Group years in life Ages 1 through 6: Assign value for television watched daily Ages 7 through 11: Assign value for television watched daily Multiply each value time 7 (days in a week). Multiply each product time the number of years in the age group. Add the two products together.</td>
</tr>
</tbody>
</table>
Table 4, *continued*

*Strategies Used by Students- Definitions and Examples*

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Students provided a verbal clarification which aided in the development of conceptual, skill, or process understanding.</th>
<th>Explain why you think the sum is about 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Student answer: $\frac{1}{4} + \frac{7}{10}$, because $\frac{1}{4}$ is 25% and $\frac{7}{10}$ is 70%, 70 and 25 is 95%. That is only 5% away from 100%, or 1.</td>
</tr>
<tr>
<td>Home</td>
<td>Students used parents, siblings, or tutors as a source of help for solving challenging mathematical tasks.</td>
<td>“I go home if I have trouble and I go to my parents or brother and organize a problem and ask my parents.”</td>
</tr>
</tbody>
</table>
Strategies Used by Students - Definitions and Examples, cont.

| General computational strategy | Students used computation strategies such as numberlines, and counting on to solve mathematical problems (see examples.) | Numberlines  
325 + 420 =  
Student creates a numberline with 325 and 420 as end points and filled in interim points. The student then counted the midpoints to solve the problem.  
Counting on  
420 – 325 =  
To count on the student changed the problem to an addition problem 325 + _____ = 420  
The student then counted up from 325 to 420.  
Skill | Student attributes successful completion of mathematical task to technical ability in mathematics. | Researcher: What are you good at?  
Student: Fractions.  
Researcher: Did you feel good at the beginning of fractions?  
Student: We learned to multiply and divide. I did well on the end of quarter test. It just took time.
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>Student attributes successful completion of challenging mathematical task to practice of mathematics.</td>
<td>Researcher: Why do you think you were successful? Student: Because I practice. At home I have a math book. I read the steps for problems we haven’t done yet.</td>
</tr>
<tr>
<td>Teacher help</td>
<td>Students attribute success to teacher help when completing challenging mathematical task.</td>
<td>Researcher: Why do you think you were successful? Student: [I did a lot of math work, worked hard, partner work, and our teacher gives us a lot of individual help when we are confused.</td>
</tr>
<tr>
<td>Text sources</td>
<td>Students attribute success to use of text book or related resources when completing mathematical task.</td>
<td>Researcher: What do you think you will be doing in class to help you be successful? Student: Practice sheets</td>
</tr>
</tbody>
</table>
Students recognized these strategies as methods for solving mathematical or learning challenges in the mathematics environment. Explanations often supported strategic thinking, or served as a strategy for working through challenging assignments. Teachers frequently required explanations in classroom discussions, encouraging students to communicate their understanding of mathematical concepts. Teachers asked, “why,” “explain as you go,” “tell me more,” or, “tell how you know.” Students in both classrooms frequently explained their responses. Students in Site B explained somewhat more than students in Site A. When students at Site B explained, they tended to focus on strategic thinking rather the processes involved in computation, as in this example.

I figured the first problem out by doubling. Then I was able to figure out the second one. I just had to do the figuring with that number there [points to original figure.] Then for the last one I just had to use the number I got from the second one and triple that. I figured it over here.

Deep strategy use was evident when students used higher levels of mathematical thinking and processing as in the following example from a classroom geometry lesson.

[Class is exploring the relationship between area and perimeter. A student is at the board with a model created by four square tiles.]

Student: I noticed that the perimeter would be 12 because if you take the area and multiply it by these two sections, and take the number of sides that touch, and multiply by two, then you subtract those two you get the perimeter.

[Teacher works through the model with the class renaming “sides that touch” as shared sides and “these sections” as A and B. The whole class then tries this model with various perimeters and areas to test the model. It works.]
Practice was frequently noted by students as a strategy resulting in successful completion of mathematical tasks.

   Researcher: Do you feel that you’ll be able to complete your homework?
   Student: Yes
   Researcher: Why?
   Student: We worked on it in school a lot, we went did [the page] half way and we [did examples] our partners.

When students noted skill as a strategy for meeting mathematics challenges they referred to their ability to perform computation necessary to complete the task at hand. One student from a traditional instruction classroom was asked how she had addressed a problem with mixed numbers that other children struggled with. “I add these…carry over the whole number that gives me the number.” At other times students used more generalized strategies. General strategy use included methods students used spontaneously or, on request during instruction. These strategies were rarely the focus of lessons designed specifically for teaching strategy use. Instead, teachers embedded various mathematical strategies in lessons designed to teach other concepts such as multi-digit subtraction or data analysis. For example, in the student examples above the students were learning perimeter, fractions, and subtraction. The teacher embedded thinking of alternative strategies, explanation, and deeper strategy use. On four occasions students worked with strategic use through mathematics games. One day, games featured general mathematics strategies. On two of the days games stressed relative value of fractions.

   Students frequently cited home as a source of strategy information. Some students mentioned parents, siblings, tutors, as alternates to their teacher and school peers for handling difficult mathematical work. As these students express it, “Usually, I learn from the person
helping me, whomever that it. When I am working, in math my revisions in my solution help me. My dad also teaches me a lot.” “When the teacher teaches us a new strategy it helps in the future. Right now my mom taught me a strategy that helped to make it easier.” Teacher help was also noted by students as a strategy for negotiating challenging mathematical situations. Teachers in Site A classrooms had two main structures for supporting students during work times. The first was moving throughout the classroom and giving feedback to individual students as the following quote exemplifies.

Teacher: Show me how you got that. So you did 10/18 for your total? 55.50. You rounded down? You may want to round up because it is greater than 5. Okay, you have 1, yes. That makes sense. Write down your data on the board under the national data.

The second structure for supporting students was taking small groups of students to a quiet place in the room to work briefly. At these times teachers would review the important concepts of the lesson and then send students back to their seats to complete the work with the rest of the class. After working at the rug students expressed confidence that they could complete the given tasks as indicated by this student.

Researcher: Can you tell me what you are doing?

Student: I am fixing my mistakes. I was just at the rug with (Teacher A)

Researcher: Did Teacher A help you?

Student: Yeah.

Researcher: Do you think you’ll get it right this time?

Student: Yes.
When asked by the researcher during independent work time, students in one class reported that strategies aided their work in ways such as these: “We did it this way in class before and I did it that way because it was easier for me,” and “we used many different strategies and ways to figure it out. At first we were random, but then we checked the diagram to figure it out.”

Students in standards-based classrooms used strategies frequently and freely chose the strategy they felt worked best for them personally. These students often focused on deeper strategy use and explanation. Their peers in traditional instruction classrooms frequently used general computation strategies within mathematics lessons. These students were likely to be taught one strategy for computing a mathematical operation and, therefore, were less likely to use an alternative strategy for computation unless they had been taught one at home. Strategy use in the standards-based classrooms was demonstrated daily through independent work and assessments. Students observed in assessment situations used general computation strategies including numberlines, counting on, and using alternative computational strategies (Refer to Table 4 for definitions of strategies).

During observations students were asked to complete pre-assessments are upcoming fraction and subtraction unit. Students were observed using strategies to solve the problems included in the assessment. Students used numberlines as an aid for addition of mixed numbers by creating a numberline which included both numbers in the given problem. Students would then fill in the missing fractions and whole numbers and find the missing amount by counting between the two fractions.

Students using counting on as a strategy for subtraction would convert subtraction of fractions into an addition problem. For example, 3/4 -2/4 = __ , becomes 2/4 + __ = 3/4. Then
the student begins at 2/4 and counted up by fourths to 3/4. In a subtraction test observation a student told the researcher:

For me counting up is easier. If I have 30,000 and 50,000 [to subtract] for me the traditional way isn’t the only way now. I used to be afraid of subtraction, but now I am not so afraid because I can do it more than that one way. Subtraction isn’t so hard, especially [with large] numbers.

Many students demonstrated alternative strategy use. For example students employed different ways to complete the same subtraction problem. To complete a subtraction problem on the same page students adjusted numbers and used place value. For example in the problem, 3,999 – 2,589, the student may have changed the numbers to 4,000 – 2,590 in order to make it into a problem that could be done with mental math. The same student may have used place value to complete another subtraction problem. In this example 2,493 – 1,421 would be changed to:

\[
\begin{align*}
2,000 + 400 + 90 + 3 \\
-1,000 + 400 + 20 + 1 \\
1,000 + 0 + 70 + 2 = 1,072
\end{align*}
\]

In this section, the strategies observed by students in standards-based and traditional instructional classrooms have been reviewed. In the next section interview data will be analyzed.

Interview Data

Student and teacher interviews confirmed data gathered through classroom observations. Small group interviews of students, conducted on two occasions, took place during student lunch periods. The researcher met with students in March and May for initial and follow-up interviews. Teachers were interviewed by the researcher in June on an individual basis. In this section, social
learning, feedback, and strategy use will be reviewed in this section through the lens of what was revealed by the interview data.

_Social Learning_

As noted in the section dedicated to revealing the results of the observation, Site A and Site B classrooms often featured instructional structures which encouraged social learning. These routines and procedures included partner work, partner discussion, and group work. Social learning was a frequent topic during student and teacher interviews. These data will be reviewed in the following sections beginning with student interviews.

_Student interviews._ Students’ responses reflected the importance of social learning structures in the mathematical classroom. Questions which asked students to consider the construct of social learning and to consider which classroom structures were effective in the mathematics classroom, elicited responses related to partner work, group work, and partner discussions. Students noted that small group and partner work supported their learning, as evidenced by the following student comments: “I like to check my work with a partner and if we have different answers we find out why,” or, “the teacher explains things better when we are working in a small group.”

Some students described “learning better” in small groups and partnerships which they often attributed to their peers’ ability to explain mathematics “on our own level.” One student related this phenomenon in these terms, “it is easier if a kid explains it…it is at your own level. Teachers already know it, so they say it different, I think.” Other students expressed the feeling that it was easier to ask questions in smaller groups, stating, “I ask the people who get it and they explain it to me,” or spoke of the benefit of the different opinions available in partnerships and small groups. “It helps to work with other people because other people have different opinions
and I can see what they are doing. Maybe I will learn something I can use later from watching them.”

Students were asked what they did if they were unsuccessful in mathematics class. In response to this question, students in all classrooms answered with various insights. Continuing effort, estimating, using alternative strategies, and moving on to easier questions were all offered. Students also suggested social learning as an effective strategy for dealing with mathematical problems, as this example shows: “I ask the people at my table for help. I’ll ask people who understand it to explain it to me.” One student noted that working in small groups was more effective than working in the whole group because the teacher gave more specific support, “When we are in small groups it is better. In the larger group the teacher gives us too many hints.” Finally, a student wrapped up the student interview by responding: “small groups are less frustrating because if one person doesn’t get it they can explain it and then you can just go on. The work and it gets done faster.”

Student follow-up interviews began by asking students to explain how working in groups or partnerships helped or hindered their mathematical work. In both groups a majority of the responses were positive in nature. The following student example demonstrates one student’s insight.

It is easier in the group to ask your question. Anyone in the group can help you and share your work with you. In a group we tell each other what you did wrong. If you really didn’t get it, we help each other.

The students who were not positive about group or partner work, had two concerns. One student preferred teacher support, the second child expressed a desire to work independently. The first student explained that she was concerned that students may copy from her paper. The second
student felt that working independently was faster. Both students stated a desire to work in partnerships when work was challenging, if they could control the membership of the group.

Site B students expressed concerns in relation to group work in follow-up questions. Students stated a sense of unease connected to the functioning of groups. Group membership, rules used in groups, how work was divided, and concerns over copying occupied the minds of students when asked about group work. For example, one student explained: “In a group kids can take advantage of me I think. They can ask me to explain and then copy my answers while I am explaining.” These concerns were not expressed by students in the standards-based classrooms where social learning was more supportive and more frequent.

The researcher also, classroom structures were listed classroom structures on a poster and students were prompted to choose all those they felt most helped them be successful in mathematics class. Students’ responses are shown in Table 5.
Table 5

*Student Response to Question 3: Follow-Up Interview*

<table>
<thead>
<tr>
<th>Structure</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site A</td>
</tr>
<tr>
<td>Visual Support</td>
<td>0</td>
</tr>
<tr>
<td>Test</td>
<td>0</td>
</tr>
<tr>
<td>Individual Help</td>
<td>2</td>
</tr>
<tr>
<td>Homework</td>
<td>0</td>
</tr>
<tr>
<td>Enrichment</td>
<td>0</td>
</tr>
<tr>
<td>Connected Lessons</td>
<td>1</td>
</tr>
<tr>
<td>Teacher Support</td>
<td>2</td>
</tr>
<tr>
<td>Games</td>
<td>1</td>
</tr>
<tr>
<td>Partner Discussion</td>
<td>2</td>
</tr>
<tr>
<td>Partner Work/Small Group</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

Based on their comments related to social learning, students in both Site A classrooms expressed a strong preference for partner work over group work, as stated by this fifth grade student: “[In partner work] you are more on an equal level [and work well together]. A group has more chance to get off track.” Site B students focused on the learning benefits of small group and partner work, a student from a standards-based classroom commented in the following way: “You can see yourself when the kid does it.” Students clearly expressed in these interviews their preference for learning through partner and small group work. As explained in the
observation section of this chapter both parallel and supportive group behaviors were observed
during social learning activities. In interviews students clearly stated the need for classroom
culture that promotes supportive group and partner structures. Students made comments such as,
“groups have the chance to get off track,” and “sometimes the kids in the group take advantage
of me.”

*Teacher interviews.* The purpose of the teacher interviews was to confirm information
collected through observations and student interviews as well as gather impressions of teacher
attitudes related to student self-efficacy. Responses from teachers of traditional programs
included focus on safe classrooms, setting boundaries, and developing rules. These teachers
explained that they felt it was their responsibility to create environments in which students could
explore and succeed. Teachers from standards-based classrooms characterized their
responsibility to provide supportive, collaborative, and warm environments. These teachers
stated that their classrooms should provide students with a place to learn different approaches to
solve problems, to take risks, to discuss, and to support growth and learning.

Teachers were also asked to reflect on how they reached out to different students to help
students feel successful in mathematics. Teachers noted many ways they accomplished this in the
mathematics classroom. Among many strategies, teachers at both sites reported partnering
students in different ways as a strategy for reaching various types of learners. Teachers from both
types of programs used group work and partner work as a strategy for helping students to feel
successful. As a teacher from Site A stated,

I start with an example problem that is related to the operation that we are studying. I
think this gives them the chance to hear what other students are thinking. We discuss
what other students have to say. I let students get help and work with a partner.
These interviews confirmed observations that social learning was used in both instructional programs.

This section reviewed data from interview sources related to social learning. In the next section interview data related to feedback will be examined.

*Feedback*

Feedback provides an individual with information related to his or her performance. Positive verbal persuasion (positive feedback) from a trusted source can signal the learner to proceed with confidence (Bandura, 1997). The following section will discuss student reflections about teacher feedback during initial and follow-up interviews.

*Student interviews.* Students expressed understanding that feedback in the classroom can be delivered in many forms. For example, one student noted that it made her feel proud when other students asked her for help. Student ease with partner and group work structures in the classroom enabled students to access peer relationships which were powerful sources of feedback. In follow-up interviews student responses included information which shed further light on the student perspective regarding types of feedback and the impact of feedback.

Students discussed individual teacher support. Teachers often moved throughout the classroom providing feedback and support to students as they worked. When asked to comment on practices that helped them in mathematics, some students commented that teachers walking around the room helping can “make me feel pressured. I’m afraid I’m wrong. I’d rather work with a partner.” Others were more positive and noted that “the teacher comes to individual students. But if you are stuck she will come over and help you and then come back and make sure you know what you are doing.”
Students considered graded worksheets, quizzes, and testing a form of feedback. Students held different opinions on the usefulness of these forms of feedback. Some students found grades helpful. “I love tests. I know what I’ve learned at the end of the subject … if I’ve got it.”

However, other students found them helpful. “I think tests just add pressure. Me, too, I feel the same.” When the researcher asked the final question of the student follow-up interview, self-efficacy was explained to students and they were asked what they felt their teacher could do to increase their feelings of self-efficacy. Four of the nine students interviewed used the construct of feedback in their responses. These students all related the desire for receiving feedback. One student remarked, “If I do a question I feel comfortable if the teacher checks it and I know I am doing it right.” Some students noted that teacher feedback gave them a sense capability for performing. “If you do it all and you get it right… and the teacher tells you [that] you can do it, you know it’s possible.” Other students echoed early comments endorsing feedback through tests and grades, or the need for positive feedback: “You need them to tell you [that] you are doing okay. Sometimes, I need to know. I like [it] when he comes to check my work in a hard lesson, stated one child.” Students expressed a need for positive feedback and an understanding that feedback can be delivered in forms and ways such as verbal feedback embedded in lessons, individual teacher support, and written feedback on tests and papers. This section analyzed student interview responses related to feedback. Students expressed the view that feedback was a positive influence in the mathematics classroom. In the next section interview data related to instructional strategies will be reviewed.

*Strategy Use.* This study interpreted student strategy use as the methods and processes students used to negotiate mathematics assignments. These strategies included practice, teacher
help, home help, mathematics strategies, alternative strategy use, rethinking, text sources, and explanations. This section explores strategy use through the perspective of students and teachers as discussed during interviews.

Students in both sites spoke about strategy use in the initial interview. They were asked about their sources of information when learning mathematics concepts. Responses from two students in traditional instruction classrooms were coded into three major categories: teacher help, home help, and text sources. Out of these students noted that teacher help included seeing the “…teacher do it because I can see how it is done. I can see how you’re supposed to do it and it helps me see the steps.” Students accessed parent help from home in a similar manner, with one stating: “I go to my parents or brother and organize [the work].” Finally, students in this group used text sources including practice and enrichment sheets offered by their teachers: “I look in the book and do a few problems. I do enrichment sheets. I like being able to have a choice to do the sheets that will help the most.”

Students in standards-based instruction classrooms answered with similar strategies. However, these answers indicated a greater degree of independence on the part of the student within the classroom. These students focused on paying attention in class, trying to do well on the work assigned in class, and doing their homework. As one student explained, “Usually I pay attention. It is easier because we go over what we will do. We go over questions and I can see why people were wrong or right.” Students noted teacher help and parent help. Students mentioned their teacher working with small groups of students or moving around the class to support students during independent work times. Small group work was also mentioned as a supportive strategy. One student from Site B provided the following summary: “Usually I learn
from the person helping me…whoever that is. When I am working in math my revisions in my solution help me. My dad also teaches me a lot.”

Students were asked to directly consider strategy the type of strategy helped them in mathematics work. Students from both sites discussed the type of strategy instruction the received in mathematics class and both groups expressed feeling confident to choose strategies that best fit their needs. One student noted, “You have to be careful how you use some of them [strategies]. I use the techniques that work the best for me. I understand [the work] and it is easier.” A different student said, “Some of the strategies we learn in math we know. If not, we go over them so we get them …like a new one. They really help when you are doing the work.”

Students also reported learning strategies at home and creating their own strategies. For example, one student explained that she had not been taught to create a drawing of a particular kind of fraction problem at school, but that she had found at home that drawing had been helpful. Other students reported being taught alternative approaches to computation at home by their parents. For example, while students were learning repeated subtraction as a strategy to solve 234 divided by 45, one student reported that his parent had helped him to do traditional long division at home.

Students reported being comfortable with the strategies taught by their teachers during lessons and finding them useful. These ranged from problem solving strategies such as underlining important words, to computational strategies such as rounding. There were no negative comments related to the strategies taught in school. No student reported feeling that they had to use every strategy taught by their teacher. “Many students explained that they felt free to find the way to make the strategies they had been taught at home and school work best for
themselves. “I do those strategies but I change the strategies that the teacher teaches us in school to strategies that work for me better.”

Students were asked what they did when mathematics presented a challenge for them. This question presented differences between the students in the two instructional settings. Students in traditional instruction classrooms used the following strategies: home help, teacher assistance, text sources, or alternative strategy use. Strategies suggested by students in standards-based classrooms included: rethinking, alternative strategies, group work, and teacher help. This question demonstrates that the children in traditional instruction classrooms are more likely to strategize through using text sources, that is using example problems in their textbook or worksheets, or to use adult help as compared to their peers in standards-based classrooms. Students in the standards-based classrooms reported working independently or relying on their peers to solve mathematical challenges. One student explained, “[If I am stuck] I try harder to move on to the end. If that doesn’t work I ask the kids at my table for help.”

This section reviewed student responses related to strategy use. Students expressed the ability to use strategies that best fit their personal needs. Students found strategies taught in class and at home useful to overcome mathematical challenges. In the next section data observed during problem-solving activities were analyzed.

Problem Solving Observations

Students developing self-efficacy can be expected to demonstrate increased levels of persistence in problem solving situations (Bandura, 1997). Therefore, in order to observe students in typical mathematics classroom in which the outcomes of self-efficacy could be observed, a problem-solving activity was conducted. Students participated in either large group or small group settings. This section discusses problem-solving observations in relation to the
constructs of social learning and strategy use. Further examination of problem solving activities, including an analysis of the results as they pertain to self-efficacy can be found in the section of this chapter dedicated to cross instrument analysis.

Students participated in large group problem solving activities during regular mathematics class periods. Small group sessions conducted by the researcher, met during student lunch periods. In order to complete researcher assigned task, the assignment students were required to estimate, compute, and explain how many hours they had watched television in their lifetime. Mathematics puzzles served as follow-up work for students who finished early. Directions read by the researcher included a statement informing students that working with peers was allowed. The intent was to provide an environment for social learning without making it obligatory.

*Social learning.* Problem solving activities offered the researcher an opportunity to observe student behavior in both sites as they worked with their peers facing the same challenge. The researcher observed how students in standards-based and traditional instruction classrooms spontaneously used social learning structures.

The researcher first observed students in small focus groups completing the problem solving activity. Traditional instruction classroom students participated in the mathematical problem with interest. Students sat around a large rectangular table to make partner or group work accessible. The four students listened carefully to directions and asked no clarifying questions. Directly after the researcher finished reading directions, the children began working quietly. As they worked, the researcher asked students questions about their thinking processes and work strategies. After approximately five minutes, students engaged in sporadic verbal interactions with each other. Students in this group primarily worked as individuals. When they
interacted with their peers there was a straightforward sharing of work. The following interchange is one example of the conversations in which students engaged:

Student 1: I am using the weeks of the year.

Student 2: Oh, I am using the seasons.

Student 1: Oh.

The students finished the problem easily within the given 30-minute time period. All students completed their responses and began the mathematics puzzles within 20 minutes.

Next, students in the standards-based instruction focus group completed the problem solving exercise. After the researcher related the directions, students immediately began interacting with their peers. Quickly, these students formed partnerships. Over the course of the activity students discussed strategies for processing the problem: “We could use the days in a year, multiply it by years.” Students adopted and discarded approaches to the problem sharing ideas with partners and within the group. The researcher observed that students adjusted their responses when partners and discussed work that would affect their own responses. Students settled on their own strategy, however, they continued to learn from their partners and look over their work repeatedly as demonstrated in the following example.

Researcher: What are you doing?

Student: I added instead of multiplying so I have to go back and fix this.

I realized this when I was writing my explanation.

[My partner] reminded me to explain.

Researcher: [Student is going back to recheck all of her computation and writing.]

Observations of whole classes engaged in the problem solving activities followed a similar pattern. These events occurred during regular mathematics class periods. Each site had
one classroom which began the activity quietly. Traditional instruction classrooms had one classroom which began quietly and remained quiet throughout the entire exercise. The second classroom at this site had a great deal of conversation before students began to work. Parallel discussions characterized classroom discussions in these classrooms. Students told each other of their intentions and talked about their work.

Student 1: I watch a lot of television.

Student 2: I’ll do my schedule in days and years.

Student 3: I don’t watch a lot. Maybe 600 or 700 hours. [Student estimates.] When I was young I did. I am going to say 700.

Students worked very quickly, moving to the mathematics puzzles well before the end of the given period. Fifteen minutes through the work period, half of the students in the class were working on mathematics puzzles indicating that students had completed the problem solving activity in half of the allotted time.

Students in the two standard-based classrooms behaved differently than students in the traditional instruction classrooms. One class started quietly and then began to compare work with neighboring classmates. These students worked with partners as they needed support or to reflect with another student mathematician. Children in the second standards-based instruction classroom began to interact with one another immediately after the directions concluded. Common topics of conversation included strategies, approaches for solutions, and questions. Most students in both of these classrooms used the majority of the work period to complete the problem solving activity. Twenty-five minutes into the activity six students had not yet begun the mathematics puzzles.
This section reviewed the problem solving activity as it related to social learning. During this activity, students applied social learning structures without direction from adults. Site A, standards-based classroom, students tended to be less efficient and proactive in their use of partner and group work than Site B, traditional instruction classroom, students. Site B students also tended to finish the problem solving task more quickly. In the next section the problem solving activity will be analyzed in terms of the construct of strategy use.

*Strategy use.* As students engaged in the problem solving activity, they demonstrated use of various strategies to aid in the completion of the assignment. This section reviews these strategies through observation data. Students completing the activity in small and large groups used similar strategies, as did students between sites.

Students in the traditional instruction classrooms each paused briefly to consider the question, arrived upon a strategy for solving the problems, and then moved toward a solution. Each child had some challenges deciding upon specific contributors to the problem, such as how many hours of television watching to attribute to a year of life. One student explained, “I keep on remembering that when I was younger I didn’t watch as much TV as I do now. (He keeps erasing.) I am using my age.” Students worked on ways to make their basic strategy work, sticking to one strategy once it was chosen. One student estimated the amount of television watched year by year. Another student reasoned that the amount of television watched would vary with the seasons and used these as a primary unit for estimation. A third student grouped the years of childhood, seven years and younger, into one group, reasoning that these were low viewing years. A final student depended on weekly viewing as a unit for estimation. Students in this group explained their success at this task based on knowledge of computation skills.
Students in standards-based classrooms began by re-reading the problem with their peers. As partners began to work together, each student none the less arrived at two separate approaches to solve the problem. One partnership reasoned that they could multiply the hours of television watched per day, multiplied by the number of days in the year. They intended to finish by multiplying by their age to arrive at a final estimate. As they worked, these students quickly realized they were dealing with numbers that were too unwieldy. They worked on strategies to reduce the size of their numbers and came upon division as a viable answer. Another partnership decided their principal unit of television watching was movies. They discussed the length of television movies and estimated the number of movies they watched in one week. After multiplying to find the amount of movie viewing hours in a year, this group returned to adjust the estimate for summer viewing. Students in both partnerships spent time going back over their work to re-prove after the initial problem solving was completed. To re-prove a student recalculated the entire problem next to the original calculations in order to check his or her work. Children in this site explained that their success was due to planning, adjusting, reproving, and computation skills.

Large group observations yielded similar results. Students in the traditional instruction site primarily choose to approach the problem in terms of the amount of television watched per day, multiplied by weeks and then years. Variations on this strategy included accounting for school days and weekends. Other reasoning took into consideration the difference in the amount of television watched at various ages. One student reasoned, “I watch one hour per school day and two per weekend day. That is nine per week. I started at the age of four. I am working it out per year.” Students working together at two tables developed a group strategy. Everyone at these tables used the same strategy, inserting their own data. Two students explained that their strategy
choice was based on the prediction of speed, “I am counting this by the days. It will be the fastest way.” Many students worked quickly and moved on to mathematics puzzles without completing a written explanation of their thinking. One student in this group stood out because of his adjusting. He explained,

I have 20 minutes of TV per day. I am estimating because I don’t watch the same amount each day. Then there [are] 365 days a year. And I took off 200 for the times I did not watch TV at all.

Students in the standards-based instruction classrooms chose similar approaches to the television estimation problem. However, they processed their approaches differently. Children most often chose hours of television watched per day, multiplied by weeks, and years as an approach. However, the researcher frequently observed variations which clarified the thinking and reasoning of this approach. Students used charts to organize yearly television viewing information, or differentiated viewing hours for weekends and weekdays. One student used a rounding strategy to make computation easier. Observations of student behaviors included rethinking strategies, reorganizing, adapting strategies, and correcting miscalculations.

This section reviewed observations of student strategy use in a problem solving activity. Many students in both classrooms chose similar approaches for solving the problem solving activity. Site A students finished the activity more quickly to begin the mathematical puzzle problems. Students in Site B spent longer working on the problem solving activity and were more likely to reconsider an initial strategy. In the next section, data from the Self-efficacy Survey will be reported.
Student Mathematics Self-efficacy Survey

In the last month of observations, students participated in a mathematics self-efficacy survey. This survey asked students to judge their self-efficacy by answering questions related to the influences and outcomes of self-efficacy. Children also reported on classroom structures which they believed helped and motivated them to be successful in mathematics class. In this section, the results of the Student Mathematics Self-efficacy Survey will be reported in terms of the four constructs of social learning, feedback, modeling and strategy use. For full results of the survey see Table 6.
Table 6

**Student Mathematical Self-efficacy Survey Results**

<table>
<thead>
<tr>
<th>Question</th>
<th>Site</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I have to solve a math problem I can think of different ways to solve it.</td>
<td>Site A</td>
<td>10.7 (3)</td>
<td>85.7 (24)</td>
<td>3.6 (1)</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site B</td>
<td>30.7 (12)</td>
<td>56.4 (22)</td>
<td>12.8 (5)</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>2. Working with a group to solve math problems is more helpful than working alone.</td>
<td>Site A</td>
<td>42.8 (12)</td>
<td>28.6 (8)</td>
<td>28.6 (8)</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site B</td>
<td>30.7 (12)</td>
<td>36.0 (14)</td>
<td>17.9 (7)</td>
<td>15.4 (6)</td>
<td></td>
</tr>
<tr>
<td>3. I am successful in math.</td>
<td>Site A</td>
<td>57.1 (16)</td>
<td>32.1 (9)</td>
<td>10.7 (3)</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site B</td>
<td>53.8 (21)</td>
<td>28.2 (11)</td>
<td>10.3 (4)</td>
<td>07.7 (3)</td>
<td></td>
</tr>
</tbody>
</table>

Note Site A: Total students in sample n=28

Note Site B: Total students in sample n= 39
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>1.</td>
<td>If I am having difficulty with a math problem I have many ways of figuring it out without going to the teacher.</td>
<td>Site A</td>
<td>21.4 (6)</td>
<td>67.8 (19)</td>
<td>10.7 (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site B</td>
<td>25.6 (10)</td>
<td>48.7 (19)</td>
<td>23.1 (9)</td>
</tr>
<tr>
<td>5.</td>
<td>Tough math makes my brain think in a good way.</td>
<td>Site A</td>
<td>57.1 (16)</td>
<td>35.7 (10)</td>
<td>7.1 (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site B</td>
<td>30.8 (12)</td>
<td>43.6 (17)</td>
<td>12.8 (5)</td>
</tr>
<tr>
<td>5.</td>
<td>If I stick with it, I can solve most math problems.</td>
<td>Site A</td>
<td>64.3 (18)</td>
<td>32.1 (9)</td>
<td>3.6 (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site B</td>
<td>56.4 (22)</td>
<td>36.0 (14)</td>
<td>5.1 (2)</td>
</tr>
</tbody>
</table>

Note Site A: Total students in sample n=28

Note Site B: Total students in sample n= 39
Table 6, continued

Student Mathematical Self-efficacy Survey Results

<table>
<thead>
<tr>
<th>Percent of total by site</th>
<th>Site</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site A</td>
<td>3.6 (5)</td>
<td>57.1 (16)</td>
<td>25.0 (7)</td>
<td>--</td>
</tr>
<tr>
<td>My classmates help me in math class</td>
<td>Site B</td>
<td>10.6 (4)</td>
<td>35.9 (14)</td>
<td>41.0 (16)</td>
<td>12.8 (5)</td>
</tr>
<tr>
<td>My thinking is important even if my answer isn’t correct.</td>
<td>Site A</td>
<td>78.6 (22)</td>
<td>21.4 (6)</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td></td>
<td>Site B</td>
<td>56.4 (22)</td>
<td>33.3 (13)</td>
<td>5.1 (2)</td>
<td>5.1 (2)</td>
</tr>
<tr>
<td>If I make a mistake I will try again in math class.</td>
<td>Site A</td>
<td>60.7 (17)</td>
<td>35.7 (10)</td>
<td>3.6 (1)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Site B</td>
<td>51.3 (20)</td>
<td>41.0 (16)</td>
<td>7.6 (3)</td>
<td>--</td>
</tr>
</tbody>
</table>

Note Site A: Total students in sample n=28
Note Site B: Total students in sample n= 39
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site A</td>
<td>17.8 (5)</td>
<td>25.0 (7)</td>
<td>42.8 (12)</td>
<td>14.3 (4)</td>
</tr>
<tr>
<td></td>
<td>Site B</td>
<td>2.6 (8)</td>
<td>28.2 (11)</td>
<td>20.5 (8)</td>
<td>30.8 (12)</td>
</tr>
<tr>
<td>1.</td>
<td>I enjoy doing math problems outside of school.</td>
<td>Site A</td>
<td>17.8 (5)</td>
<td>35.7 (10)</td>
<td>32.1 (9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site B</td>
<td>5.1 (2)</td>
<td>25.6 (10)</td>
<td>51.3 (20)</td>
</tr>
<tr>
<td>2.</td>
<td>When I finish my math work early I ask my teacher for harder work.</td>
<td>Site A</td>
<td>42.8 (12)</td>
<td>46.4 (13)</td>
<td>10.7 (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site B</td>
<td>28.2 (11)</td>
<td>48.7 (19)</td>
<td>20.5 (8)</td>
</tr>
</tbody>
</table>

Note Site A: Total students in sample n=28
Note Site B: Total students in sample n= 39
### Table 6, continued

*Student Mathematical Self-efficacy Survey Results*

<table>
<thead>
<tr>
<th>Percent of total by site</th>
<th>Site</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I could solve: 6/25 + 7.25 = ___ in two ways.</td>
<td>A</td>
<td>32.1 (9)</td>
<td>25.0 (7)</td>
<td>32.1 (9)</td>
<td>10.7 (3)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>28.2 (11)</td>
<td>51.3 (20)</td>
<td>20.5 (8)</td>
<td>--</td>
</tr>
<tr>
<td>14. Underline any of the phrases to the right that best describe what helps you succeed in math class.</td>
<td>See Table 1 for student responses.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. What do you do when you are stuck in math?</td>
<td>Try a new strategy</td>
<td>Ask a friend</td>
<td>Ask the teacher</td>
<td>Give up</td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>53.6 (15)</td>
<td>32.1 (9)</td>
<td>14.3 (4)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>48.7 (19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.5 (8)</td>
<td>28.2 (11)</td>
<td>.02.6 (1)</td>
<td></td>
</tr>
</tbody>
</table>

Note Site A: Total students in sample n=28

Note Site B: Total students in sample n=39
### Table 6, continued

**Student Mathematical Self-efficacy Survey Results**

<table>
<thead>
<tr>
<th>Site</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>35.7 (10)</td>
<td>35.7 (10)</td>
<td>21.4 (6)</td>
<td>7.1 (2)</td>
</tr>
<tr>
<td>B</td>
<td>20.5 (8)</td>
<td>12.8 (5)</td>
<td>33.3 (13)</td>
<td>33.3 (13)</td>
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</tbody>
</table>

Note: Site A: Total of students in sample n=28
Site B: Total of students in sample n=39
Table 7, continued

Student Response to Item 14 Student Mathematics Self-Efficacy Survey

<table>
<thead>
<tr>
<th>Strategy underlined by student for meeting challenge in math class</th>
<th>Number of Site A Students Selected Response</th>
<th>Number of Site B Students Selected Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>partner work</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td>teacher checks in as you work</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>homework</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>teacher works at the board</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>group work</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>students do examples on the board</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>practice problems</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>strategies you invent</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>new strategies from your teacher</td>
<td>18</td>
<td>24</td>
</tr>
</tbody>
</table>

Note: Site A: Total of students in sample n=28
Site B: Total of students in sample n=39
Table, continued

*Student Response to Item 14 Student Mathematics Self-Efficacy Survey*

<table>
<thead>
<tr>
<th>Strategy underlined by student for meeting challenge in mathematics</th>
<th>Number of Site A Students</th>
<th>Number of Site B Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>games</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>choice of work</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>enrichment</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>other fast strategies for problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>family</td>
<td></td>
<td></td>
</tr>
<tr>
<td>quizzes and tests (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>having fun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>everyday situations (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>independent work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>student work at board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>math book</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tutor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>keep trying</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Site A: Total of students in sample n=28

Site B: Total of students in sample n=39
Table 8

*Student Response To Item 16 Student Mathematics Self-efficacy Survey*

*Why do you work hard in mathematics?*

<table>
<thead>
<tr>
<th>Response Category</th>
<th>Internal or External Orientation</th>
<th>Number of students responding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Site A</td>
</tr>
<tr>
<td>Grades</td>
<td>External</td>
<td>8</td>
</tr>
<tr>
<td>To be prepared</td>
<td>Internal</td>
<td>3</td>
</tr>
<tr>
<td>Fun</td>
<td>Internal</td>
<td>5</td>
</tr>
<tr>
<td>Persistence</td>
<td>Internal</td>
<td>1</td>
</tr>
<tr>
<td>Learn new things</td>
<td>Internal</td>
<td>5</td>
</tr>
<tr>
<td>Future use</td>
<td>Internal</td>
<td>7</td>
</tr>
<tr>
<td>Job</td>
<td>External</td>
<td>1</td>
</tr>
<tr>
<td>Everyday application</td>
<td>Internal</td>
<td>5</td>
</tr>
<tr>
<td>Personal growth/challenge</td>
<td>Internal</td>
<td>1</td>
</tr>
<tr>
<td>Parents</td>
<td>External</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Site A: Total of students in sample n=28

Site B: Total of students in sample n=39

Comprised of 17 Likert-style questions, the survey employed a 4-point response format, using the following terms: 4 (*strongly agree*), 3 (*agree*), 2 (*disagree*), and 1 (*strongly disagree*).

*Social Learning*

Survey results included four social learning items. Item 2 referred to working in partnerships, or groups. Items 7 and 17 prompted students to think about relying on peers as a source of help. The final item in this category, item 14, asked students to choose from a list of
classroom structures which helped them as successful mathematics students. Choices presented on this list for students included partner work and group work.

In response to item 2 students reacted to the following statement: “Working with a group to solve math problems is more helpful than working alone.” The mean Likert score for students from both sites was 5.0, indicating that students in those classrooms generally agreed with the statement. Although students in standards-based classrooms showed a stronger preference for strongly agreeing with this question, participants at both sites choose strongly agree and agree approximately two-thirds of the time. In this way, students at both sites indicated that when faced with math problems, working in groups was a useful strategy when in challenging mathematics situations.

Students reaffirmed their support for social learning in their responses to question 7 which read: “My classmates help me in math class.” This item allowed students to consider a broader use of social learning in mathematics class. Students in traditional instruction classrooms responded with a mean score of 3.0, agree. Students in standards-based instruction classrooms judged the usefulness of help from their friends at 5.0, strongly agree. Students in the classrooms of both sites indicated their positive attitude toward working with peers in mathematics. However, students in standards-based classrooms choose strongly agree and agree approximately two-thirds of the time, while students in traditional classrooms made the same choices (strongly agree and agree) approximately half of the time. Students in both groups confirmed that peers provided support in challenging mathematics situations.

Social learning was further explored in item 14. In order to complete item 14, students selected classroom structures they believed “help(ed) you succeed in math” from a list of 12 possibilities. Students circled as many structures they felt appropriately responded to the item.
Two choices, including partner work and group work, qualified as social learning and will be considered in this section. Slightly more than half of the students in traditional instructional classrooms chose partner work as a classroom structure which helped them to be successful in mathematics. Students in standards-based classrooms made the same choice at a slightly higher rate. Students in both groups also chose group work as a structure for learning. Students in traditional instruction classrooms chose group work less than half of the time, while their peers in standards-based classrooms made this choice more than two-thirds of the time.

Item 15 asked students to choose what they did when “stuck in mathematics.” Choices included: (a) try a new strategy, (b) ask a friend, (c) ask the teacher, or (d) give up. Students in site A classrooms chose “ask a friend,” approximately one third of the time. Students in Site B classrooms made the same choice approximately one fifth of the time. Students in Site A classrooms chose “ask a friend” second only to “try a new strategy” as the explanation for what they would most likely do when challenged in mathematics class, indicating once again that they considered social learning a viable method of dealing with challenging mathematics. Students in Site B classrooms chose “ask a teacher” as the next most desirable strategy for handling difficult mathematics situations.

In this survey, students in both groups expressed belief in social learning structures as effective tools for learning. Responses to many items were similar across both sites. When the responses were not similar, students in standards-based classrooms generally expressed greater belief in social learning as an effective tool for dealing with mathematical challenges. In this section, analyzed data were related to social learning and the Student Mathematics Self-efficacy Survey. In the following section survey data related feedback will be examined.
Feedback

Survey results also reflected student beliefs about the importance and usefulness of feedback in the classroom. In this section, survey data from two questions related to feedback will be reviewed. Items 14 and 17 directly related to the self-efficacy source of feedback.

Item 14 asked students to choose from a list of possible strategies as sources for being successful in mathematics class. Feedback appeared in the group of options once as, “teacher checks in as you work.” Students in all groups expressed a belief that feedback that individual feedback was important. Students in traditional instruction classrooms chose this response sometimes, while the students in the standards-based classrooms choose this response approximately half of the time. At least one-fourth of the students in all groups studied responded that individual feedback was important to their success.

Item 17, “It is important for the teacher to tell me how I am doing in math every day,” asked students to think directly about feedback. Student response choices included:

1. Yes, I need the teacher to check in with me.
2. I would rather check in with my partner or group.
3. I know when I follow along with class work.
4. No, I know how I am doing.

Students in traditional instruction classrooms responded to the survey item with a preference for personal independence. Two-thirds of the students at this site selected, I know when I follow along with class work, or No, I know how I am doing. Students in standards-based classrooms responded to the survey item with a preference for feedback from their peers and teacher feedback. Students chose teacher feedback and group or partner work nearly one third of the time each.
Results of the survey demonstrated that students in the traditional instructional setting used teachers, friends, and the general instructional environment as sources of feedback. Students in standards-based classrooms accessed partners and groups more frequently for feedback. In this section survey data related to feedback was examined. In the next section data connected to modeling will be analyzed.

**Modeling**

Prior sections of this chapter discussed modeling in both traditional instruction classrooms and standards-based classrooms. Observations revealed that teachers at both sites modeled for students in large and small group instruction, as well as, through individual student support. The researcher also observed visual modeling at the white board during instructional discussions in both traditional and standards-based classrooms. As discussed in the previous section, Student Mathematics Self-efficacy survey item 14 required students to choose strategies which they felt would help them be successful in mathematics. One choice listed was “teacher works at board.” Students in both settings choose this option approximately half of the time with students in the traditional instruction classrooms demonstrating somewhat less of an inclination to make this choice than their peers in the standards-based classroom.

This section examined one item related to modeling. Students in both programs indicated a preference for visual information presented at the board during mathematics lessons. In the next section items relating to strategies will be reviewed.

**Strategy Use**

The Student Mathematics Self-Efficacy Survey results revealed student attitudes regarding strategy use in mathematics class. This section examines survey items related to strategy use. These items included items numbers 1, 12, 14, and 15 (See Table 6 for full survey).
Students responded to various strategy related situations. These items covered multiple strategy use, strategy adjustment, sources of strategies, and opportunities for strategy use.

Students to respond to the following: “When I have to solve a math problem, I can think of different ways to solve it,” to answer item one. Students in traditional instruction classrooms had a Likert scale score of 3.1 (4=Strongly Agree, 1=Disagree). Students in all classrooms indicated high levels of agreement with this statement. Only 6 students of the 67 in the study choose disagree or strongly disagree. This indicates a strong sense of confidence among the students regarding different types of strategy use.

In order to respond to Item 12, students reacted to the following statement: “If I make a mistake in math, I change my strategy and go on with my work.” Students from traditional instruction classrooms had a Likert scale score of 3 (agree). Children in standards-based classrooms had a Likert score of 3.3(4=Strongly agree). Students in the standards-based classrooms were slightly more likely to indicate agreement with this statement than their peers in traditional instruction classrooms who indicated a lower response. This trend in responses continued with other strategy use related items.

Item 14 offered students a list of possible structures for successfully meeting the challenges of mathematics class. Students circled all answers that applied to their mathematics experience. Two of these structures classified as strategies included: new strategies from your teacher and strategies you invent. Students from all four classrooms chose new strategies from your teacher approximately two-thirds of the time. The second strategy related-item offered related to student creation of personal strategies. Students from Site B chose strategies you invent slightly more often than students from Site A.
The final item corresponding to strategy use, item 15, related to student responses when facing challenging situations in mathematics. This item presented respondents with specific choices: try a new strategy, ask a friend, ask the teacher, give up. Students in both sites chose *try a new strategy* approximately half of the time. Children from Site A made this choice more often than students in Site B.

Students in both classrooms selected social learning, feedback, and computational strategies as helpful structures when faced with challenging situations in mathematics. Children in both instructional settings demonstrated positive attitudes toward strategy use in related questions on the Self-efficacy Survey. This section has reviewed the data related to strategies and the Student Mathematics Self-efficacy Survey. The following section will examine document analysis of work samples and teacher instructional materials.

**Document Analysis**

Document analysis of student work samples and teacher instructional materials confirmed observation and interview data. The researcher reviewed each set of documents through a set of four questions. These were formulated to answer the research questions which guided this study. In this section the document analysis will be examined in terms of the four constructs reviewed in this chapter (for full list of questions see Appendix 1.) These constructs included: social learning, feedback, modeling, and strategy use. Work samples and teacher instructional materials will be analyzed where they apply to each construct.

*Social Learning*

Shown through observations to be part of the classroom environment in both instructional settings, social learning featured student group and partner work. Conducted to establish a relationship between teacher instructional materials and structures observed in classrooms,
document analysis included a fraction and decimals unit observed in all classrooms. Review of all teacher materials was designed to determine the amount of support and guidance each program offered teachers in areas related to the development of self-efficacy. This section will review social learning related to teacher instructional materials.

*Teacher instructional materials.* Teacher materials for the traditional instruction classrooms included two wire-bound teacher manuals. The first program review question relating to social learning was question three: Do teacher materials support group work modeling and problem solving? Traditional instructional materials for this topic followed a similar pattern to other topics in the series. Designed to follow the same pattern, each day’s lesson followed a three-stage routine. Each began with a teacher directed instructional period, continued with guided practiced, and ended with independent practice. The text never suggested partner or group work to the teacher over the course of lessons for the topic. Although teachers could opt to do guided or independent work in partnerships or groups independently, the program offered no support to teachers trying to develop this practice.

Instructional materials for teachers in standards-based classrooms also followed a pattern throughout the year. However, lessons differed within each topic, including multiple day exploratory lessons, game days, instructional lessons, and wrap-up lessons. Within these lessons teachers were given specific structures for use of social learning. In the fractions and decimals topic there were four specific activities designed as partner or group activities. In addition, the teacher notes suggested partner discussion as a structure for furthering student thinking. Finally, the program featured dialogue boxes which displayed examples of student conversations for teachers. These dialogue boxes potentially supported teachers as they attempted social learning structures.
**Feedback**

Observations of teachers and students in both Site A and Site B showed feedback as an important feature of these classrooms. This section will review how teacher instructional materials supported the use of feedback in both sites, however, written feedback for student work samples were not reviewed. Although the researcher planned to collect teacher feedback written on student work samples did occur to the researcher, inconsistent responses by teachers on math log entries made this impossible to assess. Some teachers responded frequently to student work in math logs. Other teachers believed that logs were a place for free thinking and would be inhibited by feedback. Therefore, student work samples were not included in this section.

*Teacher instructional materials*. Teacher program question three examined: How do teacher materials offer support for developing feedback, enactive experiences, modeling? Teacher materials examined for the traditional instruction program supported teachers minimally beyond the computation skills developed in the unit. Materials offered no suggestions for feedback to students. Standards-based teacher materials offered specific advice for feedback through dialogue boxes and teacher notes. For example, teacher notes directed teachers to record student estimates on the board (visual support, or feedback), or move throughout the class and give feedback to students. The manual suggested ways to obtain student feedback by advising teachers to have students meet and compare results to their work. Teachers who used this program received many suggestions providing for feedback in instruction.

*Modeling*

Teachers in both groups engaged in modeling during mathematics instruction. Students also noted in interviews that their peers served as an important source of modeling information.
This section will review how teacher materials supported teacher efforts to model in the classroom.

*Teacher instructional materials.* Teacher program question three analyzed teacher instructional materials in terms of: support for developing feedback, modeling, and strategic thinking. Traditional instructional materials suggested modeling each day during the unit. The text specified direct teacher modeling of one computational process each day. Each step was straightforward and modeling was didactic. Standards-based materials used by teachers at Site A, embedded modeling in lesson instructions. Suggested examples included both student and teacher modeling. Each page of the student text was reproduced within the teacher materials. Below the copy of the student book directions for teaching the concept or skill on the page were given. Within these instruction teachers were frequently directed to explain or demonstrate concepts to students. Instructional materials coached teachers to let students model grid patterns in one session, or bring students together into a whole group and model how a procedure was done in another lesson. Teacher instructional materials advised teachers to model the connection between decimals and fractions as they occurred in discussions. General directions to teachers included modeling correct mathematical vocabulary. Teacher instructional materials for both sites included modeling. Traditional instructional materials contained teacher modeling of computation skills. Standards-based materials provided support for teachers to develop student modeling and teacher modeling of concepts, processes, and skills.

*Strategy Use*

Students in this study frequently engaged in strategy use during mathematics class. This section reviews the results of the document analysis related to strategy use. This review includes
problem solving activity work samples, teacher instructional materials and student classroom work samples.

*Problem solving activity work samples.* Student work samples from the problem solving activity were reviewed for strategy use and evidence of perseverance. Responses to the problem, which asked students to estimate the number of hours of television watched in their lifetime, were then coded and analyzed. Participants from traditional instruction classrooms chose many different approaches to this problem. The favored approach was to estimate the number of hours watched per day and multiply that by 365 for the number of hours watched in one year. Then students simply multiplied by their age for a final number of hours watched in their lifetime. This approach was chosen by approximately two-thirds of the students at Site B. One third of the students accounted for the number of hours watched in one week and multiplied to find the number of hours in a year. A few students approached the estimation through the amount of television watched per year. Four students demonstrated use of two-step strategies such as accounting for the amount of television watched in the seasons of the year with different values and arriving at a value for one year before multiplying that value by the number of years in their age. Five students included more than one strategy in their solutions.

Students from standards-based classrooms demonstrated more varied use of strategies. Half of the students used “days” as their major organizing strategy for approaching the problem. Only four students used weeks. Three students used years, the simplest strategy. Of the students using years, two varied the strategy by grouping the years of their life and assigning different values for hours watched. For example for, 0 to 3 years, 1 hour was watched per day, etc. Twelve students demonstrated use of a two-step strategy such as figuring different amounts of hours watched on weekends and weekdays.
Teacher instructional materials. The second question used to assess instructional materials was posed to confirm teacher program material content. This question was: Does the program offer students opportunities for strategies related to thinking, problem solving and metacognition? Analysis of traditional instruction materials revealed that students primarily engaged in straightforward computation during the unit lessons. Within the fraction and decimal unit, two days of lesson plans involved problem solving strategy lessons. During these days, the text directed teachers to teach specific strategies for problem solving, such as guess and check, or using a table. Word problems were part of many independent practice lesson sections, these problems typically required one-step solutions.

Instructional materials for the standards-based program embedded strategy use within instructional sessions. For example, one lesson directed students to find ways to partition strips into fractions. In this lesson, teachers directed students to take strips of plain paper and divide the strips evenly to show halves, thirds, fourths, fifths, and sixths. The text cautioned teachers not to give students strategies for completing this task. Other teacher instruction pages labeled as “student strategy” pages, outlined strategies teachers should observe and reinforce in the classroom. For example, these pages encouraged teachers to observe the strategies students used for addition of fractions with unlike denominators. Dialogue boxes on teacher pages supported strategy use by highlighting examples of student discussions which featured strategy use. These pages created teacher expectations that students should use to confer about strategies in the course of mathematics instruction.

Teacher instructional materials for both sites included strategy support. These texts presented support for strategy use differently and encouraged different types of strategy use.
Student work samples. Teachers gathered six student work samples for each student on non-observation dates. These samples provided confirmation of observational data related to the type of work students engaged in during mathematics class. In this section, analysis of student work samples reviewed strategies used in sample work. The researcher framed the analysis through six questions (see Appendix 1 for a full list of questions.) The first question related to strategy use: Does the work reflect strategic thinking?

Student work samples for students in traditional instruction classrooms revealed that strategy use was reflected in many of the assignments sampled. Occasionally, the samples contained multiple strategies. Students sometimes explained their work. When explanations were present they focused on the computations and applications. For example, the following student gave this explanation in response to a word problem.

Problem: Susan walked 2 ¼ miles each day and also biked 3 1/3 miles on Saturday. How far did she go each week doing both?

Student work and explanation:

\[
\begin{align*}
2 \frac{1}{4} \times 3 &= \frac{3}{2} \\
3 \frac{1}{3} \times 4 &= \frac{4}{12} \\
\frac{3}{12} + \frac{4}{12} &= \frac{13}{12} = 1 \frac{1}{12} \\
18 \text{ [illegible]} &= \frac{1}{2} \\
19 \frac{1}{2}
\end{align*}
\]

1. The fractions are different denominators, so I have to change them.

2. The LCD [lowest common denominator] of 3 and 4 is 12. So, I multiply 1/3 by 4 and 1/4 by 3 to get 3/12 and 4/12.
3. I multiply $2 \frac{1}{4} = 2\frac{3}{12}$ by 7 to get $15\frac{9}{12}$.

4. The answer is $19\frac{1}{2}$.

A second student took a more straightforward approach in answer to the same problem.

$$3 \frac{1}{4} \times 7 = 15 \frac{9}{12} + 3 \frac{4}{12} = 19 \frac{1}{12}$$

First, I multiplied $2 \frac{1}{4}$ miles by 7 because she walked $2 \frac{1}{4}$ miles every day of the week.

Then, I added the $3 \frac{1}{3}$ miles she biked on Saturday and got $19 \frac{1}{12}$ miles!

Finally, a third student approached the problem with a simple approach and explanation.

$$2 \frac{3}{12} + 2 \frac{3}{12} + 2 \frac{3}{12} + 2 \frac{3}{12} + 2 \frac{3}{12} + 2 \frac{3}{12} + 2 \frac{3}{12} = 15 \frac{9}{12}$$

$$15 \frac{9}{12} + 3 \frac{4}{12} = 19 \frac{1}{2}$$

I got this answer by adding.

Work samples from students in standards-based classrooms involved strategy use in most of the assignments sampled. These students also engaged in multiple strategy use and explanation of their strategies. For example, students in a Site B classroom were asked to find the answer to the following problem:

A kindergarten teacher had her class make alphabet books. There were 45 students in the class. The cover and end sheet use 1 sheet of paper each. Each letter of the alphabet used half a page, for two letters per page. No backs of pages were used. There were 100 sheets of paper per package. How many packages did the teacher need? Why?

Students solved to the problem using different strategies and approaches to communicating their thinking. One student took a step-by-step approach to her thinking and communication.

1. Front $\rightarrow$ $\rightarrow$ Back $= 2$ pages

2. $26$ letters / $2 = 13$ +
3. 2 front and back pages = 15 pages
4. 15 x 45 = 675 pages
5. \(675 \div 700 / 100 = 7\)
6. Answer – 7
7. The teacher needs 7 packs of paper because I multiplied and came up with 675 pages, but I knew to round to 700 and then the teacher used the extra on other stuff.

A second student attempted the problem with a different strategy.

45 students
26 letters
2 letters on each page
\(26/2 = 13\)

\begin{tabular}{cccccccccccc}
Front & & & & & & & & & & & & Back \\
1 & & & & & & & & & & & 1 \\
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 1 \\
\end{tabular}

\[
\begin{array}{c}
45 \\
x \ 15 \\
225 \\
450 \\
675 \\
\end{array}
\]

\[
675/100 = 6 \ R \ 75 \\
6 \ R75 = 7
\]

The kindergarten teacher will need 7 packages of paper. I know this because the total number of pages the teacher needs is 675. Seven packages will give her 700 sheets which will be enough for the class.
A third student explained his solution to this problem differently.

The teacher will need 7 packages of paper.

½ page for each letter of alphabet – 2 letters per page.

26/2 = 13 pages of letter + 2 pages for cover page and back page.

13 + 2 = 15 x 45 (students)= 675

The teacher will need 7 packages of paper. I know this because the total number of pages the teacher needs is <700.

The use of strategies in student work samples for this group differed from classroom observations. Students in these classes used strategies more often in the observed mathematics classes than was reflected in the work samples. Strategy use in class included more alternative strategies and evidence of deeper thinking (see Table 1 for explanation of strategies.) This difference could be explained by the format for work samples collection which differed from normal work collection structures for one of the teachers. One teacher at Site A did not regularly use math logs or journals to collect examples of student mathematical thinking. Therefore, students may have performed differently, or the work assigned in the math logs may have differed from normal tasks.

Conclusion

Observations, interviews, problem solving activities, a self-efficacy survey, and document reviews served as sources for this study. This section analyzed each one as it related to the four constructs of social learning, feedback, modeling, and strategy use. These examinations revealed that each construct was frequently found within the mathematics classroom environment. Students expressed support for the use of social learning structures in the classroom in interviews and surveys. Feedback and modeling were common to both instructional
settings. However, the frequency and form of feedback and modeling were found to differ depending on the site. Analyses revealed strategy use by students to be common to students in both sites. Again, the form and frequency of strategy use differed between the two sites.

The final section of this chapter will cross-analyze major constructs. Consolidated data will be examined for trends in social learning, feedback and modeling, and strategy use.

Integrated Analysis

Analysis in the following sections examines information from multiple instruments and interviews and relates the four major constructs discussed in this chapter to other significant research findings. This further exploration of the responses brings clarity and richness to understanding the experience of students in the study. This section first reexamines social learning related to problem solving, achievement, and self-efficacy. Next, the section analyzes feedback and modeling as they relate to scaffolding. Finally, the chapter concludes with a re-examination of strategies as they relate to self-efficacy and problem-solving.

Social learning

Previously in this chapter observation and interview data demonstrated that students in participating in classrooms used social learning structures. Teachers and students, used partner work, group work, and partner discussion, as structures for learning in all four classrooms. However, close examination of these data revealed that the frequency and type of social learning structures experienced by these students in Site A and B differed. In this section an analysis of social learning in these four classrooms and its relationship to problem solving, achievement and self-efficacy will be reviewed.

Problem-solving and achievement. Students in traditional instruction classrooms experienced social learning in the form of group work and partner work. These students
infrequently used social learning as a strategy in the problem solving activity. Program materials did not encourage teachers to place students in social learning situations. Students in these instructional settings participated in the problem solving activity in both a small focus group and whole classroom groups. The researcher scored the work produced by students during the problem solving activity using a rubric that included the following categories: computation, strategy use, reasoning, communication, and thoroughness (See Appendix 1). The computation indicator on the rubric was used to record student accuracy of calculations made in reaching a solution to the problem. Strategy use indicator was used to record the appropriate strategies students used to estimate the number of hours of television watched in their lifetimes. The reasoning indicator was used to record the logic and complexity of the reasoning used by students to complete the problem solving activity. Communication indicators were used to record the depth of the explanation given by students in the problem solving activity. The thoroughness indicator was used to record the extent to which students completed all of the elements of the problem solving activity including computation and explanation. Students’ mean scores for the problem solving activity revealed an area of strength in computation and weaknesses in communication and thoroughness (See Table 9).
### Table 9

**Mean Scores for the Problem Solving Activity**

<table>
<thead>
<tr>
<th>Group</th>
<th>Computation</th>
<th>Strategies</th>
<th>Reasoning</th>
<th>Communication</th>
<th>Thoroughness</th>
<th>Total Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A</td>
<td>4.0</td>
<td>3.2</td>
<td>3.0</td>
<td>3.8</td>
<td>3.8</td>
<td>3.56</td>
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<td>Focus</td>
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<tr>
<td>n=5</td>
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<tr>
<td>Site B</td>
<td>3.0</td>
<td>2.75</td>
<td>2.75</td>
<td>1.0</td>
<td>2.75</td>
<td>2.45</td>
</tr>
<tr>
<td>Focus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>n=4</td>
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<td>Site A</td>
<td>3.86</td>
<td>2.61</td>
<td>2.57</td>
<td>2.54</td>
<td>2.68</td>
<td>2.85</td>
</tr>
<tr>
<td>Large</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Site B</td>
<td>3.29</td>
<td>2.06</td>
<td>2.20</td>
<td>1.71</td>
<td>1.91</td>
<td>2.23</td>
</tr>
<tr>
<td>Large</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>n=35</td>
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</tr>
</tbody>
</table>

Students in Site A (standards-based) classrooms experienced frequent use of social learning structures. These students expressed a preference for these structures on the Student Mathematics Self-efficacy Survey. Analysis of observations revealed that standards-based classrooms not only used partner and group learning structures frequently, but they used them effectively. Program materials encouraged teachers to embed social learning in daily lessons. For example, during one lesson in the unit on fractions and decimals students were directed in one
lesson to create a grid for demonstrating decimals. Teachers were directed to have students have students work in groups. Support for group work was given to the teacher in the form of suggested student dialogue and directions for giving feedback to groups.

Children in standards-based classrooms also participated in the problem solving activity. Their achievement results revealed strengths in computation, use of strategies, and thoroughness. During the problem solving activity these students frequently used social learning structures. Observations revealed that students in standard-based classrooms relied on their peers for feedback and confirmation of their approaches to problem solving. These students also changed their response when group members communicated new information relating to their answer. Multiple observations noted students erasing and fixing work based on peer input. This exchange between the researcher and a student demonstrated students adjusting work based on information from a peer:

[Two students were discussing the solution and the problem as the researcher approaches. Student 1 was going back and erasing the part of the problem she had written. ]

Researcher: Can you tell me what you are doing?
Student 1: We were talking and I realized I had forgotten something.
Researcher: What was that?
Student 1: Well, Ellen is counting the days she watched tv on the weekend as different then the days during the week...
Researcher: Did that make you change your work.
Student 1: Yea, I thought I watched more TV when I was little, but now I have a lot of homework and stuff to do so I am starting again.
[Student begins to re-compute the estimation of time spent watching television based on new information.]

*Self-efficacy and motivation.* This section explores the coexistence of experience with social learning structures and self-efficacy. Students in both sites completed the Student Mathematics Self-efficacy Survey. Designed as a self-reporting instrument, this survey required children to respond to 17 items related to the sources and outcomes of self-efficacy (See Appendix 1 for the full survey.) Students in traditional instruction classrooms received moderate to low exposure to social learning structures. These children reported moderate self-efficacy (See table 10). When asked “Why do you work hard?” they responded 20 of 39 (51.2%) times with externally oriented answers (grades, my parents, for college). Students in standards-based classrooms experienced high levels of social learning in their mathematics classrooms. These students reported moderate levels of self-efficacy. When asked “Why do you work hard?” these children responded with internally motivated answers 18 of 28 (64.2%) times (to learn new things, it helps me, I’ll be smarter).
### Table 10

**Self-efficacy Survey Results for Classrooms in Site A and B**

<table>
<thead>
<tr>
<th></th>
<th>Mean Self-Efficacy Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site A</strong></td>
<td></td>
</tr>
<tr>
<td>Classroom 1</td>
<td>3.2</td>
</tr>
<tr>
<td>Classroom 2</td>
<td>3.2</td>
</tr>
<tr>
<td>Site Mean</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>Site B</strong></td>
<td></td>
</tr>
<tr>
<td>Classroom 1</td>
<td>3.0</td>
</tr>
<tr>
<td>Classroom 2</td>
<td>2.9</td>
</tr>
<tr>
<td>Site Mean</td>
<td>2.9</td>
</tr>
</tbody>
</table>

4=Strongly agree, 3=agree, 2=disagree, 1=strongly disagree

This section reviewed the data related to self-efficacy and social learning structures. Students in classes with low frequency levels of social learning based on observations had moderate levels of self-efficacy. These students reported high levels of externally based motivation for learning mathematics. Students in classes with high frequency levels of social learning experiences reported high-moderate levels of self-efficacy. These students reported high levels of internally based motivation for learning mathematics. In the next section feedback and modeling will be re-examined.

*Feedback and modeling.* Classroom discussions in both sites frequently included form of feedback and modeling. Students experienced both direct and indirect forms of feedback within mathematics instructional discussions. Direct feedback has been previously defined as feedback
clearly stated by the teacher. Indirect feedback was defined as positive feedback which was implied through the absence of negative feedback. For example, a teacher may have asked a student to respond to a question as part of a lesson. If the student is correct but the teacher does not directly make a statement such as, “Good job,” and simply writes the answer on the board, moving on with the lesson, this was classified as indirect feedback. As stated earlier in this chapter, teachers also embedded modeling within mathematics lessons. During these times teachers often used students as models as well. Reviewed research revealed feedback and modeling as two primary sources of student self-efficacy (Bandura, 1997). Later research tied feedback and modeling to higher levels of classroom discussion (Schweinle, Meyer, & Turner, 2006; Turner, Cox, DiCintio, Meyer, Logan & Thomas, 1998). When teachers use feedback and modeling to build understanding and develop concepts, scaffolding of learning occurs (Meyer, Logan, & Thomas, 1998). Scaffolding has been defined for this study as the use of feedback and modeling to build classroom discussions to which featured some of the following: explanation, development of problem solving, higher order thinking, or application of mathematics concepts.

Discussions in both sites included scaffolding. These discussions encompassed a series of interactions between teachers and students which featured modeling and feedback and frequently lasted for the majority of a lesson. Discussions which did not lead to scaffolding frequently contained large numbers of follow-up and clarifying questions.

Nine discussions which included scaffolding occurred during the 36 regular observation periods. Traditional instruction classrooms held one of the nine scaffolded discussions. Discussions in these classrooms contained approximately half of the total questions asked to clarify a previous statement made by students. Lessons in traditional instruction classrooms also included most of the follow-up questions asked children. These types of questions led to a
question and answer format discussion that did not include to in-depth explanations. Standards-based classrooms held eight of nine scaffolded discussions. Instruction in these classrooms included fewer of the observed clarifying questions follow-up questions. Students in the classroom with higher levels of scaffolding were more likely to have greater self-efficacy, be taught multiple strategies, and experience social learning in the classroom (Schweinle, Meyer, & Tuner, 2006). Students in standards-based classrooms reported moderate to agreement with self-efficacy statements and experienced high levels of scaffolding which supports research findings. Therefore, scaffolding of feedback and modeling into high level discussion could be indicated as an important feature of classrooms seeking to emphasize student self-efficacy.

This section has shown the importance of the connection between high quality feedback and modeling observed in this study. The final section will investigate the coexistence between strategies, self-efficacy, and problem solving achievement.

*Strategies and self-efficacy.* Students in classrooms observed for this study engaged in frequent strategy use during mathematics class. As discussed earlier in this chapter strategy use was present at both sites, although the frequency and type of strategies use differed. The researcher observed students in traditional instruction classrooms applying moderate strategy use. These students reported their self-efficacy to be moderate (See table 1). Students in standards-based classrooms demonstrated strong strategy use. Children in these classrooms reported moderate/strong self-efficacy.
Table 11

*Total Observations of Strategy Use During Classroom Observations and Problem Solving Activity Compared to Mean Student Mathematics Self-efficacy Survey Score*

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Self-efficacy Score</th>
<th>Percent of Total Strategy Use Observations Per Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom 1</td>
<td>Class 1: 3.2</td>
<td>38.88</td>
</tr>
<tr>
<td>Classroom 2</td>
<td>Class 2: 3.2</td>
<td></td>
</tr>
<tr>
<td>Site Mean</td>
<td>Group: 3.2</td>
<td></td>
</tr>
<tr>
<td>Site B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom 1</td>
<td>3.0</td>
<td>61.11</td>
</tr>
<tr>
<td>Classroom 2</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Site Mean</td>
<td>2.9</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion

This chapter examined data gathered from observations, interviews, problem solving activities, self-efficacy surveys, and document analysis in the context of four major constructs. It also analyzed traditional instructional classrooms and standards-based classrooms. Review of
data revealed that students in classrooms which experienced frequent, high quality, social learning reported higher self-efficacy and achieved higher scores in problem solving activities than students in environments which did not stress these structures. Investigation of feedback and modeling data showed that these sources of self-efficacy often formed the basis of quality high level discussions. Exploration of data related to strategy use revealed that students in classrooms with frequent strategy use reported higher self-efficacy and achieved higher scores on the problem solving activity.
CHAPTER FIVE: SUMMARY AND CONCLUSIONS

The purpose of this study was to observe students in mathematics classes as they experienced the interactions of enactive attainment, modeling, and feedback and gained understanding of how these occurred in actual classrooms. Of further interest to the researcher was the related study of the outcomes of these interactions in terms of perseverance in mathematical problem solving activities. Students in the schools observed for this study spent one hour each day in the mathematics instructional environment. During that time they encountered scores of opportunities to develop self-efficacy as they compiled prior experience, received feedback, and viewed teacher and student models. Previous research has demonstrated that students should have benefited from these experiences through increased perseverance, achievement, and strategy use (Bandura, 1997; Lent, Brown, & Larkin, 1984; Pajares & Johnson, 1993; Zimmerman & Pons, 1990).

This chapter will begin with a summary the research process. Next, the findings of this study will be explored in relation to each research question which guided this study. Then, the limitations to the research will be examined. Implications of the study will be considered in the following section of the chapter. The chapter will conclude with suggestions for future research.

Summary of Research

The central purpose of this study was to observe the daily mathematical environment of students as they encountered sources of self-efficacy (enactive attainment, modeling, feedback). Two sites participated in the study. Students from two fifth grade classrooms were studied at each site. Mathematics instruction at Site A featured standards-based teaching structures including emphasis on problem solving, strategy use, and communication of mathematical thinking (Shenk & Thompson, 2003). Mathematics instruction in Site B classrooms featured a
traditional program and teaching structures including emphasis on computation, transmission of information from teachers to students, and rote memorization. All teachers at both sites primarily followed the instructional model of the programs given to them by their administration. The differences in mathematics programs between the two sites provided the possibility of observing environmental variations that may have affected student experiences related to self-efficacy. The researcher conducted 10, 30-minute observations in each classroom. These observations had two main purposes. First, these observations were designed to gather data related to student activities during mathematics instruction. The second purpose of the observations was to study the interactions of students with the mathematics environment.

All students participated in researcher-developed problem solving activity in either whole class groups or focus groups. The researcher created balanced ability focus groups using the teacher scored Mathematics Evaluation Checklist. This checklist ranked students’ ability in mathematics strategy use, problem solving skills, and communication. The purpose of the problem solving activity was to observe students using mathematics strategies in a challenging mathematical situation. The problem solving activity required students to estimate the amount of hours they had viewed television in their lifetimes. Directions asked participants to compute a reasonable estimate and explain their reasoning. The researcher provided students who completed the problem early with supplemental mathematical puzzles.

In order to support the data gathered from observations, interviews were conducted with focus groups of students and with individual teachers from each site. Interviews with students were conducted after five observations and before the final observation. Semi-structured interviews focused on questions derived from a review of the literature and a preliminary examination of observation data. Interview questions explored the strategies students used to
overcome challenges in their mathematics classes. Teacher interviews were conducted at the end of the observation period. Questions for these interviews focused on teachers’ perceptions of their role in developing the classroom environment and student self-efficacy in mathematics.

Direct information regarding student’s mathematics self-efficacy was gathered through a survey. This instrument collected responses to 17 items which asked students to report their impressions of factors related to sources and outcomes of self-efficacy in the classroom (See Appendix 1 for full instrument). The researcher administered the Student Mathematics Self-efficacy Surveys in whole group settings, during regularly scheduled mathematics class periods.

The final data sources included two types of document analyses. The first type, six student work samples from each student, was collected by classroom teachers over the course of the study. The second type, teacher instructional materials, was analyzed at the end of the school year. Sets of questions developed by the researcher guided the analysis of both materials.

Analysis of data were both inductive and deductive. The researcher began by reviewing fieldnotes and interview transcripts and creating preliminary coding categories. As research continued, the researcher asked new questions during observations based on emerging coding themes. Follow-up interview questions were formed to answer questions derived from early data analysis. Once observations, interviews, and problem solving activities ended, final coding procedures began (For Final codes and definitions please see Appendix 1). Data from each source were analyzed separately for patterns. Next, a review of all data was undertaken to search for wider or crossing patterns.

Analysis of the data revealed four major constructs which included: social learning, feedback, modeling, and strategy use. These categories served as organizing themes for further
exploration of the data. The following sections summarize the analyses of those constructs according to each research question.

**Research Question One**

The first question which guided this research was: how do students experience the development of mathematics self-efficacy in the classroom? This question was answered through the findings related to the four major constructs of social learning, feedback, modeling, and strategy use. Each of these was analyzed separately. The findings are summarized in the following sections.

**Social learning.** Analysis of observations revealed that social learning structures (classroom routines and instructional practices) in the standards-based and traditional instruction mathematics classrooms included peer discussion, partner work, and small group work. Students in both Site A (standards-based) and Site B (traditional instruction) classrooms reported these structures as helpful strategies when faced with challenges in mathematics class. For instance, students stated in interviews that peers explained mathematics more clearly than their teacher. Children also found help from their peers more accessible than help from their teacher. The findings regarding social learning in each instructional program are reviewed below.

Traditional instruction classrooms engaged in social learning practices on a regular basis. However, the quality of student interactions was inconsistent. Although some observations revealed supportive behavior between students, peer interactions primarily consisted of parallel behaviors in which students worked beside each other without helping each other or engaging in communication which affected the outcome of the work. Partner work, the most frequent form of social learning in these classrooms, primarily focused on performance goals. Students worked on assignments with computation based tasks with one right answer. In interviews, these children
expressed concerns about the way groups and partnerships functioned. Focus was on their work being copied rather than the personal benefits of group work. In the formal problem solving activity, students from this site choose to work as individuals rather than work in partnerships or they worked as parallel partners. On the self-efficacy survey item related to social learning, (item 15, see Appendix E) approximately one fifth of the students from traditional instruction classrooms reported they would “ask a friend” when stuck in mathematics class. Unfortunately, the teacher materials for this instructional program offered no support for teachers using social learning structures. Finally, it was noted that students in these classrooms experienced less social learning and scored lower score for total problem solving on the Problem Solving Activity Scoring Rubric (see Appendix F) than their peers in the standards-based classrooms.

With the exception of days on which assessments were given, students in standards-based classrooms engaged in social learning every day that observations took place. Students in these classrooms worked effectively in groups and partnerships. Partner work was based in discussion of strategies, approaches to assignments, and computation. Partner discussions in these classrooms centered on mastery goals, such as understanding concepts and explaining processes. Teachers embedded partner discussions into their instructional routines in the form of “turn and talk” routines. Students participated in small group work for homework checking, completion of daily assignment, and problem solving activities. In the formal problem solving activity, students from the standards-based classrooms spontaneously worked with partners to discuss strategies. These children used information from their group and partner discussions to adjust their work. When asked “What do you do when you are stuck in mathematics class?” on the self-efficacy survey, almost half of the students in the standards-based classrooms chose “ask a friend.” Teacher program materials for this site supported social learning through explicit instructions for
students working with partners and in groups during activities. Student dialogue pages in the
teacher’s manual demonstrated the interactions teachers could expect from students working
together in partnerships and groups. Finally, it was noted that these students had high total
problem solving scores on the Student Problem Solving Activity Scoring Rubric and at the same
time had more frequent access to social learning in their classroom than students in traditional
instruction classrooms.

This section has reviewed the findings of this study regarding social learning. In the next
section, the finding related to feedback will be reviewed.

*Feedback.* Observations and interviews revealed that students in mathematics classrooms
received feedback from teachers and fellow students. Feedback from teachers was found to be
given directly using comments such as, “right”, “good”, “no,” or indirectly, when a teacher
embedded a student contribution in a lesson and continued on without comment. Discussions
with students revealed that they did not automatically accept indirect feedback as being positive.
During interviews students from both sites expressed contradictory opinions about different
forms of feedback found in their classrooms. Students felt that teacher support during
independent work was both helpful and intrusive. Tests and grades provided both positive and
negative feedback for different students. Some students viewed formal assessments as pressure,
where others saw them as validation of their progress. Differences between traditional and
standards-based classrooms also emerged.

Students in traditional instruction classrooms experienced feedback primarily through
responses embedded in regular instruction. Teachers asked students to participate in lessons by
asking students questions and then gave feedback in one of two ways. First, they might have
directly offered praise or criticism for the student’s answer. Second, they might have offered no
direct feedback, but may have accepted the answer and moved on, perhaps recording the answer on the board. This was considered a form of indirect feedback. Feedback experienced by students in these classrooms split nearly evenly between direct and indirect feedback within the total observations of feedback. Student feedback to each other, which children expressed as an important feature of classroom learning, accounted for a small part of the total feedback.

Feedback in these classrooms also focused on computation and questions with right or wrong answers (mastery goals). A quarter of students in this group thought that teacher support lead to success. When asked to respond to the statement: *It is important for the teacher to tell me how I am doing every day.* A majority of students reported *no feedback*, or *I pay attention in class*, as the best options for receiving feedback. Finally, teacher instructional materials for this site offered feedback support only for computation related material. Teachers were offered ways to answer student questions related to computation and process within each lesson.

Students in standards-based classrooms also experienced feedback primarily through responses embedded in regular instruction. However, the frequency and sources of feedback they received varied more widely than those of their peers in the traditional instruction classrooms. Students in these classrooms experienced mostly direct feedback with only some indirect feedback within each lesson. A review of responses to the Student Mathematics Self-efficacy Survey concluded that feedback from their peers was important on the Student Mathematics Self-efficacy Survey. Most students in this group, when asked about the importance of daily teacher feedback reported that they would benefit from either peer or teacher feedback. The remaining students choose *no feedback*, or *I pay attention in class*. Teacher instructional materials for this program supported the development of feedback structures in the classroom through explicit directions and examples.
Modeling. Students in both instructional programs experienced modeling as a part of mathematics instruction. Teachers and students served as models for students during mathematics classes. Traditional and standards-based classrooms varied in the frequency and format of the modeling students experienced. On the Student Self-efficacy Survey, when asked which strategies helped them to succeed in math class, students from both groups choose visual support as an important strategy for success in math (for a list of other responses see Appendix E.) Visual support included teacher work done on the white board, overhead projector, and data projector during mathematics class. This support typically consisted of a visual record of the classroom discussion.

Students in traditional instruction classrooms frequently served as models during class discussions. Teachers primarily asked students to share one brief statement focused on computation and mathematic process-related skills at the board. Follow-up and clarifying questions generally related to how the students arrived at their answers. When the teacher served as the model, computation was also the primary topic. Modeling examples tended to be brief, rarely accompanied by explanation. Teachers in these classrooms frequently used the white board as a visual support for modeling. Peer modeling within partner and group work was not observed during any of the sessions by this researcher. Instructional materials offered teachers of the traditional program suggestions for modeling computational processes.

Standards-based mathematics classrooms also featured modeling. Teachers frequently modeled: computation, strategy use, application, and explanation of mathematical processes. Student modeling in standards-based classrooms included initial computation as well as, explanations of strategies and alternative processes for reaching the same answer. Teachers asked students open-ended questions which led to broader possibilities for modeling as students
gave individual answers. Students also frequently modeled for peers within social learning situations. When teachers in these classrooms served as the model, the example tended to include explanations, strategies, and applications, as well as, computations. Students frequently provided models for their peers in small groups and partnerships. It was observed that students switched the roles of modeler and learner frequently. Teacher support materials for this program embedded suggestions for modeling in the lesson instructions. Examples of teacher modeled mathematical reasoning, strategies, and applications were given. Program directions also featured opportunities for student models in many lessons. For example, during a lesson in which students were directed to use grids to determine the value of decimals teachers were directed to have students model their successful strategies for other students.

*Strategy use.* Students at both sites used strategies to navigate challenges in mathematics class. When interviewed, students expressed confidence in using and adjusting strategies to suit their individual needs. Strategies were most clearly observed in the TV Time Estimation Problem Solving Activity and then discussed with students in interviews. The TV Time Estimation Problem Solving Activity asked students to estimate the number of hours they had watched television in their lifetimes.

Strategies for navigating the challenges of mathematics class were categorized into two groups; independent strategies and help from outside sources. Students in the traditional instruction classrooms sited parent help and text sources as the best strategies for meeting the challenges of mathematics class. When working to solve the TV Time Estimation Problem Solving Activity these students generally chose one strategy and did not deviate from that approach. More than any other strategy, students chose the simplest strategy for completing the task, which was to estimate the number of hours of television watched per year and to multiply
this value by age. Alternative strategies chosen by students at this site included estimating the amount of hours watched in a week, season, or day. When asked to explain their success, students from the traditional instruction classrooms stated that they knew their computation skills. A majority of students in these classes also reported being able to think of and use alternative strategies when faced with challenges in mathematics. Student work samples confirmed the use of basic strategies by these students. Of the six mathematics assignments collected from this group for document analysis, three required that students use strategic thinking to successfully complete the task. Students were observed using some multiple strategies as well as single strategies in math logs.

Students in standards-based classrooms reported strategies for navigating the mathematics classroom which fell within the independent category. These included: paying attention and “asking the people around me.” Students offered as responses: use of alternative strategies, rethinking, using group members, and asking the teacher, as the best strategies for handling challenges in mathematics class. All but the last of these strategies required the students to be independent in their learning, or work without adult support. Within the problem solving activity, students from this site used various strategies for estimating the hours of television viewing in their lives. Strategies used included days, weeks, and hours per year for which they viewed television. Students also applied variations to their work through rounding strategies to account for differences in weekend viewing. When asked to explain why they believed they had been successful on this task, students sited planning, adjusting, reproving, and using their computation skills as their most successful strategies. Responses to strategy-related items on the Student Mathematics Self-efficacy Survey demonstrated a strong comfort level with strategy use. Most students in this group reported being able to think of a new strategy when in a challenging
situation, while the majority reported changing their strategy when challenged. Student work samples for standards-based instruction classrooms revealed that two-thirds of the assignments collected required strategy use. As with the traditional instruction students, students in the standards-based classrooms demonstrated the ability to use multiple strategies within the same problem.

In this section the findings related to strategy use were summarized. Cross analysis yielded findings related to feedback and modeling, and perseverance. The following section will summarize the findings related to feedback and modeling.

**Feedback and modeling.** Cross analysis of observation data revealed a pattern of embedding feedback and modeling in classroom discussions. When teachers used feedback and modeling to raise the level of understanding, thinking, and strategizing within the mathematics lesson the structure was re-categorized as scaffolding (Schewinle, Meyer, & Turner 2006; Turner, Cox, DiCintio, Meyer, Logan, Thomas, 1998). Observed on a total of nine occasions, scaffolding primarily occurred in standards-based classrooms. Instructional materials supported the development of scaffolding for teachers in this program through pages which demonstrated scaffolded classroom discussions. Discussions in traditional instruction classrooms were more likely to include strings of follow-up and clarifying questions. Rather than building toward higher levels of thinking, discussions in these classrooms related computational information and information related to use of algorithms.

**Strategies and self-efficacy.** Cross-analysis of data from multiple sources revealed increased self-efficacy in classrooms which also engaged in high levels of strategy use. Students in traditional instruction classrooms reported moderate agreement with self-efficacy statements (2.9) on the Student Mathematics Self-efficacy Survey and demonstrated moderate use of
strategies both in the classroom and in the researcher’s problem solving activity. Students in standards-based classrooms reported strong agreement with self-efficacy statements (3.2) and demonstrated high use of strategies both in the classroom and in the TV Time Estimation Problem Solving Activity.

This section summarized the findings related to research question one. Findings connected to the constructs of social learning, feedback, modeling, and strategy use. In addition the findings related to scaffolding and self-efficacy and strategy use were summarized. In the next section, findings related to question two will be summarized. These findings include perseverance and problem solving.

Research Question Two

The second question to guide this research was; how do students experience perseverance in problem solving activities? To answer this question, the researcher observed students in the classroom and students participated in a formal problem solving activity. Participants in this activity estimated the amount of television viewed over their lifetime, calculated that amount, and explained their processes for reaching a solution to the problem. Findings related to problem solving achievement and perseverance will be summarized in this section.

Perseverance. Student perseverance was observed in the form of effort, persistence, and rethinking. Students in standards-based classrooms were three times more likely to engage in these behaviors than their peers in traditional instruction classrooms. Student work samples from produced as a result of the problem solving activity were analyzed. Findings of this analysis revealed a pattern similar to the classroom observations. Behaviors categorized as demonstrating perseverance included erasing, redoing work, rethinking, checking work, and assessing thoroughness. Students (n=42) in traditional instruction classrooms had a total of 27 observations
of perseverance. Students (n=39) in standards-based classrooms totaled 69 examples of perseverance. Erasures accounted for a large part of the perseverance observed in students in the traditional instruction classrooms. Thoroughness, redoing work, checking, and rethinking accounted for a very small portion of the perseverance. Erasures accounted for approximately half of the perseverance observed in students in standards-based classrooms. A majority of the remaining observations of perseverance standards-based classrooms were in thoroughness. The remaining observations were split between redoing work, checking work, rethinking, and proving work. Evidence of these work attributes was gathered through student work. For example, some participants completed the computations which would support their estimation, drew a vertical line down the page, and then completely redid the work using new computational methods. One student, when asked by the researcher to explain his work, categorized this work as “reproving.” Rethinking was evidenced when students had crossed large sections of work, or changed their approach to the solution. Students in the traditional instruction classes were less likely to demonstrate perseverance related behaviors. However, when they did, these behaviors most often took the form of erasing. Standard-based students were more likely to exhibit thoroughness in their work.

*Problem solving achievement.* Data related to self-efficacy and problem solving total scores are summarized in the following section. Students in traditional instruction classrooms averaged the following scores on the Problem Solving Activity Scoring Rubric: focus group, 12.25; whole group, 10.97. Students in the standards-based classrooms averaged the following total scores on the Problem Solving Activity Scoring Rubric: focus group, 14.0; whole group 14.26. These scores demonstrated that students in the traditional instruction classroom exhibited lower strategy use and lower thoroughness than students in the traditional instruction classes.
During the problem solving activity, students in the traditional instruction group were more likely to rely on independent work than on social learning strategies. When asked to judge their own ability to succeed on the task before work began, 2% of students in traditional instruction classrooms choose highly likely to succeed. Forty-two percent of students in standards-based classrooms selected highly likely to succeed. Overall, mathematical self-efficacy, as reported on the Student Mathematics Self-efficacy Survey, matches the achievement results of the problem solving activity. Students in traditional instruction classrooms reported moderate self-efficacy and achieved moderate results on the problem solving activity. Students from standards-based classrooms agreed to strongly agreed with self-efficacy statements and demonstrated moderate to high total scores the problem solving activity.

Research Question Three

The final question to guide this research study was: how do teachers view their role in the classroom in terms of developing the mathematics self-efficacy of their students? This section will summarize the findings related to this question.

Teacher interviews. In most instances, teacher interviews confirmed data gathered through observations and student interviews. However, in order to answer question three, direct contact with teachers was necessary. Teacher interviews revealed that teachers felt they had an important part in developing classroom environment. Teachers from the traditional instruction classrooms focused on the features of the environment which were categorized as procedural. These teachers mentioned setting boundaries, offering a safe environment, and setting classroom rules. They also mentioned creating positive environments in which students could explore and succeed. Teachers in these classrooms reported using group and partner work to help students succeed. According to teachers from this site (B), student success was attributable to a
combination of home influence, student interest, and confidence. They viewed student persistence as a fixed attribute primarily developed at home.

Teachers in standards-based classrooms explained their responsibility to create positive environments in terms of attributes such as: collaboration, support, and warmth. They stressed that their classrooms should be places where students learn different approaches to solving problems, taking academic risks and where growth and learning were supported. Teachers from standards-based classrooms saw partnerships and group work as structures that would increase achievement, help all students feel successful, and reach struggling students. These teachers mentioned feedback and modeling strategies as ways to make students feel more successful.

Teachers from this site saw their students as persistent in the face of challenge, or they had strategies they used to help students who were less persistent.

This section summarized the findings for research question three. In the next section limitations to the study will be reviewed.

Limitations

This research, like all research studies, was subject to threats of internal and external validity. One effort to control these threats was through triangulation (Lincoln & Guba, 1985). Data methods were triangulated to confirm the data gathered from each method. Site selection was purposeful, which limited the representative ability of the sample. Additionally, a large portion of the data used in this study was gathered from student self-reporting methods. These data were open to student perception and therefore limited to the students’ personal understanding of the development of self-efficacy. These reflections may not fully explain the development of self-efficacy in the classroom, nor do they always replicate the observations of the data gathered in observations.
The study is delimited in four ways. First, while gender is often considered a factor in studies of mathematics in the classroom, it was not within the scope of this study. The comparison of male and female reactions within the classroom, or the study of only male or female students was not feasible within the context of this study to explore this construct in depth. Second, the use of problem solving within this study was primarily as a vehicle for viewing student persistence. The goal of the study was to explore persistence as an outcome of self-efficacy. Therefore, problem solving as a separate construct was not studied. This focus would have changed the study making it too broad and unfocused. Third, there are four influences of self-efficacy: enactive experience, modeling, feedback, and physiological and affective information. Within the classroom setting and the confines of this study, it proved feasible to study the first three. Physiological and affective information were more difficult to gather reliably and, therefore, can be the focus of further investigations. Fourth, although every effort was made to secure the consent of every student in the four classrooms included in this study, it was not possible to gain full consent in every case. This led to uneven groups of participants and one small group of participants in Site A. Finally, classrooms chosen for this study were chosen for a number of reasons: convenient location, available mathematics program, years of teaching for participants, and teacher willingness to participate. Although it was preferable to include teachers with more than five years teaching experience that was not always possible. When teachers had fewer than five years experience, recommendations from building principals and compensating life experiences were taken into consideration for teacher selection.
Conclusions of the Study

The primary purpose of this research was to study mathematics students in the classroom environment as they encountered the sources of self-efficacy and to observe students as they demonstrated behaviors known to be related to increased self-efficacy. After observing, interviewing, surveying, and analyzing data gathered from students and their teachers from two different types of mathematics programs it was reasonable to draw conclusions related to the four major constructs around which this research developed. In this section conclusions from this research study will be discussed in relation to each of the four major constructs which guided the analysis of the data. These included: social learning, feedback, modeling, and strategy use.

Social Learning

Social learning accounted for a large part of the mathematical learning structures in the standards-based classrooms. These classrooms used partner discussions as a routine part of their lessons. These partner discussions were used by teachers and students to talk about new ideas and concepts being developed during lessons. Students in these classes functioned as supportive group members who freely served as models to their peers, gave feedback, and adjusted their work when needed. Traditional instruction classrooms primarily used groups and partnerships to get work assignments completed. Students in these classes frequently worked side-by-side without helping each other. On occasions when students did help each other, support was likely to take the form of supplying the answer to the problem. In these classrooms, partner discussions during lessons were rare. Consequently, these students did not use social learning spontaneously during the formal research problem solving activity.

Analysis of these data leads to the conclusion that classrooms in this study that fostered strong environments for social learning encouraged a range of student behaviors that were
beneficial to their students. For example, students in the classrooms in this study who engaged in more frequent and higher quality social learning, demonstrated greater perseverance and achievement in problem solving. Social learning was also tied to strategy use. Students in standards-based classrooms, where social learning was high, reported and demonstrated higher frequency and higher level strategy use. Finally, students in classes with high levels of social learning reported moderate to high levels of mathematics self-efficacy.

Social learning offered students access to additional sources of feedback and modeling. According to students interviewed for this study, these sources can be more valuable, at times, than the adult models in the classrooms. Therefore, it was concluded that for the students in this study, the frequent access to high quality social learning was a powerful learning structure.

**Feedback**

Feedback was an important frequent source of self-efficacy information for students at both sites. There were four major conclusions drawn from the data related to feedback. First, in this study feedback from teachers was categorized into direct and indirect feedback. Direct feedback meant those occasions when teachers gave overt positive or negative comments to students related to their mathematics work. For example, a teacher might have said, “Good job.” Indirect feedback refers to occasions when teachers offer no verbal comments. Teachers heard an answer from a student, but moved on in the lesson without directly saying if the student’s answer was correct or
incorrect. Whereas adults assumed their tacit approval of student’s responses when there was no negative feedback, some students expressed confusion about what was meant by the lack of a direct teacher response. Second, related to the importance of direct feedback was a pattern of increased feedback and confidence. Students in standards-based classrooms received higher levels of total feedback and direct feedback. These students also expressed higher levels of confidence leading the researcher to make the observation that further study is this area is warranted. A third area of interest concerned student to student feedback. Student feedback was important to students due to its proximity to the student. Students sited the relationship between peers and level of thinking they shared with peers as important features of proximity. Students in standards-based classrooms experienced a great deal more student feedback. This feedback occurred during social learning structures and occurred the same classrooms as those with high total problem solving, thoroughness, and strategy use. Finally, students in classes with higher frequency of all types of feedback also reported higher self-efficacy than students in classes with a lower frequency of feedback. For students in this study, direct teacher feedback was preferable to indirect teacher feedback and student feedback was an important addition to any type of teacher feedback.

Feedback and Modeling

Students all classrooms studied experienced feedback and modeling during mathematics lessons. However, their observations yielded different patterns in the use of these sources of self-efficacy between traditional instruction and standards-based classrooms. Students in traditional instruction classrooms frequently experienced lessons in which student contributions to the lesson (models) were followed by feedback and follow-up questions or clarifying questions. Students in standards-based classrooms frequently experienced mathematics lessons in which
student contributions to the lessons were followed by feedback and modeling. Lengthy periods of modeling were more frequent in the standards-based classrooms. Explanations of processes, applications, and strategies by teachers and by students to each other were the key features of these models. In traditional instruction classrooms during the use of modeling, the focus was on computation and processes.

For students in standards-based classrooms, the development of mathematics discussions which featured feedback and modeling in a scaffolded lesson lead to deeper conceptual thinking. Students in standards-based classrooms reported moderate to high self-efficacy and experienced high levels of scaffolding. Scaffolding of feedback and modeling into higher order thinking and woven into classroom discussion occurred in the same classrooms where students reported higher self-efficacy.

*Strategy Use*

Students in all studied classrooms used strategic thinking to manage the challenges of the mathematics classroom. The frequency and degree of strategy use differed between traditional instruction classrooms and standards-based classrooms. Strategies used in problem solving related to achievement and use of social learning structures in the classroom for students in these case studies. Types of strategies used also varied by case. Students in traditional instruction classrooms focused on one-step strategies while students in standards-based classrooms used two-step strategies. Also, students from traditional instruction classrooms were more likely to adjust and check their strategy use. Students in the standards-based classrooms more frequently went to their peers for help when challenged in mathematics than students in traditional classrooms. However, the data related to strategies taught during mathematics lessons does not vary widely from site to site. For students in this study, strategy use related to additional related
factors. Scafolded lessons which incorporated deeper strategy use, social learning which encouraged strategy feedback and modeling from peers, and general increased self-efficacy, all contributed to increased strategy use.

Suggestions for Future Research

Suggestions for future research include closer supervision of student work samples, wider diversity in cases within the multi-case design to include a wider socio-economic base, and further study into the implications of mathematical problem solving as it related to self-efficacy. Finally, explorations into the social learning structures should be explored.

As part of the design for this study, student work samples were included to confirm activities observed in the classroom. However, as analysis proceeded it became clear that work samples could serve a broader purpose. Some student work yielded information regarding strategy use, mathematics communication, and perseverance. Although directions, read to teachers from a script at introductory meetings, clearly stated expectations for sample collection, a wide variation of types of work were collected. In the future, it would be beneficial to include student work samples that demonstrated daily class work. Explicit written directions with examples could provide greater consistency. Periodic collection of samples accompanied by feedback to the teacher regarding the appropriateness of the samples could improve the value of the work collected.

The sample for this study included a purposive sample with limited socioeconomic and racial diversity. This sample represented a limited population of students in classrooms in a particular region of the nation. Replication of the study with a wider, more varied sample would provide validation of data across an increasingly representative population of school age.
children. This repetition would provide information relating to the constructs studied with various populations.

In this research, problem solving served as a vehicle for studying perseverance. However, problem solving holds many opportunities for study connected to mathematical self-efficacy in the classroom. Although it was beyond the scope of this study to include an in depth exploration of problem solving, such research would enhance the understanding of the constructs reviewed here. Problem solving in classrooms such as the standards-based instruction classrooms included in this study offer connections for understanding student feedback, social learning, strategy use, and student modeling. Further, problem solving contains its own set of constructs that could enrich the understanding of self-efficacy and related themes.

Finally, social learning was an effective structure within the mathematics classrooms studied. The standards-based classrooms were especially proficient in the use of this tool. Analysis of the standards-based teacher program materials demonstrated greater support for teachers in this area than for traditional instructional program teachers. Considering the presence of higher self-efficacy in the classroom with greater social learning skills, further study of the relationship between mathematics program and social learning could be meaningful. Teachers and students need support in finding effective ways to develop social learning. For example, students in both sites were placed in groups at desks which were made into tables with students facing each other. However, students at one site were observed engaging in supportive group behaviors more often than at the other. Further study is needed to fully understand the effect of teacher instructional materials, teacher background, and other curricular programs.
Conclusion

This study explored students in two mathematics classroom settings as they experienced the development of self-efficacy. Related constructs included social learning, feedback, modeling, and strategy use. Analysis of data from multiple sources revealed that students in standards-based classrooms and traditional instructional classrooms experienced the same sources of self-efficacy and related constructs. However, the frequency and quality of these constructs differed. Students in the traditional instruction classes focused on computational level skills, experienced lower levels of direct feedback, and scaffolding, and demonstrated lower use of a variety of strategies. Students in standards-based classrooms frequently experienced social learning in the classroom and used it spontaneously in problem solving situations. Social learning, direct feedback, scaffolding, and strategy use, were shown to be effective structures within the classrooms where students reported moderate to high self-efficacy.
References


Harter, S. (1992). The relationship between perceived competence, affect and motivational development...


Engagement in academic work: the role of learning goals, future consequences,
pleasing others, and perceived ability. Contemporary Educational Psychology, 21, 388-422.


Appendix A: Mathematics Student Evaluation Checklist
# MATHEMATICS EVALUATION CHECKLIST

**Rater**

**Date**

Directions: For each student listed, mark a “+” in the appropriate space when you first observe the student exhibiting any of the behaviors listed in the first column.

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Student Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solves word problems with ease</td>
</tr>
<tr>
<td></td>
<td>Finds multiple approaches to solve the problem</td>
</tr>
<tr>
<td></td>
<td>Able to explain solutions</td>
</tr>
<tr>
<td></td>
<td>Creates own word problems</td>
</tr>
<tr>
<td></td>
<td>Demonstrates higher order thinking in mathematics</td>
</tr>
<tr>
<td></td>
<td>Enjoys logic problems</td>
</tr>
<tr>
<td></td>
<td>Uses tools and materials effectively</td>
</tr>
<tr>
<td></td>
<td>Recognizes patterns</td>
</tr>
<tr>
<td></td>
<td>Perseveres in attempting to solve problems</td>
</tr>
<tr>
<td></td>
<td>Has an unusual approach to solving a problem</td>
</tr>
</tbody>
</table>
Appendix B: Student Interview Questions
Initial Student Interview Questions
1) What is your favorite subject in school?
2) When your teacher tells you it is time for math, how do you feel?
3) When you are learning something new in math where do you get your best information?
4) Are the strategies you learn in math class helpful to you when you work?
5) Why do you try hard in mathematics? Why do you work?
6) What do you do when you are stuck or challenged in mathematics?

Follow-up Student Interview Questions
1) Tell me about how working in groups or partnerships in math is helps you be successful in math. Or if you feel it does not help you be successful, why not?
2) Are there things that your teacher does that help you be/ feel successful in math? What?
3) Sometimes teachers do the following things when teaching math. Do any of these things help you feel more able to complete the work you are expected to do in math? (Students are shown a poster size copy of list)
   Writing examples on the board
   Carefully connecting one days lessons to the day before
   Working in groups
   Having students check their own homework
   Giving tests
   Working with the whole class at the board
   Having students work with a partner
   Homework
   Turn and talk
   Different levels of work
4) Do you feel more prepared for better math the students who do examples at the board in class? How? Why?
5) Many students said that homework helped them to feel successful? Why?
6) My study is about self-efficacy. This means that if you believe you can do something you are actually more able to do it. What do you think teachers could do/ or already do to help you feel more able to do even your toughest math?

Appendix C: Teacher Interview Questions
Teacher Interview Questions

1) How long have you been teaching here in Ridgefield? How did you come to teach 5th grade?

2) What do you think is the teacher’s role in developing the classroom environment?

3) How do you see different types of students in your class affected by different types of classroom activities?

4) Do you feel that you have control over the materials you use in your classroom and the way in which they are delivered to the students?

5) What things do you do in the classroom that you think help your student feel positive about their chances of being successful in mathematics?

6) Do you feel your students are persistent in the face of learning challenges? Why/why not?
Appendix D: Problem Solving Activity
TV Tally Problem Solving Activity

Directions:
Read the problem carefully.
Calculate your estimated solution.
Fully explain how you arrived at your estimated solution. Include all parts of your thinking and solution.

TV Tally Problem
About how many hours of television have you watched in the last year? Estimate the number of hours of television you think you have watched over the last year.

Record your estimate and explain your reasoning. Include all of your computations. Tell what strategies you used for making your estimates and reasonable calculations.

Before beginning answer these questions: Circle One Answer for Each Question

1. How likely do you feel you are to be successful at this problem?
   Highly likely
   Not Likely
   1             2             3             4             5

2. How likely do you feel you are to finish this problem within the given class period?
   Highly likely
   Not Likely
   1             2             3             4             5
3. How likely do you feel you are to begin the extension problem within the given class period?

<table>
<thead>
<tr>
<th>Highly likely</th>
<th>Not Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Appendix E: Student Mathematics Self-efficacy Survey
Elementary Mathematics Self-Efficacy Scale

Class Number__________

The purpose of this activity is to measure some of your feelings about math. You should not write your name on your paper. Your teacher will not see the answers you right on your paper.

You do not have to complete this activity if you feel uncomfortable at anytime. If you choose to finish, please answer the questions as honestly as you can. There are no right or wrong answers. You will not receive a grade for your paper.

This activity has 17 questions. It should take about ten minutes to complete, but you may take as little, or as much time as you would like to finish.

Student Mathematics Self-efficacy Survey

Number______

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>When I have to solve a math problem I can think of a different ways to solve it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Working with a group to solve math problems is more helpful than working alone.</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>3.</td>
<td>I am successful in math.</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>If I am having difficulty with a mathematics problem I have ways of figuring it out without going to the teacher.</strong></td>
<td><strong>Strongly Agree</strong></td>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
<td><strong>Strongly Disagree</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Tough math makes my brain work in a good way.</strong></td>
<td><strong>Strongly Agree</strong></td>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
<td><strong>Strongly Disagree</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If I stick with it I can solve most math problems.</strong></td>
<td><strong>Strongly Agree</strong></td>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
<td><strong>Strongly Disagree</strong></td>
<td></td>
</tr>
<tr>
<td><strong>My classmates help me in math class.</strong></td>
<td><strong>Strongly Agree</strong></td>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
<td><strong>Strongly Disagree</strong></td>
<td></td>
</tr>
<tr>
<td><strong>My thinking is important even if my answer isn’t correct.</strong></td>
<td><strong>Strongly Agree</strong></td>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
<td><strong>Strongly Disagree</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If I make a mistake I can try again in math class.</strong></td>
<td><strong>Strongly Agree</strong></td>
<td><strong>Agree</strong></td>
<td><strong>Disagree</strong></td>
<td><strong>Strongly Disagree</strong></td>
<td></td>
</tr>
</tbody>
</table>
10. I enjoy doing math problems outside of school. | Strongly Agree | Agree | Disagree | Strongly Disagree
11. When I finish my math early I ask my teacher for harder work. | Strongly Agree | Agree | Disagree | Strongly Disagree
12. If make a mistake in math, I change my strategy and go on with my work. | Strongly Agree | Agree | Disagree | Strongly Disagree
13. I could solve: \( \frac{6}{25} + 7.25 = \) two ways. | Strongly Agree | Agree | Disagree | Strongly Disagree
14. Underline any of the phrases to the right that best describe what helps you succeed in math class. 
   partner work teacher checks in as you work 
   homework teacher works at the board 
   group work students do examples at the board 
   practice problems strategies you invent 
   new strategies from your teacher games 
   choices of work enrichment 
   other: 
   ____________________________________________ 
15. What do you do when you are stuck in math? 
   Try a new strategy | Ask a friend | Ask the teacher | Give up 
16. Why do you work hard in math? 
17. It is important for the teacher to tell me how I am doing in math every day. 
   Yes, I need the teacher to check in with me. | I would rather check in with my partner or group. | I know when I follow along with class work. | No, I know how I am doing.
Appendix F: Problem Solving Activity Scoring Rubric
<table>
<thead>
<tr>
<th></th>
<th>High - 4</th>
<th>Medium - 3</th>
<th>Fair - 2</th>
<th>Low - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computation</td>
<td>Accurate</td>
<td>Somewhat accurate</td>
<td>Somewhat inaccurate</td>
<td>Inaccurate</td>
</tr>
<tr>
<td>Strategy Use</td>
<td>Well-defined</td>
<td>Suited to purpose and strong solution.</td>
<td>May be mixed</td>
<td>Vague or weak strategy. Does not contribute to strong solution.</td>
</tr>
<tr>
<td>Reasoning</td>
<td>Estimate based on logical and thoughtful reasoning. Reveals full understanding of complexity of problem.</td>
<td>Some limited thought to reasoning. Reasoning involves multiple steps and appropriate understanding of complexity of problem</td>
<td>Reasoning vague or limited. Does not contribute to strong solution.</td>
<td>Based on guessing</td>
</tr>
<tr>
<td>Communication</td>
<td>Explanation is clear and fully explains strategic thinking.</td>
<td>Identifies some strategies but fundamentally explains computation.</td>
<td>Describes computation and too brief to give insight into student strategic thinking.</td>
<td>Explanation limited or missing</td>
</tr>
<tr>
<td>Thoroughness</td>
<td>Work is extensive and fully addresses elements of the question.</td>
<td>Work addresses some elements of the question with a variety of thought</td>
<td>Work is brief and narrow in scope. Answers question on surface level only.</td>
<td>Very little work. Leaves question unanswered.</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix G: Student Consent Forms
Consent to Participate in Research Study
Doctoral Dissertation Research Project to Study Mathematics Self-Efficacy

Dear Parent or Guardian,

I am currently enrolled in the doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. I have chosen a study of mathematics program and student self-efficacy for my research.

The purpose of this research is to better understand how mathematics programs, and the classroom environments they foster, help students feel more capable and productive as mathematics students. This sense of how productive and capable one can be in mathematics is called mathematics self-efficacy.

As part of my research I will be observing fifth grade mathematics classrooms in the Ridgefield Public Schools. I will be in your student’s classroom ten times for thirty minutes. During my time in these classrooms I will be as unobtrusive as possible. Student math logs will be reviewed in order to understand how the work they are given helps facilitate better self-efficacy. Three students in each class will be selected at random to be interviewed. The questions in these interviews focus on math activities. Students may be asked to complete a short survey of their perceptions of their capability to perform mathematics tasks. The results will not be reported to their teacher or be attached to their mathematics grades in any way. Student names will not appear on the survey.

This project is approved by the Ridgefield Public Schools and it is hoped that at the completion of the research project I will be able to provide insight to Ridgefield elementary school teachers on practices that benefit other students.

Participation in this project is completely voluntary. All information is completely confidential. No school data will be collected on your student for this project.

If you have any questions, or would like further information about my project, please contact me at XXXXXXXX School (XXX- XXXX) or via email at xxxxxx@xxxxxx.org.

If you agree to have your student participate in this project, please sign the attached state and return it to the classroom teacher by ____________________________.

Sincerely,
Krys Salon
I, _________________________________, the parent/legal guardian of the minor named below, acknowledge that the researcher has explained to me the purpose of this research, identified any risks involved and offered to answer any questions I may have about the nature of my child’s participation. I freely and voluntarily consent to my child’s participation. I understand that all information gathered during this project will be completely confidential. I also understand that a copy of this consent form has been provided for my files.

Name of Minor: ________________________________________________________

Signature of Parent/Legal Guardian

Date
Dear Parent or Guardian,

I am enrolled in the doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. I have chosen a study of mathematics program and student self-efficacy for my research. As you are aware I am currently conducting a research project in your child’s classroom.

The purpose of this research is to better understand how mathematics programs, and the classroom environments they foster, help students feel more capable and productive as mathematics students. This sense of how productive and capable one can be in mathematics is called mathematics self-efficacy.

Your child has been selected at random as a potential subject for a student interview. This interview will focus on his or her perceptions of mathematics instruction. Students in the selected group will also complete one classroom activity in a small group in order that I may observe their discussion and strategy use. In order to insure the accuracy of my data it will be important for me to audio tape these sessions. No names will ever be connected to the students. All tapes will be transcribed as coded data and held in locked files until no longer needed. The results will not be reported to their teacher or be attached to their mathematics grades in any way. Student names will not appear anywhere on the report.

This project is approved by the Ridgefield Public Schools and it is hoped that at the completion of the research project I will be able to provide insight to Ridgefield elementary school teachers on practices that benefit other students.

Participation in this project is completely voluntary. All information is completely confidential. No school data will be collected on your student for this project.

If you have any questions, or would like further information about my project, please contact me at XXXXXX School (XXX- XXXX) or via email at xxxxx@xxxxxxxxxx.org.

If you agree to have your student participate in this project, please sign the attached state and return it to the classroom teacher by ____________________________.

Sincerely,
Krys Salon
Western Connecticut State University  
Institutional Review Board  

Consent to Participate in Research Study  
Interview with Video Tape

I, _____________________________________, the parent/legal guardian of the minor named below, acknowledge that the researcher has explained to me the purpose of this research, identified any risks involved and offered to answer any questions I may have about the nature of my child’s participation. I freely and voluntarily consent to my child’s participation. I understand all information gathered during this project will be completely confidential. I also understand that a copy of this consent form has been provided for my files.

Name of Minor: _____________________________________

________________________________________________________________________

Signature of Parent/Legal Guardian
Date

Appendix H: Teacher Consent Form
Western Connecticut State University  
Institutional Review Board  

Teacher Consent to Participate in Research Study  
Doctoral Dissertation Research Project to Study Mathematics Self-Efficacy

Dear Teacher,

I am currently enrolled in the doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. I have chosen a study of mathematics program and student self-efficacy for my research.

The purpose of this research is to better understand how mathematics programs, and the classroom environments they foster, help students feel more capable and productive as mathematics students. This sense of how productive and capable one can be in mathematics is called mathematics self-efficacy.

As part of my research I will be observing fifth grade mathematics classrooms in the Ridgefield Public Schools. I will be in your classroom ten times for thirty minutes. During my time in your classrooms I will be as unobtrusive as possible. Student math logs will be reviewed in order to understand how the work they are given helps facilitate better self-efficacy. I will request an interview with you later in the study. Our discussion in this interview will focus on student’s attitudes in mathematics and how they are developed in the classroom. Students in your class asked to complete a short survey of their perceptions of their capability to perform mathematics tasks. Your name will not appear on any observation or interview notes or reports. No student results will be reported to you by name.

This project is approved by the Ridgefield Public Schools and it is hoped that at the completion of the research project I will be able to provide insight to Ridgefield elementary school teachers on practices that benefit other students. Participation in this project is completely voluntary. All information is completely confidential. No school data will be collected on your students for this project.

If you have any questions, or would like further information about my project, please contact me at Branchville School (XXX- XXXX) or via email at xxxx@xxxxxxxx.org.

If you agree to participate in this project, please sign the attached state and return it to me by

Krys Salon  

Appendix H: Teacher Consent Form
Western Connecticut State University
Institutional Review Board

Teacher Consent to Participate in Research Study
Developing Mathematics Self-Efficacy Instrument

I, _____________________________________, the participant named below, acknowledge that the researcher has explained to me the purpose of this research, identified any risks involved and offered to answer any questions I may have about the nature of my child’s participation. I freely and voluntarily consent to my participation. I understand all information gathered during this project will be completely confidential. I also understand that a copy of this consent form has been provided for my files.

Name of Participating Adult: ____________________________________________________

Signature ___________________________________________ Date ____________

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Appendix I: Protocol for Administration of Problem Solving Activity
Administrators Script for Problem Solving Activity

Good Morning (afternoon). Over the last few weeks I have seen you work in mathematics. I know you work on mathematical problems in class. Today I have a new problem for you to solve. While you are working I am going to watch how you work. You will not be graded by your teacher, but I am interested in how you work as mathematicians. Please try your best. If you finish the basic problem there is an enrichment problem for you to work on.

Please listen while I read the directions to today’s problem solving activity. When I am finished reading there will be time to ask questions. Read along silently while I read aloud:

Directions:
- Read the problem carefully.
- Calculate your estimated solution.
- Fully explain how you arrived at your estimated solution. Include all parts of your thinking and solution.

Now let’s read the problem you will be solving. Again read along silently while I read aloud.

TV Tally Problem
- About how many hours of television have you watched in your lifetime? Estimate the number of hours of television you think you have watched over the years of your life.
- Record your estimate and explain your reasoning. Include all of your computations. Tell what strategies you used for making your estimates and reasonable calculations.

Each student will work on their own answers, however you may work with a partner for the first few minutes to share ideas on how to work.

Now, are there any questions?
(Take and answer procedural questions only.)

Before we begin I want you to answer three questions at the bottom of your coversheet for me. Please don’t discuss the answers with your neighbors.

1. How likely do you feel you are to be successful at this problem?
   - If you feel it is highly likely circle one. If you feel it is unlikely circle 5. Exactly in the middle circle 3. Choose the number that best expresses how you feel.
2. How likely do you feel you are to finish this problem within the given class period? (30 minutes)
3. How likely do you feel you are to move on to the enrichment problem within the given class period?
   - Okay, you may begin your work. Please remember to be as complete in your answer as possible.

If you finish early move on to the enrichment work.

Appendix J: Protocol for Administration of Student Mathematics Self-efficacy Survey
Protocol for Administering Student Mathematics Self-efficacy Survey
Good Morning (afternoon), over the last few weeks I have been observing your work in mathematics class. Today I have a few questions I would like to ask you about your feelings when you work in mathematics. When I pass out your paper please do not put your name on your paper. Instead write your class student number on the “number” line.
Now, I am going to read the directions on the front cover page. Please read these directions silently to yourself as I read them aloud.
The purpose of this activity is to measure some of your feelings about math. You should not write your name on your paper. Your teacher will not see the answers you right on your paper. You do not have to complete this activity if you feel uncomfortable at anytime. If you choose to finish, please answer the questions as honestly as you can. There are no right or wrong answers. You will not receive a grade for your paper. This activity has seventeen questions. It should take about ten minutes to complete. We will be reading the questions together.

Now, please turn the page. Please look at the top of columns to the right. They are titled strongly agree, agree, disagree, strongly disagree. As I read each statement please read along with me. Then decide which choice BEST fits how you feel. Do you strongly agree, agree, disagree, or strongly disagree? You may not find an answer that exactly fits how you feel. That is all right. Find the one that is the closest. Are there any questions? (Answer procedural questions.) Begin.
Appendix K: Major Codes and Definitions
Codes by Category
<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOOK</td>
<td>Book</td>
<td>Student expresses getting information from textbook as a strategy for success</td>
</tr>
<tr>
<td>CH</td>
<td>Choice</td>
<td>Classroom activity that gives students choice within activity; event in which students are given choice of work</td>
</tr>
<tr>
<td>CHALL</td>
<td>Challenging work</td>
<td>Work student identifies as frustrating, needing help to</td>
</tr>
<tr>
<td>CON</td>
<td>Confident</td>
<td>Student expresses confidence in ability to complete</td>
</tr>
<tr>
<td>CQ</td>
<td>Clarifying question</td>
<td>Teacher asks clarifying question to clarify student understanding</td>
</tr>
<tr>
<td>EFRT</td>
<td>Effort</td>
<td>Student uses or expresses use of effort as strategy.</td>
</tr>
<tr>
<td>ENRICH</td>
<td>Enrichment</td>
<td>Work beyond classroom assignment or work designed for students who have attained concepts/skills</td>
</tr>
<tr>
<td>ENV</td>
<td>Environment</td>
<td>Classroom behavior, culture, attitudes, that effect mathematics</td>
</tr>
<tr>
<td>EXPL</td>
<td>Explanation</td>
<td>Situations in which student is asked to give explanation of thinking, strategies, or work</td>
</tr>
<tr>
<td>FQ</td>
<td>Follow-up question</td>
<td>Teacher asks follow-up question to further understanding</td>
</tr>
<tr>
<td>GP/PAR</td>
<td>Group/parallel work</td>
<td>Group working together in parallel manner that each</td>
</tr>
<tr>
<td>GP/SH</td>
<td>Group/sharing</td>
<td>Group working together sharing work in manner that</td>
</tr>
<tr>
<td>GRADES</td>
<td>Grades</td>
<td>Grades as a motivation for persistence in mathematics</td>
</tr>
<tr>
<td>GS</td>
<td>Group Support</td>
<td>Situations in which student is supported by partner or group to achieve task</td>
</tr>
<tr>
<td>GW</td>
<td>Group Work</td>
<td>Work or task attempted through group effort</td>
</tr>
<tr>
<td>HMK</td>
<td>Homework</td>
<td>Work completed at home.</td>
</tr>
<tr>
<td>LEVEL2</td>
<td>Level 2 strategy</td>
<td>Student uses strategy that is more complex</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MT</td>
<td>Multiple trials</td>
<td>Student makes multiple attempts to complete find solution</td>
</tr>
<tr>
<td>OSE</td>
<td>Observer student exchange</td>
<td>Observer interaction with student in classroom during observation period</td>
</tr>
<tr>
<td>OVERTM</td>
<td>Overtime</td>
<td>Student exhibits attitude or skill over length of time</td>
</tr>
<tr>
<td>PD</td>
<td>Partner discussion</td>
<td>Mathematical discussion between two/three students</td>
</tr>
<tr>
<td>PER</td>
<td>Persistence</td>
<td>Student repeatedly tries alternate solutions in work,</td>
</tr>
<tr>
<td>PRAC</td>
<td>Practice</td>
<td>Student expresses practice as strategy for success</td>
</tr>
<tr>
<td>PS</td>
<td>Problem solving</td>
<td>Problem solving event/activity</td>
</tr>
<tr>
<td>PSO</td>
<td>Problem solving Observation</td>
<td>Problem solving observation</td>
</tr>
<tr>
<td>PW</td>
<td>Partner Work</td>
<td>Mathematics work attempted by two/three students</td>
</tr>
<tr>
<td>RETHINK</td>
<td>Rethink</td>
<td>Student reconsiders an action taking and possibly changes</td>
</tr>
<tr>
<td>SGM</td>
<td>Student group model</td>
<td>Student provides model for class in large group setting</td>
</tr>
<tr>
<td>SI</td>
<td>Student interview</td>
<td>Interview between researcher and students in study.</td>
</tr>
<tr>
<td>SK</td>
<td>Skill</td>
<td>Student exhibits or expresses use or knowledge of</td>
</tr>
<tr>
<td>SPRED</td>
<td>Student prediction</td>
<td>Student prediction in relation to ability to succeed at a given task</td>
</tr>
<tr>
<td>SSE</td>
<td>Student/student exchange</td>
<td>Verbal exchange between two or more students</td>
</tr>
<tr>
<td>SSEE</td>
<td>Student/student enactive experience</td>
<td>Student/student verbal exchange focused on mathematics understanding which builds new learning on prior learning</td>
</tr>
<tr>
<td>SSEF</td>
<td>Student/student exchange feedback</td>
<td>Student/student verbal exchange focused on mathematics understanding in which one student provides feedback to another</td>
</tr>
<tr>
<td>SSEM</td>
<td>Student/student</td>
<td>Student/student verbal exchange focused on mathematics understanding</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>STRAT</td>
<td>Strategy</td>
<td>Situation in which strategic thinking is required</td>
</tr>
<tr>
<td>TAL</td>
<td>Talent</td>
<td>Student expresses talent as strategy for success</td>
</tr>
<tr>
<td>TCHRHELP</td>
<td>Teacher Help</td>
<td>Student expresses getting help from teacher as strategy</td>
</tr>
<tr>
<td>TI</td>
<td>Teacher interview</td>
<td>Interview between researcher and teacher in study</td>
</tr>
<tr>
<td>TM</td>
<td>Teacher moves</td>
<td>Teacher moves throughout room.</td>
</tr>
<tr>
<td>TSE</td>
<td>Teacher/student exchange</td>
<td>Teacher/student verbal exchange</td>
</tr>
<tr>
<td>TSEE</td>
<td>Teacher/student exchange enactive experience</td>
<td>Teacher/student verbal exchange focused on mathematics understanding which builds new learning on prior learning</td>
</tr>
<tr>
<td>TSEF</td>
<td>Teacher/student exchange feedback</td>
<td>Student/student verbal exchange focused on mathematics understanding in which the teacher provides feedback to the student</td>
</tr>
<tr>
<td>TSEM</td>
<td>Teacher/student exchange modeling</td>
<td>Teacher/student verbal exchange focused on mathematics understanding in which the teacher provides modeling for the student</td>
</tr>
<tr>
<td>TT</td>
<td>Thinking time</td>
<td>Student pauses to consider next action</td>
</tr>
<tr>
<td>UNDER</td>
<td>Understand</td>
<td>Student exhibits understanding through ability to use mathematical concepts in application, analysis, or discussion.</td>
</tr>
<tr>
<td>VS</td>
<td>Visual Multi-trial support</td>
<td>Teacher provides visual model for students at board or overhead, etc.</td>
</tr>
<tr>
<td>WRKSHT</td>
<td>Worksheet</td>
<td>Worksheet, bookwork, prepared paperwork</td>
</tr>
<tr>
<td>Codes by Category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Student Strategies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>similar problems home</td>
<td>level 2 strategy test</td>
<td>request teacher help thinking time</td>
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<tr>
<td><strong>Types of Work</strong></td>
<td></td>
<td></td>
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<tr>
<td>book</td>
<td>homework</td>
<td>independent work</td>
</tr>
<tr>
<td><strong>Teacher practice</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>teacher help/support enrichment</td>
<td>text sources environment</td>
<td>adjust to student need problem solving</td>
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<tr>
<td><strong>Discussion Elements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clarifying questions</td>
<td>follow-up questions explanation*</td>
<td>scaffolding</td>
</tr>
<tr>
<td><strong>Social Learning</strong></td>
<td></td>
<td></td>
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<tr>
<td>group support partner discussion</td>
<td>group work</td>
<td>group work parallel</td>
</tr>
<tr>
<td><strong>Student Reflection</strong></td>
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<td></td>
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<tr>
<td>understand talent</td>
<td>easy unchallenging skill work</td>
<td>prediction</td>
</tr>
<tr>
<td><strong>Perseverance</strong> effort</td>
<td>persistence*</td>
<td></td>
</tr>
<tr>
<td><strong>Self-efficacy Outcomes</strong> confidence</td>
<td>persistence*</td>
<td></td>
</tr>
<tr>
<td><strong>Motivation</strong> grades</td>
<td>personal goal</td>
<td>personal history</td>
</tr>
<tr>
<td><strong>Influences (to SE)</strong> direct feedback indirect feedback practice</td>
<td>enactive attainment teacher model student model visual support student/student feed-class practice/time positive assessment student/student model</td>
<td></td>
</tr>
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</table>
Appendix L: Questions for Review of Teacher Instructional
Questions for Reviewing Teacher Instructional Materials

1. Does the program offer students opportunities for strategic thinking, explanation, and metacognition?

2. Does the program offer structures supporting group work, modeling, and problem solving?

3. Does the program offer the teacher support for developing feedback, enactive experiences, and modeling.
Appendix M: Materials and Student Classroom Work

Samples
Questions for Reviewing Student Classroom Mathematics Work Samples

1. Does the work reflect strategic thinking?
2. Does the work reflect chances for independent thinking?
3. Does the work reflect classroom practice observed by the researcher?
4. Does the work reflect rethinking, or other evidence of perseverance?
5. Does the work reflect mathematical accuracy?
6. Are there student reactions to feedback?
Appendix N
Table 1

Codes by Category

<table>
<thead>
<tr>
<th>Student Strategies</th>
<th>Types of Work</th>
<th>Teacher practice</th>
<th>Discussion Elements</th>
<th>Social Learning</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>(1) explanation*</td>
<td>(1) book</td>
<td>(1) adjust to student need</td>
<td>(1) clarifying questions</td>
<td>(1) group support</td>
</tr>
<tr>
<td>(2) home strategy</td>
<td>(2) homework</td>
<td>(2) choice</td>
<td>(2) explanation*</td>
<td>(2) group work</td>
</tr>
<tr>
<td>(3) level 2</td>
<td>(3) independent work</td>
<td>(3) enrichment</td>
<td>(3) follow-up</td>
<td>(3) group work</td>
</tr>
<tr>
<td>(4) rethink *</td>
<td></td>
<td>(4) environment</td>
<td></td>
<td>(4) partner discussion parallel</td>
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<tr>
<td>(5) request teacher help</td>
<td>(5) problem solving</td>
<td>(5) problem solving</td>
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<td></td>
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<td>(6) similar problems</td>
<td>(6) teacher help</td>
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<td></td>
<td></td>
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<tr>
<td>(7) thinking time</td>
<td>(7) text sources</td>
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<td>test</td>
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Table 1, *continued*

*Codes by Category*

**Student Reflection**

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<tr>
<td>(1)</td>
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<tr>
<td>(2)</td>
<td>prediction</td>
</tr>
<tr>
<td>(3)</td>
<td>skill</td>
</tr>
<tr>
<td>(4)</td>
<td>talent</td>
</tr>
<tr>
<td>(5)</td>
<td>understand</td>
</tr>
<tr>
<td>(6)</td>
<td>unchallenging</td>
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<tr>
<td>(7)</td>
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**Perseverance**

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<tbody>
<tr>
<td>(1)</td>
<td>effort</td>
</tr>
<tr>
<td>(2)</td>
<td>erase*</td>
</tr>
<tr>
<td>(3)</td>
<td>persistence*</td>
</tr>
<tr>
<td>(4)</td>
<td>rethink*</td>
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</table>

**Self-efficacy Outcomes**

<table>
<thead>
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<th>Description</th>
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<tbody>
<tr>
<td>(1)</td>
<td>confidence</td>
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<tr>
<td>(2)</td>
<td>persistence*</td>
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**Motivation**

<table>
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<th>Description</th>
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</thead>
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</tr>
<tr>
<td>(2)</td>
<td>personal goal</td>
</tr>
<tr>
<td>(3)</td>
<td>personal history</td>
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</table>

**Influences (to SE)**

<table>
<thead>
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<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>(1)</td>
<td>class practice</td>
</tr>
<tr>
<td>(2)</td>
<td>direct feedback</td>
</tr>
<tr>
<td>(3)</td>
<td>enactive attainment</td>
</tr>
<tr>
<td>(4)</td>
<td>indirect feedback attainment</td>
</tr>
<tr>
<td>(5)</td>
<td>practice</td>
</tr>
<tr>
<td>(6)</td>
<td>positive</td>
</tr>
<tr>
<td>(7)</td>
<td>student group</td>
</tr>
<tr>
<td>(8)</td>
<td>student model</td>
</tr>
<tr>
<td>(9)</td>
<td>student model</td>
</tr>
<tr>
<td>(10)</td>
<td>student/student feedback</td>
</tr>
<tr>
<td>(10)</td>
<td>student/student feedback</td>
</tr>
<tr>
<td>(10)</td>
<td>teacher model</td>
</tr>
<tr>
<td>(11)</td>
<td>visual support</td>
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</table>

*Note: Codes arranged in alphabetical order within category with no reference to importance.*
Appendix O
<table>
<thead>
<tr>
<th>Code</th>
<th>Total Occurrences</th>
<th>Site A</th>
<th>Site B</th>
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<tbody>
<tr>
<td>Partner Work</td>
<td>21</td>
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<td>8</td>
</tr>
<tr>
<td>Partner Discussion</td>
<td>17</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Group Work</td>
<td>32</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>Group Support</td>
<td>42</td>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td>Parallel Group Work</td>
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<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Perseverance</td>
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<td>26</td>
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<tr>
<td>Persistence</td>
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<td>28</td>
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<tr>
<td>Effort</td>
<td>27</td>
<td>17</td>
<td>10</td>
</tr>
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<td>Rethinking</td>
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<td>4</td>
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<tr>
<td>Direct Feedback</td>
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<td>59</td>
<td>19</td>
</tr>
<tr>
<td>Indirect Feedback</td>
<td>73</td>
<td>24</td>
<td>49</td>
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