GOALS, REFLECTION, AND STUDENTS' MATHEMATICS SELF-EFFICACY

By

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ABSTRACT

This study investigated what changes occurred in students' self-efficacy beliefs when reflection on goal progression and academic achievement was integrated in the classroom. It also identified how students' views towards setting goals and reflecting on their learning changed over time.

At the beginning of the semester, 57 Algebra I students created four course goals. A Chapter Writing Assignment was given after each of the six chapters in the semester which asked students to reflect and write about their goal progression as well as their overall academic achievement. Three questionnaires were given during the semester; students rated their confidence about completing 15 mathematical tasks as well as their beliefs on the value of goal setting and reflecting on learning. The questionnaires also included open-ended items allowing students to write about their overall confidence in mathematics and growth as learners.

The study's results supported four conclusions. First, the Semester Goals sheet and the Chapter Writing Assignment served as effective instruments in providing an opportunity for students to write goals and reflect on their goal progression and overall learning during the semester. Second, calculated means showed an increase in self-confidence levels of students for 13 of the 15 mathematical tasks. Third, mean scores and open-ended responses indicated that students found goal setting and reflecting on learning valuable. Finally, the students also expressed an overall increase in confidence throughout the semester as evident through their written responses on the questionnaires.

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CHAPTER ONE

THE RESEARCH PROBLEM

Introduction

Students' attitudes and beliefs greatly influence their motivation to engage in a learning activity or task. Since the 1980s, there has been a great deal of research focused on student motivation and achievement. While some believe students are either "motivated" or "not motivated," research has noted that motivation is determined by various factors interacting and influencing one another (Linnenbrink & Pintrich, 2002). Self-efficacy is one of the major factors that contributes to students' motivation to participate in learning. It refers to a student's confidence level or "beliefs concerning his or her ability to successfully perform a given task or behavior" (Hackett & Betz, 1989, p. 261). Self-efficacy influences whether a person will engage in, devote effort to, and persist in completion of a task (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; McCarthy, Meier, & Rinderer, 1985; Miller & Brickman, 2004; Schunk & Zimmerman, 2007). Therefore, a person's self-efficacy affects his or her overall academic achievement (Chouinard, Karsenti, & Roy, 2007; Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; Pajares & Miller, 1997; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002).

Goal setting is another important factor that contributes to students' motivation (Linnenbrink & Pintrich, 2002). Thus, it is important for students to not only set goals, but also monitor their progression toward goal achievement (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Chouinard, Karsenti, & Roy, 2007; Desautel, 2009; Hannula, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004;

National Council of Teachers of Mathematics [NCTM], 1995; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Stenmark, 1991; Zimmerman, 2002, 2008). Self-regulation is one process by which students can "activate and sustain their thoughts, behaviors, and emotions to attain learning goals" (Ramdass & Zimmerman, 2008, p. 20). Students who utilize the process of self-regulation have been found to benefit through greater knowledge attainment and overall academic success (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Hannula, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008).

In *Assessment Standards for School Mathematics*, the National Council of Teachers of Mathematics (1995) expressed a need for a shift in assessment practices. They specifically stated that students should become participants in assessing their own progress and that assessment should encompass more than quizzes and tests (NCTM, 1995). Student self-assessment and self-evaluation are two means by which students can assess their learning, yet they are terms that are not only defined differently but also used interchangeably by various researchers. This can lead to confusion as to which process a writer is referring to. For the purpose of this study, the definitions and distinctions given by Kenney and Silver (1993) will be understood unless specifically addressed within the context. Kenney and Silver (1993) defined self-assessment as "the process of actively monitoring one's own progress in learning and understanding and of examining one's own mathematical knowledge, process, and attitudes" (p. 229). Self-assessment involves self-awareness and self-evaluation. Self-awareness is "taking stock of one's own repertoire of mathematical knowledge, processes, strategies, and attitudes" (p. 230). Self-evaluation is a component of self-assessment that "involves going beyond mere self-awareness and taking a critical look at one's own mathematical knowledge, processes and

dispositions. Verbs such as monitor, regulate, reflect, and oversee are often associated with self-evaluation" (p. 230). Self-reflection is one method for students to use to participate in the self-evaluation process. Self-reflection provides opportunities for students to gain knowledge of themselves. It invites students to reason about how they reason, to interpret their thoughts and actions, and evaluate their intentions and motives (Von Wright, 1992).

In *Principles and Standards for School Mathematics,* NCTM (2000) advocated for an enhancement of communication by students in the classroom. One method of communication that has highly been promoted is writing in the classroom. This is because the process of writing encourages students to establish connections and relationships between their thoughts and actions and requires students to be active participants in their learning (Emig, 1977). Writing serves as a means for students to communicate about their learning in the mathematics classroom through describing mathematical processes, explaining mathematical content, and discussing concepts they have mastered or struggled with (Dougherty, 1996; Miller, 1992; NCTM, 2000; Pugalee, 1997).

Statement of the Problem

The purpose of this study was to investigate what changes in students' self-efficacy occurred as a result of establishing and reflecting on goals and overall academic achievement as well as identify how students' views of goal setting and reflecting on learning changed over time. The research questions posed were:

1. What changes in Algebra I students' self-efficacy beliefs occurred when self-reflection on goal progression and overall academic achievement was integrated in the mathematics classroom?

2. How did students' views of setting goals and reflecting on their learning change over the course of the study?

Fifty-seven Algebra I students at Bishop Carroll Catholic High School located in Wichita, KS participated in the study. At the beginning of the school year, students established four goals for themselves. These goals consisted of a course grade goal, a participation in class goal, a preparation for class goal and a personal goal. After each of the six chapters taught over the course of the semester, students completed a Chapter Writing Assignment which asked them to reflect on their goal progression and overall mathematics achievement for the particular chapter. To measure students' mathematical self-efficacy, data were collected via a questionnaire that was given at the beginning of the year, after the first nine weeks, and before the semester final. The questionnaire asked the students to evaluate their confidence about completing specific mathematical tasks as well as their overall mathematics confidence. The students were also asked to assess their personal views about the value of goals and reflection by rating how strongly they agreed or disagreed with statements about goals and reflection. Students also answered a few open-ended questions about how goals and reflection have affected their learning.

Rationale for the Study

Educational research has reported that self-efficacy influences whether a student will engage in, devote effort to, and persist in task completion (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; McCarthy, Meier, & Rinderer, 1985; Miller & Brickman, 2004). It is a component in determining a student's academic achievement (Chouinard, Karsenti, & Roy, 2007; Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; Pajares & Miller, 1997; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002). Educators contribute the

most to the competence beliefs students hold (Chouinard, Karsenti, & Roy; 2007); thus it is critical for them to provide an environment where student self-efficacy beliefs can be fostered (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002). Therefore, mathematics educators should inquire how students feel about their mathematics knowledge because it will influence their self-efficacy and overall learning achievement, whether positively or negatively (Lerch, Bilics, & Colley, 2006; Ramdass & Zimmerman, 2008). However, few educators take the time to ask students to evaluate their self-efficacy on tasks prior to learning concepts resulting in educators not knowing how confident students are in their learning (Zimmerman, 2002).

Self-efficacy initiates and sustains the pursuit of goals (Miller & Brickman, 2004). Goal setting has been correlated with increased academic achievement because it fosters the use of cognitive strategies, organizational strategies, study skills, and overall engagement in the task (Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004; Zimmerman, 2002). Yet the number of teachers who have students set goals as a regular classroom routine is limited (Zimmerman, 2002).

Self-regulation includes the processes of establishing and reflecting upon goals and has been shown to enhance learning (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Hannula, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). Reflecting on overall academic achievement forces students to ask themselves key questions such as: Where am I going? Where am I now? What should I change to do better? This in turn allows students to develop avenues for academic achievement (Carr, 2002; Chappuis, 2005; Hickman, Quick, Haynie, & Flakes, 2000; Kenney & Silver, 1993; Lerch, Bilics, & Colley, 2006; Opitz, 1995; Von Wright, 1992). Self-reflection allows students to become more aware of how they think and learn thus empowering them with a greater

knowledge of self (Von Wright, 1992). Writing is one avenue for students to communicate their knowledge and provides them with an active involvement in the learning process (Emig, 1977). Despite the research supporting the use of goal setting and self-evaluation, few educators implement these strategies in the classroom (Zimmerman, 2002). Students are rarely asked to evaluate their work or describe their level of confidence in completing a task (Zimmerman, 2002). There is also a need for specific pedagogical methods and instruments to engage students in reflecting on mathematics (Powell & Ramnauth, 1992).

At Bishop Carroll Catholic High School, time is not specifically set aside for students to evaluate their confidence levels on tasks, to set and monitor goals, or to reflect on learning. If these were to occur, it would be up to the individual teacher to implement them as part of the classroom routine. For this study, those tasks were implemented by means of writing assignments and students' self-efficacy was measured and students' views of goal setting and reflection were collected. The results of this study will add to the literature in the areas of goal setting, self-regulation, self-reflection, and self-efficacy.

Assumptions

In order for the results of this study to be interpreted, some assumptions were made. The first set of assumptions corresponds to the instruments and participants of this study. Throughout the course of the study, students were asked to complete questionnaires, a Semester Goals sheet, and Chapter Writing Assignments. It was assumed that students understood the questions and requirements of these instruments. If a student misunderstood, their response to a specific question would be inaccurate. Second, it was assumed that students were completely honest throughout the course of the study. Students had to be honest in their self-efficacy responses on the three questionnaires they were given. If students did not honestly indicate their

confidence in their ability to complete the stated mathematical tasks as well as their overall confidence, the data received from the questionnaires would not be accurate and would alter the results of the study. Students also had to be honest in evaluating how important they thought goal setting and reflecting on learning was in answering the questions on the questionnaires. Again, if students were not honest in their opinions, the data would be inaccurate which would affect the overall results. Finally, students had to be truly open and honest in their responses to the Chapter Writing Assignment questions. Before each assignment, it was stressed that they needed to be open and honest, but it was up to them to be truthful in their responses. It was assumed they reported their responses honestly.

The second set of assumptions corresponds to the researcher. Because the researcher was also the teacher of the participants, it was assumed that bias did not affect this study from both the angle of the student or the researcher. First, it was assumed that the students did not respond to questions in a way they may have thought their teacher would have liked them to respond. Second, it was assumed that the researcher did not misinterpret student responses due to bias for her students. This study has both quantitative and qualitative data and the results thus have an objective and subjective nature. It was assumed the researcher was completely honest in the representation of the data from the study and that the interpretation of the data was not biased.

Limitations

This study was carefully conducted, yet it is important to not overgeneralize. First of all, the teacher was the researcher which provides a limitation. Next, all students were freshmen who attended Bishop Carroll Catholic High School and had the same teacher. Because the students were freshmen and came from a variety of middle schools, their previous mathematical learning experiences were all different.

As self-reported on Questionnaire #1, thirty percent of students reported they had previous experiences setting goals in a mathematics class while seventy percent reported they had not. Twenty-three percent of students reported they had previous experience reflecting in a mathematics class while seventy-seven reported they had not. These varieties in their educational background could limit the results of the study because it would affect the value students placed on goal setting and self-reflection.

Seventy-nine percent of students reported on Questionnaire #1 they had previously taken a Pre-Algebra course while twenty-one percent did not. Fifty-three percent of students reported they had previously taken an Algebra I course in 8^{th} grade while forty-seven percent did not. Although a course may be titled "Pre-Algebra" or "Algebra I" there are differences within these groups because the students came from a variety of middle schools and not all middle schools cover the same amount of material as others in the courses. Although a course may be called "Algebra I" there are at times Algebra I concepts that are not covered due to time constraints. These varieties in the educational backgrounds of the students could limit the results of the study because it would affect their initial self-efficacy selections.

The instruments used in the study also provide limitations. On Questionnaire #1 and Questionnaire #2/#3, students had to answer questions yes/no and identify values to correspond with how confident they were that they could perform mathematical tasks. Because the students did not have an opportunity to explain why they selected yes/no or the value they did, this is a limitation of the study. On the Chapter Writing Assignments, some students wrote thorough responses while others were not as thorough. This too is a limitation because there is less information for some students and more for others.

Finally, it is also possible that students with other various mathematical experiences would perform differently in this same study. The context of this study was an Algebra I classroom in a Catholic high school and therefore the results may not be representative of other levels of mathematical courses, other Catholic schools, or public schools.

Overview

Chapter 2 contains a review of current research about writing, goals, self-efficacy, and self-reflection of learning. It specifically focuses on writing in the mathematics classroom, the impact of motivation, goal setting, and self-efficacy on student achievement, and the benefits of implementing self-evaluation, self-reflection, and self-regulation as means of assessing students' mathematics learning gains. Chapter 3 presents the methodology used in the research study. It includes information on the subjects, instruments, procedures and data analysis that were used over the course of the study. Chapter 4 contains the results of data analysis. Finally, Chapter 5 provides a summary, conclusions and discussion, and recommendations from the study.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

This chapter contains the findings of a literature review on the use of writing, student self-efficacy beliefs, self-evaluation and self-reflection, and self-regulation in the mathematics classroom. It begins by describing the implementation of writing in the classroom. Included in this section are standards related to communication in the classroom, writing's relationship to cognition, types of writing, benefits of writing for students and teachers, and concerns about the implementation of writing in the classroom. Next, metacognition and its correspondence with writing and problem solving are discussed. Then literature is presented on the importance of student motivation, goal-setting, self-efficacy, and their effects on student achievement. The chapter concludes with information on student self-assessment, self-evaluation, self-reflection, and self-regulation and how teachers can incorporate these in the classroom.

Writing in the Mathematics Classroom

Communicating mathematically within the classroom is a means of increasing conceptual knowledge (National Council of Teachers of Mathematics [NCTM], 2000; Steele, 2005). The National Council of Teachers of Mathematics (2000) stated that "communication is an essential part of mathematics and mathematics education. It is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and amendment" (p. 60). Thus the National Council of Teachers of Mathematics (2000) endorsed four avenues that encourage and enhance communication. Students should:

- organize and consolidate their mathematical thinking through communication;

- communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- analyze and evaluate the mathematical thinking and strategies of others;
- use the language of mathematics to express mathematical ideas precisely. (p. 60)

NCTM (2000) further stated that "writing in mathematics can also help students consolidate their thinking because it requires them to reflect on their work and clarify their thoughts about the ideas developed in the lesson" (p. 61).

In 1984, Applebee reviewed research from the 1960s and 1970s and discovered that students did little writing in mathematics classes that pertained to discussing concepts and reasoning (Silver, 1999). In response to the lack of written communication in the classroom, Bell and Bell (1985) explained that "a society which cannot verbally or numerically conceptualize its thoughts on significant issues and then clearly and accurately record them can neither transmit its insights nor continue to think clearly about its goals and values" (p. 211). Hence, during the mid to late 1980s, writing in mathematics class became more frequent as part of the writing across the curriculum movement which aimed to help students gain a deep understanding through thinking (Miller & England, 1989; Pugalee, 1997).

Cognitive psychologist Vygotsky insisted that students reach higher level thinking processes by becoming active learners (Albert & Antos, 2000). Vygotsky also advocated that writing requires the writer to develop a structural web of meaning (Pugalee, 2004). Writing is a "unique mode of learning" (Emig, 1977, p. 122) because it establishes connections and relationships, and requires an active involvement in the learning process. Emig (1977) explained that "writing involves the fullest possible functioning of the brain, which entails the active participation in the process of both the left and right hemisphere" (p. 125).

Writing promotes cognitive development in three phases (Shepard, 1993). In the first phase, students can formulate personal examples of concepts based on their observation of patterns and generalizations. In the second phase, students can explain relationships and connections between concepts. In the third phase, students can apply and explain how and why concepts apply beyond the classroom. As students engage in writing based in progressively higher order thinking, their "structural development of conceptual bodies of knowledge" (p. 289) increases as well.

The types of writing that can be implemented in the mathematics classroom can be divided into three main categories: journal writing, expository writing, and transactional writing (Miller, 1992). Journal writing involves students expressing their concerns, struggles, or successes with learning. Writing in journals allows students to reach an understanding by using their own experiences and use of journals to foster the understanding of mathematical concepts because they "require students to collect, internalize, and evaluate knowledge" (Pugalee, 1997, para. 4). Expository writing entails students writing about mathematical processes by describing, defending, or telling "how to" go about a process (Dougherty, 1996; Miller, 1992). Transactional writing requires students to inform and explain mathematical content (Dougherty, 1996; Miller, 1992).

Traditional tasks, such as drill and practice, do not always demonstrate what students understand (Dougherty, 1996; Mayer & Hillman, 1996; Steele, 2005). In a study conducted in a first-year algebra class, Miller and England (1989) discovered that "students may be able to quote rules and properties, but they do not know how to apply them" (p. 308). Writing provides an avenue for students to show when and how to apply their knowledge (Clarke, Waywood, & Stephens, 1993; Hickman, Quick, Haynie, & Flakes, 2000).

Thus, through journal writing, expository writing, and transactional writing in the classroom, students increasingly begin to construct "meanings and connections" (Clarke, Waywood, & Stephens, 1993, p. 243) for mathematics. In particular, Jurdak and Abu Zein (1998) found that "journal writing produces cognitive benefits in mathematics achievement at the level of conceptual understanding, procedural knowledge, and mathematical communication" (p. 416). Additionally Albert and Antos (2000) reported that "thinking and writing about how mathematics is used in daily life helped the students make connections between classroom learning and real-world situations and gave them different ways to express their mathematical knowledge" (para. 8). Writing enables the students to reflect and take ownership on what they have learned. Countryman (as cited in Pugalee, 1997) agreed by stating that "writing can provide opportunities for students to construct their own knowledge of mathematics" (para 2) by making connections to prior knowledge, and recognizing and summarizing new information. For example, a task such as having students re-word definitions in their own words, promotes internalization (Borasi & Rose, 1989). The record of students' journal responses over a period of time also provides a report of progress and a means for reflection (Borasi & Rose, 1989; Clarke, Waywood, & Stephens, 1993) on how students show particular skills or growth of knowledge (Mayer & Hillman, 1996).

"Writing in mathematics can be an integral part of the learning, teaching, evaluation, and assessment process" (Dougherty, 1996, para. 4). Writing is an alternative form of assessment because it gives insight into how and what students have learned thus teachers are able to diagnose student misunderstanding, reflect on their teaching strategies, and make instructional decisions (Bell & Bell, 1985; Borasi & Rose, 1989; Chapman, 1996; Clarke, Waywood, & Stephens, 1993; Goldsby & Cozza, 2002; Johnson, 1983; Miller, 1992; Miller & England, 1989;

Nahrgang & Petersen, 1986; Pugalee, 1997, 2001). After reading students' writing, teachers considered:

> (a) re-teaching immediately;
>
> (b) delaying an exam because a lack of understanding was reflected in the writings;
>
> (c) designing and scheduling a review based on what was learned from the students' writings;
>
> (d) initiating private discussions with individual students who held misconceptions; and,
>
> (e) using writing prompts during a lesson, rather than at the beginning to ascertain if students understood what was presented in that lesson. (Miller, 1992, p. 335)

Finally, writing can provide an assessment tool where teachers can assess student thinking at various levels of Bloom's taxonomy (Nahrgang & Petersen, 1986).

Both students and teachers at the junior high and secondary level agree that writing creates an avenue of communication between students and teacher where students feel comfortable in asking questions or expressing concerns they have about something they are learning (Bell & Bell, 1985; Borasi & Rose, 1989; Chapman, 1996; Clarke, Waywood, & Stephens, 1993; Dougherty, 1996; Goldsby & Cozza, 2002; Mayer & Hillman, 1996; Miller, 1992; Pugalee, 1997). This in turn creates a positive, productive learning environment (Borasi & Rose, 1989; Dougherty, 1996; Goldsby & Cozza, 2002; Miller, 1992) where there is an increase in individual instruction as teachers respond to needs of students that become evident as they read written responses (Borasi & Rose, 1989; Miller, 1992).

In addition to fostering communication between teacher and students, Mayer and Hillman (1996) recognized that students were building confidence in their mathematical abilities as they became accustomed to the writing process. With time students could articulate their reasoning in

a focused, organized fashion (Clarke, Waywood, & Stephens, 1993; Miller & England, 1989; Nahrgang & Petersen, 1986). Miller and England (1989) discovered that students tended to write more when they were hypothetically writing to someone else and found that students enjoyed writing at the beginning of class because it put them in a "frame of mind" (p. 308) for class. Students became accustomed to the class routine and wanted to continue writing in the future (Miller & England, 1989).

Grading and time constraints are two limitations of writing as Chapman (1996) related: "I found reading and responding to the assignments a daunting task" (para. 20). In addition, writing does not always display a student's understanding (Jurdak & Abu Zein, 1998; Miller, 1992; Porter & Masingila, 2000). Porter and Masingila (2000) studied the effects of writing and the conceptual knowledge of calculus students. They found no significant differences in the group that engaged in writing activities and the group that did not (Porter & Masingila, 2000). They concluded that the "real benefits of using writing to learn mathematics may be due, not to the actual activity of writing, but rather to the fact that it requires students to spend time thinking about mathematical ideas and then communicating these ideas to others" (Porter & Masingila, 2000, p. 174). Jurdak and Abu Zein (1998) also concluded that writing about mathematics would produce similar results when compared to implementing other types of communication based strategies in the classroom.

The amount of active involvement in writing in the classroom depends on teachers (Shepard, 1993). Thus, "writing should become an integral part of teacher development, producing practitioners who are concerned about reflection, adaptation, and process" (Pugalee, 2001, p. 243). It must be a part of the mathematics curriculum (Bell & Bell, 1985; Pugalee 1997), not just an occasional classroom activity (Miller, 1992). Successful writing activities will

reinforce the math content being taught (Bell & Bell, 1985). Hopefully, "the entire [writing] process will give students valuable practical experience in expressing their thoughts in writing, a skill that they will most certainly need in any future position of responsibility" (Johnson, 1983, p. 117).

Metacognition

Metacognition is defined as "thinking about thinking" (Desautel, 2009, p. 2000). It refers to the processes by which people contemplate and control how they think (Desautel, 2009; Prescott, 2001). These processes include planning and implementing learning strategies, understanding, recalling, and evaluating information, and assessing one's learning after a task is completed (Desautel, 2009; Prescott, 2001). Thus, metacognition involves acknowledging and monitoring the use of cognitive strategies (Prescott, 2001; Pugalee, 2001).

Writing encourages students to reflect on and synthesize their knowledge so that concepts become their own (Nahrgang & Petersen, 1986; Pugalee, 1997, 2001). In this way, writing can facilitate the development of metacognitive skills and conceptual knowledge (Pugalee, 2001, 2004).

Besides writing, metacognition is specifically important in applying mathematical problem solving strategies because problem solving involves "predicting, planning, revising, selecting, checking, guessing, and classifying" (Pugalee, 2001, p. 237). Students demonstrate mathematical reasoning in written descriptions of the problem solving process; thus, written descriptions support the theory that students are aware of metacognitive behaviors while solving problems (Pugalee, 2001). Additionally, Goldsby and Cozza (2002) concluded that students' reflection on solution processes increased their learning by making them more aware of their metacognitive behaviors.

Bell and Bell (1985) evaluated the influence that writing activities had on how students learned problem solving processes. They found that the students who wrote about their learning activities had a statistically significant larger learning gain then those who did not engage in writing activities. Bell and Bell (1985) reported that by writing, students "became more aware of their thinking processes and more conscious of the choices they are making as they carry out the computation and analysis involved in solving math problems" (p. 220). Pugalee (2004) investigated the differences between students' written and verbal descriptions of problem solving processes. He discovered that students who wrote to describe their thinking arrived at correct solutions at a statistically significant higher rate than those who verbalized their thinking (Pugalee, 2004). Steele (2005) analyzed the impact of writing on students' development of schematic knowledge in solving algebraic problems. She concluded that through writing students learned to explain and justify solutions thus sharing their schematic knowledge (Steele, 2005).

Motivation, Goals, and Self-Efficacy

Cognitive skills and motivation collaborate and influence one another in an effort to enable students to achieve academic success in school (Chouinard, Karsenti, & Roy, 2007; Hannula, 2006; Linnenbrink & Pintrich, 2002). Social cognitive models of motivation view motivation as "a dynamic, multifaceted phenomenon" (Linnenbrink & Pintrich, 2002, p. 313) that can be utilized to understand how and why students are motivated when it comes to learning. A student's behavior is the manifestation of his or her motivation (Hannula, 2006). Furthermore, motivation is an interaction between the learning domain and what the student brings to the domain (Linnenbrink & Pintrich, 2002). Thus, each student is uniquely motivated in various

ways and his or her motivation can vary depending on background, personality, and classroom environment (Linnenbrink & Pintrich, 2002).

Linnenbrink and Pintrich (2002) outlined the four main categories of the social cognitive motivation model that enable academic achievement: intrinsic motivation, attributions, goal orientations, and self-efficacy. These four factors work together and enhance one another resulting in student motivation.

Intrinsic motivation is defined as the "motivation to engage in an activity for its own sake" (Linnenbrink & Pintrich, 2002, p. 318). One critical aspect of intrinsic motivation is a student's interest in a task (Linnenbrink & Pintrich, 2002; Zimmerman, 2002). Linnenbrink and Pintrich (2002) further explained that there is both personal and situational interest directing a student's participation in a task. Personal interest refers to a student's preference for and how much a student likes a topic (Linnenbrink & Pintrich, 2002). Situational interest refers to the "catch and hold" factors of the learning environment (Linnenbrink & Pintrich, 2002). The "catch" factor stimulates students while the "hold" factor makes the task or content meaningful and valuable thus creating a sustained interest and engagement in the activity or task (Linnenbrink & Pintrich, 2002). Personal and situational interests enable academic achievement because they have been shown to increase students' attention, persistence, and use of cognitive strategies while engaging in a learning task (Linnenbrink & Pintrich, 2002). Chouinard, Karsenti, and Roy (2007) and Miller and Brickman (2004) also reported that students' perception of the value of a learning task is related to the effort they exert in participating in the learning activity.

The attribution theory of motivation centers a student's attention on understanding and analyzing why events occur (Linnenbrink & Pintrich, 2002). A student will attribute his or her

successes or failures to factors in his or her environment. For example, if a student does well he or she may attribute this to effort or luck; whereas if a student performs poorly, it could be attributed to a lack of effort, bad luck, or bias from the teacher. Student beliefs about the causes of successes or failures can be influenced through positive and negative feedback. Thus, a teacher's reactions following successes or failures weigh heavily on how students attribute their performance. Attributions result in students formulating outcomes regarding future efforts and how they feel about a subject; therefore, attributions are associated with engagement and achievement.

The goal achievement theory of motivation proposes that behaviors are goal directed (Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004). The two general types of goal orientations are mastery (or learning) goals and performance goals. Mastery goal orientations focus students on learning and understanding concepts, increasing their level of competence, developing new skills, and mastering standards of learning. Performance-approach goals focus students on their ability to reach achievements when compared to others (for example, earning higher grades than classmates), and result in tangible incentives such as awards or recognitions (Chouinard, Karsenti, & Roy, 2007; Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004). Performance-avoidance goals focus students on trying to avoid appearing incompetent (Chouinard, Karsenti, & Roy, 2007; Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004).

Goal setting has been correlated with increased academic achievement (Linnenbrink & Pintrich, 2002; Miller & Brinkman, 2004; Zimmerman, 2002). Mastery goals in particular foster the use of cognitive strategies, organization strategies, metacognition, study skills, and self-regulation, and overall engagement in the task thus resulting in high achievement outcomes (Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004). Regardless of age or gender, the

level of mastery goals set by students has been found to be a predictor of the effort students put forth in their mathematics learning (Chouinard, Karsenti, & Roy, 2007). As students gain practice in setting goals, they begin to refer to themselves in terms of their performance (Desautel, 2009). Students also develop their metacognitive knowledge as they examine and explain why they succeeded or failed in meeting a goal (Desautel, 2009). Thus they feel more ownership in their learning (Opitz, 1995).

Distinct and clear goals produce higher levels of achievement when compared to vague goals because the path toward goal attainment is more evident (Miller & Brickman, 2004). At times, one goal may be necessary for the successful completion of another (Hannula, 2006). When students form distinct future goals, they develop a network of sub-goals that guide them in achieving the future goal (Miller & Brickman, 2004). Because the attainment of sub-goals is critical to the achievement of future goals, students self-regulate their behavior and persist in achieving their sub-goals (Miller & Brickman, 2004). Overall, when students assess and recognize the value and impact a learning activity will have on them reaching their goals, they are more motivated, invested, and self-determined to participate in that learning task (Miller & Brickman, 2004).

The National Council of Teachers of Mathematics (NCTM, 1995) insisted that "helping students set and attain goals is at the heart of good teaching" (p. 29). Yet the number of teachers who have students set goals as a regular classroom routine is limited (Zimmerman, 2002). Stenmark (1991) advocated that students who set goals and think about and discuss their progress towards the achievement of goals based on evidence will nurture understanding and control their academic success. Linnenbrink and Pintrich (2002) stressed "to foster mastery goal adoption, evaluation should focus on individual improvement as well as mastery of ideas" (p.

323). Therefore, Miller and Brickman (2004) encouraged educators to help students commit themselves to establishing goals, monitoring their goals progression, adjusting their behavior and efforts, and establishing new goals. NCTM (1995) expressed that setting and monitoring goal progress is unproductive unless educators regularly communicate with students on their progress toward achievement. Chappuis (2005) reminded educators that it is the quality of feedback, not its quantity, which students need. The most valuable feedback identifies successes and offers suggestions and encouragement for students who are struggling to achieve a goal (Chappuis, 2005). Thus when teachers collaborate with students to establish goals, and effectively monitor and communicate progress toward attaining these goals, the result is an enhancement of learning (NCTM, 1995).

Self-efficacy is the final category in the social cognitive model of motivation (Linnenbrink & Pintrich, 2002). Social cognitive theorist Bandura explained that self-efficacy is "a person's beliefs concerning his or her ability to successfully perform a given task or behavior" (Hackett & Betz, 1989, p. 261). Bandura believed students would carry out a task if they both knew how to carry out the task and believed they could do it successfully (McCarthy, Meier, & Rinderer, 1985). Self-efficacy is different from self-concept or self-esteem beliefs in that it measures confidence in performing a specific task, such as solving a one-step algebra equation, instead of referring to an overall general ability in mathematics (Linnenbrink & Pintrich, 2002). It is usually evaluated by self-report questionnaires (Linnenbrink & Pintrich, 2002). Self-efficacy influences whether a person will engage in, devote effort to, and persist in task completion (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; McCarthy, Meier, & Rinderer, 1985; Miller & Brickman, 2004; Schunk & Zimmerman, 2007).

Linnenbrink and Pintrich (2002) reviewed the results of various experimental and correlational research studies dealing with student self-efficacy across a variety of age groups and academic subjects. They reported that self-efficacy beliefs are predictive of students' cognitive engagement in tasks, promote persistence and engagement in learning, influence the use of student self-regulation, and are related to higher levels of achievement and learning by students.

Other researchers too have indicated that a person's self-efficacy affects his or her motivation to engage in learning and successfulness on academic tasks (Chouinard, Karsenti, & Roy, 2007; Hackett & Betz, 1989; Pajares & Miller, 1997; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002). Zimmerman (2002) stated that "increases in self-satisfaction enhance motivation, whereas decreases in self-satisfaction undermine further efforts to learn" (p. 68). Chouinard, Karsenti, and Roy (2007) reported that self-efficacy beliefs have an effect on how valuable students view tasks. In addition, Miller and Brickman (2004) found self-efficacy initiates and sustains the pursuit of goals. Thus students who set goals and monitor their performance demonstrate higher levels of self-efficacy than those who do not (Zimmerman, 2002). Self-efficacy influences motivation by influencing the amount of effort and energy a learner will contribute to a task (Chouinard, Karsenti, & Roy, 2007; Hackett & Betz, 1989; Lerch, Bilics, & Colley, 2006; Schunk & Zimmerman, 2007). Students with positive or high self-efficacy will work harder, persist longer, and achieve at higher levels when compared with students with negative or low self-efficacy (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; McCarthy, Meier, & Rinderer, 1985; Miller & Brickman, 2004). Thus, expecting positive outcomes and valuing a learning experience will increase students' motivation, perseverance,

and achievement (Linnenbrink & Pintrich, 2002; Pajares & Miller, 1997; Schunk & Zimmerman, 2007).

Hackett and Betz (1989) investigated the relationship between mathematics self-efficacy and student performance and reported students with positive or high mathematics self-efficacy possessed positive attitudes toward mathematics, displayed higher performance, and were more likely to choose future mathematics education and career choices when compared with students with negative or low self-efficacy. Pajares and Miller (1997) indicated that the levels of mathematics confidence students have in their abilities are a factor in how they apply and utilize knowledge and skills they have acquired; thus academic achievement is determined in part by the confidence a student possesses. Pajares and Miller (1997) also stated that "various researchers have reported that students' judgments of their capacity to solve mathematics problems are predictive of their actual capacity to solve those problems" (p. 214). McCarthy, Meier, and Rinderer (1985) explained that strong self-efficacy beliefs are related to cognitive deep processing which entails thinking abstractly, finding meaning, comparing and contrasting, and evaluating. In addition, Ramdass and Zimmerman (2008) and Zimmerman (2002) found that students with high levels of mathematics self-efficacy naturally set high goals for themselves. These students also utilized effective learning strategies, monitored their work more effectively, endured through challenges, evaluated their performance with higher proficiency, and achieved at higher levels when compared to their counterparts (Ramdass & Zimmerman, 2008; Zimmerman, 2002).

Hackett and Betz (1989) discovered students with negative or low self-efficacy experienced mathematics anxiety when completing learning and assessment tasks. McCarthy, Meier, and Rinderer (1985) also indicated there is a correlation between students with high

anxiety and students with low self-efficacy which leads to poor performance. Lerch, Bilics, and Colley (2006) warned that if students view themselves as unable to learn mathematics, this emotion "would provide a self-fulfilling prophecy" (p. 9) because students with negative or low self-efficacy fail to endure and persist when completing learning tasks. Boekaerts and Cascallar (2006) supported this by stating that "negative emotions experienced while doing mathematics increase the students' ruminating thoughts and decrease their self-regulation, which in turn decrease mathematical achievement" (p. 205). Chouinard, Karsenti, and Roy (2007) studied the relationship among competence beliefs, utility value, achievement goals, and effort in mathematics and found that students who have lower competence beliefs will attribute less importance to success, set lower achievement goals, and exert less effort to succeed.

Self-efficacy is based on past accomplishments and failures (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002). Prior learning experiences invoke emotions and beliefs that consequently influence present and future motivation and task initiation and persistence (Boekaerts & Cascallar, 2006; Hackett & Betz, 1989; Hannula, 2006). Hannula (2006) explained that experiences often leave an association between emotions felt while completing a task and the task itself. These "emotional associations form the core of attitude as an emotional disposition" (Hannula, 2006, p. 171). Emotions are directly linked to motivation manifested in positive or negative forms (Hannula, 2006). Few educators ask students to evaluate their self-efficacy on tasks prior to learning and thus do not identify student competency or motivation barriers (Zimmerman, 2002). Therefore, it is critical for mathematics educators to recognize how students feel about their mathematics knowledge because it will influence their self-efficacy and their learning achievement, whether positively or negatively (Lerch, Bilics, & Colley, 2006; Ramdass & Zimmerman, 2008).

It is also important for students' self-efficacy beliefs to be accurate and calibrated to their actual achievements; therefore, students should not underestimate or overestimate their abilities (Labuhn, Zimmerman, & Hasselhorn, 2010; Linnenbrink & Pintrich, 2002). Educators should assess students' self-efficacy beliefs and compare them to actual performance (Hackett & Betz, 1989; Hannula, 2006). Educators must also provide an environment where student self-efficacy beliefs can be modified (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002). This could be done through implementing learning experiences and assessments that foster success resulting in new knowledge, skills, and positive self-efficacy beliefs amongst all students (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002).

McCarthy, Meier, and Rinderer (1985) recognized that self-efficacy beliefs are developed by positive feedback. Chouinard, Karsenti, and Roy (2007) reported "adolescents' academic motivation level is influenced greatly by their perceptions of the level of support and encouragement provided by parents and teachers" (p. 503). They found that while parents contribute the most to the utility value students place on mathematics, teachers contribute the most to the competence beliefs students hold (Chouinard, Karsenti, & Roy, 2007). Therefore, Ramdass and Zimmerman (2008) stressed the importance of the need for teachers to evaluate student self-efficacy as well as knowledge attainment because the classroom environment "must not only cultivate the knowledge to succeed, but should nurture the belief that one can succeed" (p. 37).

Self-Assessment, Self-Evaluation and Self-Reflection

Student self-assessment and self-evaluation are terms that are defined differently and used interchangeably by various researchers. Stallings and Tascione (1996) defined "student self-assessment as the process in which a student determines the types of errors made in her or

his mathematics work. Student self-evaluation is the student's reflections about his or her general understanding of the mathematics explored up to that point" (para. 2). On the other hand, Andrade and Valtcheva (2009) defined self-assessment as "a process of formative assessment during which students reflect on the quality of their work, judge the degree to which it reflects explicitly stated goals or criteria, and revise accordingly" (p. 12) and self-evaluation as the "approaches that involve students in grading their work" (p. 13).

The definitions of self-assessment and self-evaluation provided by Kenney and Silver (1993) depict the relationship between self-assessment and self-evaluation. They defined self-assessment as "the process of actively monitoring one's own progress in learning and understanding and of examining one's own mathematical knowledge, process, and attitudes" (p. 229). Self-assessment involves both self-awareness and self-evaluation. Self-awareness is "taking stock of one's own repertoire of mathematical knowledge, processes, strategies, and attitudes" (p. 230). Self-evaluation is a component of self-assessment that "involves going beyond mere self-awareness and taking a critical look at one's own mathematical knowledge, processes and dispositions. Verbs such as monitor, regulate, reflect, and oversee are often associated with self-evaluation" (p. 230).

The National Council of Teachers of Mathematics (1995) expressed the need for a shift in assessment practices. NCTM expressed that students should learn to assess their own progress in conjunction with their teachers "in order to increase their mathematical power" (p. 29). NCTM (1995) addressed a need for four specific shifts in assessment practices:

- A shift toward judging the progress of each student's attainment of mathematical power, and away from assessing students' knowledge of specific facts and isolated skills;
- A shift toward communicating with students about their performance in a continuous, comprehensive manner, and away from simply indicating whether or not answers are correct;
- A shift toward using multiple and complex assessment tools (such as performance tasks, projects, writing assignments, oral demonstrations, and portfolios), and away from sole reliance on answers to brief questions on quizzes and chapter tests;
- A shift toward students learning to assess their own progress, and away from teachers and external agencies as the sole judges of progress. (p. 29)

Yancey (1998) too stressed that self-assessment is not an essential part of curriculum; instead, it is typically integrated as a supplemental or optional task. Students are therefore not accustomed to assessing their own work and view that as one of the roles of their teachers. If self-evaluation is valued as important to student learning then it needs to be incorporated in both curricular standards and assessments within the classroom.

Chappuis (2005) recalled that teachers frequently are making decisions on curriculum and instruction based on data received from students' formative assessments. While teachers create the environment for learning, it is ultimately up to the students to decide how they will participate in the learning environment. Self-assessment and self-evaluation are means for students to contribute to their own success.

Self-assessment and self-evaluation promote students' thinking about what they have done and the quality of their work (Andrade & Valtcheva, 2009; Chappuis, 2005; Opitz, 1995;

Stallings & Tascione, 1996). Self-evaluation involves students taking a step back to think about how effective their learning strategies were (Kenney & Silver, 1993; Stallings & Tascione, 1996). Stenmark (1991) expressed the idea that self-evaluation encourages metacognition skills in students as well as student ownership in learning. Andrade and Valtcheva (2009) added that self-evaluation increases learning and achievement. When students become accustomed to evaluating their own work, they increase their capacity for analysis and problem solving (NCTM, 1995). Ramdass and Zimmerman (2008) stressed that in order for self-evaluation to be effective, it must be relatively accurate. Labuhn, Zimmerman, and Hasselhorn (2010) also indicated that the ability to accurately judge one's learning capacity is critical for academic achievement.

Self-reflection is a type of self-evaluation (Kenney & Silver, 1993). Self-reflection allows individuals to actively "make sense of events in terms of their own conceptions of reality" (Von Wright, 1992, p. 60). The main goal of reflection is for students to focus on answering the questions: What have I done? What have I learned? What are areas for me to improve? How have I learned? How have I changed? Where am I now as I have completed assignments, activities, projects, and other formative assessments? (Carr, 2002; Chappuis, 2005; Hickman, Quick, Haynie, & Flakes, 2000; Kenney & Silver, 1993; Lerch, Bilics, & Colley, 2006; Optiz, 1995; Von Wright, 1992).

Von Wright (1992) explained "one cannot gain a measure of control over one's own thinking while one remains unaware of it" (p. 62). He advocated that self-reflection on experiences provides students with access to a new domain of knowledge – the knowledge of self. Self-reflection provides opportunities for students to reason about how they reason, to

interpret their thoughts and actions, and to evaluate their intentions and motives. This process engages students in metacognition and enables them to create new cognitive structures.

Ramdass and Zimmerman (2008) found that self-reflection is critical to success in mathematics provided it is accurate. Inviting students to reflect and think about their accomplishments and feelings is an influential way for students to recognize what they know and what they still need to learn (Opitz, 1995). Reflection activities aid students in comprehending their learning and engage them in critical thinking (Desautel, 2009; Lerch, Bilics, & Colley, 2006). In response to reflecting on their learning, students gain insights into their learning, begin to monitor their learning, and set new goals for future learning thus supporting students' active participation and ownership in the learning process (Carr, 2002; Chappuis, 2005; Kenney & Silver, 1993; Opitz, 1995). The process of self-reflection allows students to connect their current learning experiences to previous experiences and knowledge (Lerch, Bilics, & Colley, 2006; Powell & Ramnauth, 1992).

The process of taking a "time out" in the classroom for students to write about what they know and their learning strategies provides students with an opportunity to engage in self-reflection (Kenney & Silver, 1993). Learning is enhanced when students respond to questions that are personalized to their progress (Powell & Ramnauth, 1992). Prescott (2001) found that having students write reflectively enabled them to answer metacognitive questions and express how they knew they had achieved understanding of concepts. Desautel (2009) also recognized the development of metacognitive skills in students as they explained how and why they reached or failed to reach a goal. Answering self-reflective questions and writing responses results in students becoming better communicators, critical thinkers, and active participants in their learning (Carr, 2002; Chappuis, 2005; Desautel, 2009; Hickman, Quick, Haynie, & Flakes, 2000;

Kenney & Silver, 1993; Stallings & Tascione, 1996). Having students write and explain what "they understood and what they did not understand helps them think more systematically about their processes of problem solving" (Stallings & Tascione, 1996, para. 20). Hickman et al. (2000) discovered that "encouraging students to think and write reflectively helps them to internalize key concepts and to create a true connection between what they learn and what they live" (para. 2) thus guiding them to a better understanding of concepts. Chappuis (2005) indicated that through collecting their work "students have the opportunity to reflect on their learning, develop an internal feedback loop, and understand themselves better as learners" (p. 42-43). Desautel (2009) also discovered that the reflection time incorporated into the classroom became an important element in the class' sense of community.

Stallings and Tascione (1996), Prescott (2001), and Andrade and Valtcheva (2009) found that having students self-evaluate and write reflectively increased their confidence. Ramdass and Zimmerman (2008) identified similar results in that "students' self-efficacy is strengthened with tangible indicators of progress" (p. 21). Chappuis (2005) explained that self-reflection motivated students to look back at their work and see how far they have come in their learning. Lerch, Bilics, and Colley (2006) attributed this increase in self-efficacy as a consequence of the reflective writing process because through reflective writing, students experience emotional responses to the subject. Positive experiences with the subject enable students to change any previous negative feelings and beliefs (Lerch, Bilics, & Colley, 2006).

To study the effects of reflection on learning and critical thinking, Lerch, Bilics, and Colley (2006) had College Algebra students at a university participate in several writing activities during a semester. Students wrote mathematical autobiographies identifying and describing past learning experiences. They set goals for the semester. After exams, students

provided an error analysis report describing why they missed problems. At the mid-point of the semester, the students wrote a letter to their parents noting why they had the grade they did as well as discussing if they were achieving their goals. Before finals, the students evaluated their growth over the semester and detailed how they met their goals. Lerch, Bilics, and Colley (2006) noted, as the semester continued, that students were able to set goals, correct errors, and view previous learning experiences in a new way. The students utilized higher levels of thinking in their reflections. Lerch, Bilics, and Colley (2006) concluded that learning is deepened by critical reflection because students reflect on prior experiences and identify changes they should make to become better learners in the future.

Powell and Ramnauth (1992) promoted the idea that educators need pedagogical methods that engage students in reflecting on mathematics. One such method is writing because "it can prompt students to reflect critically on their mathematical experiences and respond to mathematical situations and questions that are personal and of their own choosing" (p. 12). Stenmark (1991) specifically suggested that educators should ask students to examine and identify evidence of growth, changes in self-confidence, or changes in understanding of mathematical concepts in their work. Once these have been identified, students should write a summary describing their growth through explaining the factors that contributed to this growth thus enabling students to foster understanding and control of their success (Stenmark, 1991). Kenney and Silver (1993) also advocated that as students become accustomed to the self-evaluation process of reflecting and writing, they begin to internalize questions and give more thorough descriptions and answers in the written responses.

Lerch, Bilics, and Colley (2006) insisted that it is crucial for educators to understand students' feelings about mathematics and what inhibits students' progress; therefore having

students reflect and write about their feelings is an avenue for educators to reach this understanding. Stallings and Tascione (1996) reported that self-assessment and self-evaluation not only allowed students to explain what they understood by explaining processes in their work, but it also gave them the chance to explain what caused them difficulties and where they needed further explanations from the teacher.

Finally, Andrade and Valtcheva (2009) outlined several criteria that educators should incorporate for effective self-evaluation. Students need to understand the value of self-evaluation, and have a specific task to evaluate and criteria on which to base the evaluation (Andrade & Valtcheva, 2009). Furthermore, educators must provide students with opportunities to practice self-evaluation and models of self-evaluation, and give direction and assistance during the self-evaluation process in order for it to be successful (Andrade & Valtcheva, 2009; Chappuis, 2005).

NCTM (2000) recognized "reflection and communication are intertwined processes in mathematics learning. With explicit attention and planning by teachers, communication for the purposes of reflection can become a natural part of mathematics learning" (p. 61). When students communicate through continuous and comprehensive self-evaluations, they provide teachers with valuable information including feedback about instruction, students' self-perceived strengths and weaknesses, students' interests in specific learning activities, students' learning progression, and when and how students apply knowledge (Andrade & Valtcheva, 2009; Carr, 2002; Hickman, Quick, Haynie, & Flakes, 2000; NCTM, 1995; Prescott, 2001). Educators can thus apply the information gained from the students' responses in planning future instruction and making decisions about students' academic growth (Carr, 2002; Hickman, Quick, Haynie, & Flakes, 2000; NCTM, 1995).

Self-Regulation

Self-regulated learning has become a key component in education. Research indicates that students who have the capacity to actively engage in the self-regulation process benefit through knowledge attainment and academic achievement (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Hannula, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). Students who regulate their learning are "more metacognitively, motivationally, and behaviorally responsible for their own learning" (Labuhn, Zimmerman, & Hasselhorn, 2010, p. 174). Ramdass and Zimmerman (2008) defined self-regulation to include all the "processes people use to activate and sustain their thoughts, behaviors, and emotions to attain learning goals. It encompasses processes such as setting goals, using strategies to solve problems, self-evaluating one's performance, seeking assistance when needed, and satisfaction with one's efforts" (p. 20). It is self-directed, self-controlled, and aimed at aiding students in reaching their goals (Boekaerts & Cascallar, 2006; Ramdass & Zimmerman, 2008). Zimmerman (2008) stated that self-regulated learning empowers learners to transform their mental abilities into academic performance skills. Zimmerman (2002) also explained that self-regulation is an important aspect in cultivating life-long learning skills because it requires a learner to selectively use processes that are tailored to each new learning task.

Self-regulation encompasses three main phases: forethought, performance, and self-reflection (Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008). The forethought phase involves processes that occur before learning, mainly goal setting and strategic planning for reaching a standard. These goals and standards can be established internally or externally (Labuhn, Zimmerman, & Hasselhorn, 2010). Other elements of the forethought phase include "self-efficacy beliefs, out-

come expectations, task interest or value, and goal orientation" (Zimmerman, 2008, p. 178). Because self-motivation rests on self-beliefs such as efficacy, interest, outcome expectations, and results of learning (Zimmerman, 2002), Boekaerts and Cascallar (2006) stressed self-efficacy is a critical element of the forethought phase of self-regulation because students' perceptions of their emotions, beliefs, and needs influence their use of self-regulation. Positive emotions increased students' self-regulation and thus mathematics achievement (Boekaerts & Cascallar, 2006). Hannula (2006) also expressed the idea that students' beliefs regarding the accessibility of their goal attainment affects their motivation to engage in self-regulation. There must be a desirable, valuable goal and the belief that achieving this goal is possible (Hannula, 2006).

The second phase in the self-regulation model is the performance phase. This includes self-control and self-observation which are the processes implemented during the actual learning process (Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008). Self-control refers to the use of learning methods and strategies that affect the learners' attention to the task at hand. These methods and strategies were selected during the forethought phase. Self-observation is the tracking of the use of these strategies.

Finally, the third phase of the self-regulation model is self-reflection which includes self-judgment and self-reaction to learning after a task (Andrade & Valtcheva, 2009; Labuhn, Zimmerman, & Hasselhorn 2010; Miller & Brickman, 2004; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). The self-reflection phase consists of the thinking processes of self-evaluation and reactions to efforts, performance, and achievements of goals and standards. Self-evaluation is the key self-judgment process that entails learners comparing the quality of their individual performance with a goal or a standard after receiving feedback from oneself or

another about the outcomes of a learning task. This comparison could be with one's previous performance, another student's performance, or a specific expected standard or quality and level of performance. Self-evaluation also includes monitoring progress toward reaching the goals established in the forethought phase. Self-reactions are derived from self-evaluation. Self-reactions include beliefs and feelings of satisfaction or dissatisfaction that arise from evaluating performance. In this final phase of the self-regulation model, learners evaluate their goal progression and adjust strategies if necessary to continue the completion of a task (Labuhn, Zimmerman, & Hasselhorn, 2010; Miller & Brickman, 2004; Schunk & Zimmerman, 2007; Zimmerman, 2008). The self-reflection process motivates learners to embark on the forethought phase of a new self-regulation cycle (Labuhn, Zimmerman, & Hasselhorn, 2010; Miller & Brickman, 2004; Schunk & Zimmerman, 2007; Zimmerman, 2008). Therefore, the self-regulation model is cyclical because the self-reflection phase prompts the subsequent forethought phase for future performance due to its natural influence on new self-efficacy beliefs, motivation, and goals (Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008).

There are a variety of benefits gained from implementing self-regulation in the learning process (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Desautel, 2009; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). First, self-regulation provides students with control and ownership over their learning, cognitive processes, and choices made in that learning process (Boekaerts & Cascallar, 2006; Kenney & Silver, 1993; Opitz, 1995). It provides students with a "sense of agency" (Ramdass & Zimmerman, 2008, p. 20) in their learning. Second, it provides students with an opportunity to engage in metacognitive processes through their awareness of learning process and strategies

(Desautel, 2009; Labuhn, Zimmerman, & Hasselhorn, 2010). Third, it allows students to set specific goals for themselves; goal setting has been correlated with increased academic achievement (Desautel, 2009; Miller & Brickman, 2004; NCTM, 1995; Zimmerman, 2002). Fourth, students who frequently utilized the processes of self-regulation reached out to their parents, teachers, and classmates for assistance in their learning more frequently than students who did not utilize the self-regulation process (Zimmerman, 2008). Fifth, it increases students' motivation and interest in learning (Miller & Brinkman, 2004; Zimmerman, 2008). Sixth, it affects students' self-efficacy because students who set goals and self-monitor their progress towards achievement of these goals have displayed higher levels of self-efficacy and motivation to continue the self-regulation cycle than other students who did not set goals (Andrade & Valtcheva, 2009; Labuhn, Zimmerman, & Hasselhorn, 2010; Miller & Brickman, 2004; NCTM, 1995; Pajares & Miller, 1997; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008). NCTM (1995) insisted students who establish learning goals and identify the progress they are making towards these goals "are more likely to be reflective and confident learners of mathematics" (p. 44).

Labuhn, Zimmerman, and Hasselhorn (2010) advocated that accurate monitoring and evaluating of one's progress and further adapting strategies will result in effective self-regulation. Self-regulatory processes influence achievement and learning provided they are routinely implemented in the learning process. They reported that

> empirical studies have proven the strong link between the capacity to self-regulate one's learning and self-efficacy, intrinsic task interest, and academic achievement. Thus, the goal to enhance academic achievement might be accomplished through increasing

students' self-regulation. The question remains in what way a clear understanding of self-regulatory processes contributes to achieving this goal. (p. 174)

Therefore, there exists a need for educators to explore teaching methods that promote the use of student self-control in the classroom. Labuhn, Zimmerman, and Hasselhorn (2010) encouraged educators to find ways for "students to monitor their self-improvement over time and reflect on reasons for their improvement" (p. 177). Kenney and Silver (1993) too recognized the need for educators to develop educational experiences and instruments that invite students into the self-regulation process. These instruments should direct students to ask themselves questions regarding self-efficacy beliefs and self-evaluation (Kenney & Silver, 1993). Kenney and Silver (1993) described a mathematically powerful learner as one who demonstrates the ability to identify what they know, how much they know, the quality of their knowledge, and what strategies are needed to attain and enhance future knowledge. Pugalee (2001) advocated the use of writing in the mathematics classroom as one way to promote metacognition and self-regulation. Upon completion of a study that implemented self-regulation processes of goal setting and reflecting in the classroom, Desautel (2009) stated "I have confirmed my own confidence in the value of instruction in oral and written self-reflection, coupled with academic and personal goal setting, as a means to enrich students' self-awareness as learners" (p. 2016).

Summary

The National Council of Teachers of Mathematics (2000) advocated the need for increased communication in the classroom. NCTM (2000) stated that "communication is an essential part of mathematics and mathematics education. It is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and amendment" (p. 60). Communicating mathematically within the

classroom is a means of increasing conceptual knowledge (NCTM, 2000; Steele, 2005) and enables students to develop concepts, skills, attitudes, and processes (Dougherty, 1996).

Writing is a means of communication that promotes cognitive development (Shepard, 1993). Writing helps students establish connections and relationships, and requires an active involvement in the learning process (Emig, 1977). It entails students reflecting on what they have done and clarifying their understanding of concepts (NCTM, 2000). Students are also forced to organize, analyze, synthesize, and evaluate their thoughts when writing (Miller & England, 1989; Nahrgang & Petersen, 1986). Writing serves as an alternative form of assessment because it gives insight into how and what students have learned thus helping teachers diagnose student misunderstanding, reflect on their teaching strategies, and make instructional decisions for the future (Bell & Bell, 1985; Borasi & Rose, 1989; Chapman, 1996; Clarke, Waywood, & Stephens, 1993; Goldsby & Cozza, 2002; Johnson, 1983; Miller, 1992; Miller & England, 1989; Nahrgang & Petersen, 1986; Pugalee, 1997, 2001). In addition to fostering communication between teacher and students, students built confidence in their mathematical abilities as they became accustomed to the writing process in the classroom (Mayer & Hillman, 1996).

Metacognition is defined as "thinking about thinking" (Desautel, 2009, p. 2000). It refers to the processes by which people contemplate and control how they think (Desautel, 2009; Prescott, 2001). Metacognition involves acknowledging and monitoring the use of cognitive strategies (Prescott, 2001; Pugalee, 2001). Because writing encourages students to reflect on and synthesize their knowledge so that concepts become their own (Nahrgang & Petersen, 1986; Pugalee, 1997, 2001), writing can facilitate the development of metacognitive skills and conceptual knowledge (Pugalee, 2001, 2004).

Intrinsic motivation, attributions, goal orientations, and self-efficacy are aspects of the social cognitive motivation model that work together and influence students' motivation, investment, engagement, and achievement of learning activities and tasks (Linnenbrink & Pintrich, 2002). Intrinsic motivation is defined as the "motivation to engage in an activity for its own sake" (Linnenbrink & Pintrich, 2002, p. 318). A student's perception of the value of a learning task and interest in the task is related to the effort he or she exerts in participating in it (Chouinard, Karsenti, & Roy, 2007; Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004; Zimmerman, 2002). The attribution theory of motivation centers a student's attention on understanding and analyzing why events occur (Linnenbrink & Pintrich, 2002). A student will attribute his or her successes or failures to factors in the learning environment and these attributions influence future engagement and achievement (Linnenbrink & Pintrich, 2002).

The goal achievement theory of motivation includes two types of goal orientations: mastery (or learning) goals and performance goals (Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004). Mastery goal orientations focus students on learning and understanding concepts, increasing their level of competence, developing new skills, and mastering standards of learning. In particular, mastery goals foster the use of cognitive strategies, organization strategies, metacognition, study skills, self-regulation, and overall engagement in the task thus resulting in high achievement outcomes. Performance-approach goals focus students on their ability to reach achievements when compared to others and result in tangible incentives such as awards or recognitions (Chouinard, Karsenti, & Roy, 2007; Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004). Research has indicated that teachers play a significant role in helping students successfully establish and monitor goals (Chappuis, 2005; Linnenbrink & Pintrich, 2002; Miller & Brickman, 2004; NCTM, 1995). When teachers collaborate with students to

establish goals, and monitor and communicate progress toward attaining these goals, the result is an enhancement of learning (NCTM, 1995).

Social cognitive theorist Bandura explained that self-efficacy is "a person's beliefs concerning his or her ability to successfully perform a given task or behavior" (Hackett & Betz, 1989, p. 261). Bandura believed students would carry out a task if they both knew how to carry out the task and believed they could do it successfully (McCarthy, Meier, & Rinderer, 1985). Self-efficacy influences whether a person will engage in, devote effort to, and persist in task completion (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; McCarthy, Meier, & Rinderer, 1985; Miller & Brickman, 2004). Students with high levels of mathematics self-efficacy naturally set high goals for themselves, utilize effective learning strategies, monitor their work more effectively, endure through challenges, evaluate their performance with higher proficiency, and achieve at higher levels when compared to their counterparts (Ramdass & Zimmerman, 2008; Zimmerman, 2002). Students with positive or high mathematics self-efficacy are also more likely to choose future mathematics education and career choices when compared with students with negative or low self-efficacy (Hackett & Betz, 1989). Additionally, the level of mathematics confidence students have in their abilities is a factor in how they apply and utilize knowledge and skills they have acquired; thus academic achievement is determined in part by the confidence a student possesses (Pajares & Miller, 1997). Therefore, it is critical for mathematics educators to recognize how students feel about their mathematics knowledge because it will influence their self-efficacy and their learning achievement, whether positively or negatively (Lerch, Bilics, & Colley, 2006; Ramdass & Zimmerman, 2008).

The National Council of Teachers of Mathematics (1995) stressed a need for the shift in assessment practices that enable students to be active participants in evaluating their work.

Kenney and Silver (1993) defined self-assessment as "the process of actively monitoring one's own progress in learning and understanding and of examining one's own mathematical knowledge, process, and attitudes" (p. 229). Self-assessment involves both self-awareness and self-evaluation (Kenney & Silver, 1993). Self-evaluation is a component of self-assessment that "involves going beyond mere self-awareness and taking a critical look at one's own mathematical knowledge, processes and dispositions" (Kenney & Silver, 1993, p. 230). Self-evaluation provides students with self-awareness of their performance which can enrich their strengths and decrease their weaknesses (Kenney & Silver, 1993). Self-evaluations also offer students and educators valuable feedback that can be utilized to enhance the educational learning environment (Andrade & Valtcheva, 2009; Carr, 2002; Hickman, Quick, Haynie, & Flakes, 2000; NCTM, 1995; Prescott, 2001).

Self-reflection is a type of self-evaluation (Kenney & Silver, 1993). The process of taking a "time out" in the classroom for students to write about what they know and their learning strategies provides students with an opportunity to engage in self-reflection. Research has indicated that answering self-reflective questions through writing results in students becoming better communicators, critical thinkers, and active participants in their learning, while giving them an opportunity to realize what they do and do not understand (Carr, 2002; Chappuis, 2005; Desautel, 2009; Hickman, Quick, Haynie, & Flakes, 2000; Kenney & Silver, 1993; Stallings & Tascione, 1996). Research has also shown that having students self-evaluate and write reflectively increased their confidence (Andrade & Valtcheva, 2009; Prescott, 2001; Stallings & Tascione, 1996). Self-reflection motivates students to look back at their work and see how far they have come in their learning (Chappuis, 2005) thus their self-efficacy was strengthened (Ramdass & Zimmerman, 2008).

Self-regulation includes all the "processes people use to activate and sustain their thoughts, behaviors, and emotions to attain learning goals. It encompasses processes such as setting goals, using strategies to solve problems, self-evaluating one's performance, seeking assistance when needed, and satisfaction with one's efforts" (Ramdass & Zimmerman, 2008, p. 20). It is self-directed, self-controlled, and aimed at aiding students in reaching their goals (Boekaerts & Cascallar, 2006; Ramdass & Zimmerman, 2008). Self-regulation encompasses three main phases: forethought, performance, and self-reflection (Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008). The forethought phase involves processes that occur before learning, mainly goal setting and strategic planning for reaching a standard. It includes the motivation and self-efficacy beliefs that a learner brings to a task (Zimmerman, 2008). The second phase in the self-regulation model is the performance phase which includes self-control of learning strategies and self-observation (Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008). Finally, the third phase of the self-regulation model is self-reflection which includes self-judgment and self-reaction to learning after a task (Andrade & Valtcheva, 2009; Labuhn, Zimmerman, & Hasselhorn 2010; Miller & Brickman, 2004; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). In this final phase of the self-regulation model, learners evaluate their goal progression and adjust strategies if necessary to continue the completion of a task and to embark on the forethought phase of a new self-regulation cycle (Labuhn, Zimmerman, & Hasselhorn, 2010; Miller & Brickman, 2004; Schunk & Zimmerman, 2007; Zimmerman, 2008).

Research indicates that students who have the capacity to actively engage in the self-regulation process benefit through knowledge attainment and academic achievement (Andrade &

Valtcheva, 2009; Boekaerts & Cascallar, 2006; Hannula, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). Through reflecting on progress toward goal achievement, students enhance their self-efficacy and motivation to continue to improve learning strategies and thus their overall academic achievement is elevated (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Desautel, 2009; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). Therefore, there exists a need for educators to explore teaching methods, educational experiences, and instruments that promote the use of student self-control in the classroom (Kenney & Silver, 1993; Labuhn, Zimmerman, & Hasselhorn, 2010).

CHAPTER THREE

METHODOLOGY

Introduction

This study was specifically designed to determine what changes occurred in Algebra I students' self-efficacy beliefs when reflection on goal progression and academic achievement was integrated in the classroom. It was also designed to identify any changes in student views towards setting goals and reflecting on their learning. The research questions posed were:

1. What changes in Algebra I students' self-efficacy beliefs occurred when self-reflection on goal progression and overall academic achievement was integrated in the mathematics classroom?
2. How did students' views of setting goals and reflecting on their learning change over the course of the study?

This chapter presents information on the subjects and instruments implemented in this study as well as the procedures and data analysis.

Subjects

The subjects for this study included three classes of Algebra I students at Bishop Carroll Catholic High School located in Wichita, KS. All were students of the researcher. In the beginning of the semester, 61 students were participating in the study; however, insufficient data were collected from four of the students. Therefore, a total of 57 students participated in the study. All were freshmen ranging in ages from 13 to 15 years old. Thirty-two were female and twenty-five were male. Fifty of the students were White, five were Asian, and two were Hispanic.

All of the students in this study resided in Wichita, KS. The estimated population of Wichita, KS was 345,850 at the end of 2006 (City of Wichita, 2008). The breakdown of ethnicities within the city was as follows: 72.6% White, 12% Hispanic, 11.7% Black/African American, 4.6% Asian, 1.1% American Indian, and 10% other/multiple ethnicities. The per capita personal income level was $33,671.

Instruments

The instruments used for this study included a Semester Goals sheet, Questionnaires #1 and #2/#3, and the Chapter Writing Assignment. The Semester Goals sheet can be found in Appendix A. Questionnaire #1 can be found in Appendix D and Questionnaire #2/#3 can be found in Appendix E. Finally, the Chapter Writing Assignment can be found in Appendix F.

At the beginning of the semester, students established four course goals: first, a goal about a grade in the course; second, a goal regarding preparation for class; third, a goal about participation in class; and fourth, a personal goal of choice. These goals were recorded on the student's Semester Goals sheet.

Questionnaire #1, used at the beginning of the semester, consisted of three parts. In Part One, students were asked demographic information regarding their gender, grade level, where they went to middle school, whether they had taken a Pre-Algebra or Algebra I course before, and if they had prior experience with writing, goal setting, and reflecting in the mathematics classroom. In Part Two, students were asked to estimate their confidence about completing specific mathematical tasks as well as their overall mathematics confidence. An answer was given as a numerical value between one (not at all confident) and five (very confident). Eleven of the mathematical tasks were based on content the students likely studied in a Pre-Algebra course and were topics that would be covered during the semester. The other four tasks were

generalized to learning, applying, and thinking about mathematics. In Part Three, students were asked to rate their personal value of goals and reflection by indicating how strongly they agreed or disagreed with goal setting and reflection statements. They also explained their choices.

Questionnaire #2/#3 consisted of three parts. The instrument labeled Questionnaire #2 was given after the first nine weeks of school and the same instrument, this time labeled as Questionnaire #3, was given at the end of the semester. Part One consisted of demographic information including gender, grade level, and whether students had previously taken a Pre-Algebra or Algebra I course. Part Two was identical to Part Two of Questionnaire #1. Part Three was identical to Part Three of Questionnaire #1 with the addition of two open-ended questions. The questions asked students to describe whether their mathematics confidence level had increased since the beginning of the year and identify what they had discovered about themselves as mathematics learners.

The Algebra I course for the semester consisted of six chapters. A Chapter Writing Assignment was given at the end of each chapter once students received the graded chapter test. The Chapter Writing Assignment consisted of two questions. The first question required students to reflect and report on their progress toward the goals they set at the beginning of the semester. The second question required students to reflect and report on their overall learning for the chapter.

Procedures

Prior to the beginning of the study, Questionnaire #1 was given to the researcher's college-aged brother and high-school-aged brother and two of his friends to assure that the questions were clear and concise. The high-school-aged brother and friends were 16. The feedback indicated that the last three questions in Part One needed to be written more

specifically. Part Three was also edited after seeing these initial responses because answers to the open-ended questions were vague. An agree/disagree scale was added in Part Three so that a numerical value could be aligned with the written responses.

At the beginning of the semester, students were given a Parental Consent form explaining the details of the study. A copy of the consent form is located in Appendix C. Students were required to take home the consent form and have their parents read it. If they were allowed to participate in the study, the parent had to sign it, and the student returned the form by a set deadline.

Research began on August 24th, 2007. All students were given Questionnaire #1 to complete in class. They were instructed to answer all items honestly. Questionnaires were then turned into a folder upon completion. The same procedure was used when students completed Questionnaire #2 on October 29th, 2007, and Questionnaire #3 on December 19th, 2007.

On August 24th, 2007, students were given the Semester Goals sheet to fill out. Before students completed the Semester Goals sheet, the researcher discussed the definitions of the words *preparation* and *participation* so that the students would not be confused when writing these two goals. The researcher instructed students to be thoughtful and thorough in the description of their goals. These were then turned into the teacher and copies were made so that the student could retain the original copy and the teacher could keep a copy for use during this study. The students' original Semester Goals sheets were returned to the students so that they could refer to their goals throughout the semester when they completed the Chapter Writing Assignments.

After each chapter, students completed a Chapter Writing Assignment where they were required to reflect and report on the progress of their goals. They also had to briefly describe

their overall learning from the chapter including the topics that they had mastered and those they had not mastered. The chapter and dates for each Chapter Writing Assignment were as follows: Chapter 1 on September 5th, Chapter 2 on September 18th, Chapter 3 on October 5th, Chapter 4 on October 30th, Chapter 5 on November 30th, and Chapter 6 on December 18th. The procedure for each was the same. The Chapter Writing Assignments were completed in class. After the Chapter Writing Assignments were handed out, the students were instructed to answer the questions openly and honestly as well as be thoughtful and thorough in their responses. Instructions on answering each question were given verbally in addition to being written on the assignment. The Chapter Writing Assignments were then collected once all students had time to complete them. It took all students approximately 10 to 15 minutes to complete each Chapter Writing Assignment. Each Chapter Writing Assignment was copied and the copy was kept by the researcher for purposes of this study. The original student Chapter Writing Assignments were read by the teacher. The teacher wrote comments on the Chapter Writing Assignments to give students feedback. The nature of these comments depended upon the responses by the students. If students were meeting their goals and expressed that they were mastering material, comments such as "Great job" or "Keep up the good work" were written. These comments were intended to encourage and motivate students to continue to do well in class. When students expressed that they generally did not understand something, comments that encouraged students to ask more questions were made. For example, "Come and ask me for help before or after school" or "Please ask me questions if there is something you do not understand while I am teaching. I will re-explain" were common comments that the teacher wrote. When students were very specific in what they did not understand, the teacher wrote out an explanation answering the question. If students expressed discouragement because they were not meeting their goals or

were having a difficult time understanding a concept, the teacher wrote comments such as "Keep trying, the semester is not over yet" or "We will be practicing this concept again so be sure to ask for help when we do." The original Chapter Writing Assignments were then returned and retained by the students.

Data Analysis

At the beginning of the semester, students were given the Semester Goals sheet to complete in class. To report the various goals set by students, the Semester Goals sheets were read and the ideas present in each goal were recorded by grouping similar responses. For example, if one student's preparation for class goal was "to turn in homework on time" and another student's goal was "to have no late homework," these were considered to be the same idea. A table was then created for each of the four goals to display each goal that was set and the number of students who reported that as their goal. Often students set more than one goal within each category. For example, one student wrote "I will bring all my work done and supplies in class" for his preparation for class goal. Thus, this goal was reported under both the category of "Bring all supplies/everything I need to class" and "Have no late homework" in the preparation for class goals table. Because of this, the total number of goals for the preparation for class goal, participation for class goal, and personal goal is more than 57, the number of participants in the study.

When students completed Questionnaire #1 and Questionnaire #2/#3, they identified themselves by their student identification number assigned by the school. After the questionnaires were completed, the responses were recorded in a Microsoft Excel workbook. The responses were first sorted by increasing student identification numbers and a general number of 1 through 57 was then assigned to each student for the purpose of reporting results of

this study. After the data were entered and numbers assigned to the students, tables were created to report the demographic information for the student participants.

Next, information was gathered from students' responses to the self-efficacy statements. Data values were recorded in Microsoft Excel, and mean values and frequencies were found for each of the 15 self-efficacy statements for all three questionnaires. A table was created to show the mean values of all statements on each questionnaire and a table was also created to show the change in mean values for each item between questionnaires. Frequency tables were also created that show the responses that were reported by the students for each item on each questionnaire.

A similar method was conducted to find the frequency and means of students' responses to the setting and monitoring goals statement and reflection statement in #1a and #2a of Part Three of the questionnaires. The responses were recorded in Microsoft Excel and frequencies and means were calculated. Tables were created to display the mean values and change in mean values. To organize the open-ended responses to items #1b and #2b in Part Three of the questionnaires, student responses were collated according to similar ideas. Tables were created to show the general ideas made by students and the number of students who expressed these ideas. Part Three #1a, #1b, #2a, and #2b were on all questionnaires.

Part Three #3 and #4 were not on Questionnaire #1 but did appear on Questionnaire #2/#3. To organize the students' responses, the statements were typed and organized according to similar ideas expressed by the students. Tables were then created to display the general ideas and number of students who reported these responses.

Finally, students' Chapter Writing Assignments were analyzed. As each Chapter Writing Assignment was read, several trends were recorded. First, whether a student was meeting all of his or her goals, some of his or her goals, or none of his or her goals was recorded. If students

recognized and specifically identified what they needed to do better or continue to do to meet their goals, key phrases of these responses were recorded and tallied as well. Thus similar responses were grouped together. Next, students' responses to whether they had mastered the material in the chapter were read. The number of students who mentioned specific material they had mastered or not mastered was recorded. The frequency of how many students mentioned whether they had generally mastered material or not mastered material was recorded. Some students gave an explanation of why they mastered or did not master material; this frequency was recorded too. Finally, if students reported a general statement about their overall learning or confidence in their response, this was recorded as well.

CHAPTER FOUR

RESULTS

Introduction

This study was specifically designed to determine what changes occurred in Algebra I students' self-efficacy beliefs when reflection on goal progression and academic achievement was integrated in the classroom. It was also designed to identify any changes in student views towards setting goals and reflecting on their learning. The research questions posed were:

1. What changes in Algebra I students' self-efficacy beliefs occurred when self-reflection on goal progression and overall academic achievement was integrated in the mathematics classroom?
2. How did students' views of setting goals and reflecting on their learning change over the course of the study?

This chapter presents the data that were collected throughout the course of the study. Fifty-seven students at Bishop Carroll Catholic High School participated in the study. At the beginning of the semester, students established four goals for themselves. Students then were given Questionnaire #1 on August 24th, 2007, Questionnaire #2 on October 29th, 2007, and Questionnaire #3 on December 19th, 2007. Each questionnaire asked students to evaluate their level of confidence of completing 15 different mathematical tasks. The questionnaires also asked students to rate how strongly they agreed or disagreed with statements regarding goal setting and monitoring and reflecting on their learning. Only Questionnaire #2/#3 asked students two open-ended questions regarding their growth in confidence as mathematics students and what they discovered about themselves as mathematics learners. After each chapter during the

semester, students completed a Chapter Writing Assignment. This Chapter Writing Assignment asked them to report on their progress in meeting their goals and their overall mathematics achievement.

Part one of this chapter displays information about the goals the students established at the beginning of the semester. Part two describes the demographics of the students as reported in Questionnaire #1. Part three outlines the results for the self-efficacy statements reported by the students in Questionnaires #1 and #2/#3. Part four shows how strongly students agreed or disagreed with goal and reflection statements as well as their open-ended responses to questions regarding their confidence and mathematics learning. Finally, part five summarizes the students' Chapter Writing Assignment responses.

Semester Goals Data

At the beginning of the semester, students established four goals for themselves: a course grade goal, a preparation for class goal, a participation for class goal, and a personal goal. Student sample goal sheets can be found in Appendix B.

Table 1 shows the distribution of course grade goals. Thirty of the students set their course grade goal as an A, fourteen as an A or a B, eight as a B, three as an A, B, or C, and one as a C. One student stated he just wanted to pass the class.

Table 1 – Number and Percent of Students Choosing each Course Grade(s) Goal

Course grade	Number of students	Percent of students
A	30	52%
A or B	14	25%
B	8	14%
A, B, or C	3	5%
C	1	2%
Pass the class	1	2%

The following tables display information about the goals that were set for the preparation for class goal, participation in class goal, and the personal goal. Similar responses are reported together. If a student identified more than one goal for each category, they were all recorded; thus the total number of goals in each category is greater than 57.

Table 2 displays the various preparation for class goals. Thirty-two of the students reported they would bring all their supplies to class. Another 18 indicated they would turn in their work on time and 17 wanted to stay organized. Twelve students reported they would make it to class on time. Other responses and number of students can be found in the following table.

Table 2 – Preparation for Class Goals

Preparation for class goal	**Number of students**
Bring all supplies/everything I need to class	32
Have no late homework	18
Stay organized	17
Be to class on time	12
Study for tests	4
Use agenda/planner to write down assignments	3
Pay attention in class	2
Be prepared to learn new things	2
Eat breakfast	1
Get enough sleep	1
Ask questions	1
Study and look over notes every night	1

Table 3 displays the participation in class goals. The majority of students identified their goals relating to answering and asking questions in class. There was some overlap in responses in these participation goals with goals written about class preparation. Some students selected goals that others had established as preparation for class goals. For example, having "no late homework" appears on both tables. However, no individual student repeated the same goal for both the preparation for class goal and the participation in class goal.

Table 3 – Participation in Class Goals

Participation in class goal	Number of students
Answer questions in class	20
Ask questions in class	18
Pay attention/stay focused in class	14
Participate as much as possible (speak up)	11
Participate in group activities	4
Stay out of trouble/no talking	4
Make new friends	2
Try my best/apply myself in class	2
No late homework	2
Help others	2
Participate in group discussions	1
Be on time to class	1
Will not complain	1
Volunteer to work at the board	1
Understand what we are learning	1
Have no demerits	1
Study for tests	1
Always uphold high Catholic standards	1

Table 4 displays the personal goals that were established by the students. Some students selected personal goals that were related to their Algebra I class that they had not previously stated as a goal. For example, one student wrote "I want to get everything turned in on time." While this could also be considered a preparation for class goal, the same student's preparation for class goal was "to come to class prepared." Therefore, many of the personal goals written by students appeared as similar goals for other students in another category. Some students created goals that did not directly deal with their Algebra I class such as wanting to make new friends or graduating high school.

Table 4 – Personal Goals

Personal goal	Number of students
Work hard/do my best	16
No late homework	13
Get good grades	8
Have a better understanding of Algebra	7
Ask for help if I need it	5
Study more for tests	5
Be organized	4
Stay focused/pay attention	4
Have no demerits	2
Make new friends	2
Be prepared for class everyday	2
Graduate from high school	2
No incomplete homework	1
Be responsible	1
Follow directions	1
Write down everything in my agenda	1
Come away with something new everyday	1
Work without any trouble understanding	1
Apply myself	1
Not be forgetful	1
Need to try everyday	1
Leave freshmen year better than I found it	1
Let math help me with life later on	1
Want to get into a good college	1
Remember material I learned	1
Get an A on quizzes and tests	1
Achieve my other goals	1
Pass this class with ease and precision	1
Study hard	1
Take school seriously	1
Try to solve every problem	1
Have no Ds or Fs on my report card	1
Be better at math because I will need it later on	1
Know that I did my best so I can feel good about myself	1

Demographic Information on Student Participants

On August 24th, 2007, students were given Questionnaire #1 in class to complete. The following tables display the demographic information reported by the students.

Table 5 displays the number of males and females who participated in the study. Table 6 displays the various middle schools that the students attended as 8th graders. Approximately 60% of the students attended either St. Elizabeth Anne Seton Parish School or St. Francis of Assisi Parish School while the other students came from a variety of other middle schools. All schools are located in the Wichita metropolitan area.

Table 5 – Number and Percent of Students' Gender

Gender	Number of students	Percent of students
Male	25	44%
Female	32	56%

Table 6 – Number and Percent of Students' Middle Schools

Middle schools	Number of students	Percent of students
Christ the King Parish School	5	9%
Colwich Grade School	2	3%
Maize Middle School	1	2%
St. Anne Parish School	4	7%
St. Cecilia Parish School	1	2%
St. Elizabeth Anne Seton Parish School	15	26%
St. Francis of Assisi Parish School	19	34%
St. Jude Parish School	2	3%
St. Margaret Mary Parish School	1	2%
St. Mark Parish School	1	2%
St. Mary Parish School	1	2%
St. Patrick Parish School	2	3%
St. Peter Schulte Parish School	3	5%

Table 7 presents data on the previous mathematical experiences reported by the students. Nearly 80% of students had previously taken a Pre-Algebra course and nearly 50% of the students had previously taken an Algebra I course. Approximately 25% of students indicated they had written and reflected on their learning in a mathematics class before and 30% of students had previously set goals.

Table 7 – Number and Percent of Students with Relevant Previous Mathematics Classroom Experiences

Previous mathematics classroom experience	Number of students who responded "yes"	Number of students who responded "no"	Percent of students who responded "yes"	Percent of students who responded "no"
Have you previously taken a Pre-Algebra course?	45	12	79%	21%
Have you previously taken an Algebra I course?	30	27	53%	47%
In the past, have you written in a mathematics class?	14	43	25%	75%
In the past, have you had a mathematics teacher require you to set goals for yourself?	17	40	30%	70%
In the past, have you had a mathematics teacher require you to reflect on your learning?	13	44	23%	77%

Self-Efficacy Data

Students were given Questionnaire #1 on August 24th, 2007, Questionnaire #2 on October 29th, 2007, and Questionnaire #3 on December 19th, 2007. Part Two of each questionnaire asked students to evaluate how confident they were that they could complete 15 different mathematical tasks. A frequency comparison table for each item between questionnaires can be found in Appendix H. Mean values were calculated for each of the individual 15 statements and are

reported in Table 8. A value of 1 was associated with a rating of "not confident at all" and a value of 5 was associated with a rating of "very confident."

Table 8 - Mean Values for Self-Efficacy Statements

Self-Efficacy statement	Mean from Questionnaire #1	Mean from Questionnaire #2	Mean from Questionnaire #3
1. Follow the order of operations to simplify expressions	4.61	4.67	4.67
2. Use formulas given values of variables	4.11	4.16	4.25
3. Translate words into algebraic symbols and equations	4.02	3.86	4.07
4. Add, subtract, multiply, and divide integers	4.30	4.40	4.47
5. Solve equations for unknown variables	4.14	4.35	4.28
6. Use the rules of exponents	3.91	4.23	4.44
7. Add, subtract, multiply, divide, and simplify fractions	3.82	3.88	4.09
8. Find the least common denominator given two fractions	3.89	3.75	3.89
9. Find equivalent fractions	3.84	3.96	4.07
10. Find the factors of a number	4.05	4.12	4.21
11. Set up and solve word problems	3.70	3.26	3.12
12. Describe your own mathematical thinking in words	3.19	3.33	3.47
13. Learn something new in mathematics	4.33	4.21	4.37
14. Apply mathematics in your daily life	3.95	3.81	3.79
15. Overall ability in mathematics	3.72	3.75	3.93

Throughout the course of the semester, students' confidence levels increased for some items and decreased for others. Table 9 shows the change in the means between each questionnaire. Students showed the greatest increase of confidence between Questionnaire #1 and Questionnaire #3 with item #6, the use of the rules of exponents. Overall, all items except

#11 (Set up and solve word problems) and #14 (Apply mathematics in your daily life) saw an increase from the beginning of the semester to the end.

Table 9 - Change in the Means for Self-Efficacy Statements

Self-Efficacy statement	Change in means between Questionnaire #1 and #2	Change in means between Questionnaire #2 and #3	Change in means between Questionnaire #1 and #3
	Mean of #2- Mean of #1	Mean of #3 – Mean of #2	Mean of #3 – Mean of #1
1. Follow the order of operations to simplify expressions	0.06	0	0.06
2. Use formulas given values of variables	0.05	0.09	0.14
3. Translate words into algebraic symbols and equations	-0.16	0.21	0.05
4. Add, subtract, multiply, and divide integers	0.1	0.07	0.17
5. Solve equations for unknown variables	0.21	-0.07	0.14
6. Use the rules of exponents	0.32	0.21	0.53
7. Add, subtract, multiply, divide, and simplify fractions	0.06	0.21	0.27
8. Find the least common denominator given two fractions	-0.14	0.14	0
9. Find equivalent fractions	0.12	0.11	0.23
10. Find the factors of a number	0.07	0.09	0.16
11. Set up and solve word problems	-0.44	-0.14	-0.58
12. Describe your own mathematical thinking in words	0.14	0.14	0.28
13. Learn something new in mathematics	-0.12	0.16	0.04
14. Apply mathematics in your daily life	-0.14	-0.02	-0.16
15. Overall ability in mathematics	0.03	0.18	0.21

Goals and Reflection Statements Data

The first two items on Part Three of each questionnaire were identical. These items asked students how strongly they agreed or disagreed with a statement regarding goal setting and monitoring and reflection on learning. Students chose a value from 1 (strongly disagree) to 5 (strongly agree). Students then had the opportunity to explain their responses. Questionnaire #2/#3 had two additional questions to which students responded. These questions asked students to explain if they had gained confidence in their mathematics abilities and what they had discovered about themselves as mathematics learners.

A frequency comparison table for each item between questionnaires can be found in Appendix I. Table 10 displays the mean values of the results indicating how strongly students agreed or disagreed with the goals and reflection statements. Table 11 shows the change in mean values between the questionnaires. The mean value increased for each questionnaire for the goals statement and increased and remained the same for the reflection statement.

Table 10 - Mean Values for Goals and Reflection Statements

Setting/Monitoring goals and reflection statement	Mean from Questionnaire #1	Mean from Questionnaire #2	Mean from Questionnaire #3
1a. Setting and monitoring goals is important	4.14	4.19	4.25
2a. Reflecting on your learning is important	3.81	4.02	4.02

Table 11 - Change in the Means for Setting/Monitoring Goals and Reflection Statements

Setting/Monitoring goals and reflection statement	Change in means between Questionnaire #1 and #2	Change in means between Questionnaire #2 and #3	Change in means between Questionnaire #1 and #3
	Mean of #2- Mean of #1	Mean of #3 – Mean of #2	Mean of #3 – Mean of #1
1a. Setting and monitoring goals is important	0.05	0.06	0.11
2a. Reflecting on your learning is important	0.21	0	0.21

Table 12 presents the open-ended responses students gave to item #1b on all three questionnaires which asked them to explain the level of agreement they had with the statement "Setting and monitoring goals is important." There was a progression and regression of responses when comparisons were made between questionnaires. In particular, the number of students who reported that "goals help you work harder and motivate you to succeed" in the beginning of the semester was a lot larger when compared to the responses later in the semester. On the other hand, the number of students who reported that "goals help you strive for something/try for something" on Questionnaire #1 was similar to the number of students giving other responses on this questionnaire, but was the most frequent response on Questionnaire #3 at the end of the semester. Approximately the same number of students had indicated that "goals are important, but are not completely necessary or important for me to succeed" on all three questionnaires.

Table 12 – Students' Explanations about their Rating for "Setting and Monitoring Personal Goals is Important"

Statement	Number of students who responded with similar responses for each questionnaire		
	#1	#2	#3
Goals give you a path to follow	2	4	8
Goals help you know what to accomplish	4	8	5
Goals help you strive for something/try for something	3	3	11
Goals help you work harder and motivate you to succeed	16	10	6
Goals will help you do better and be successful	5	7	8
Goals will help you feel good about yourself when you reach your goal	4	2	1
Setting goals allows you to see how you have progressed	4	6	3
Goals help you reach higher goals	2	0	0
Goals are important, but you do not know if you will reach them	2	0	0
Goals are important, but are not completely necessary or important for me to succeed	10	11	9
I do not think goals are that important; I do not think we should have to write goals	5	1	1
I don't know	0	2	0
Goals help you challenge yourself	0	2	1
Goals help you stay organized	0	1	1
Goals are important	0	0	1
Goals might make you feel bad if you don't meet them	0	0	2

Table 13 displays the responses students gave to #2b on all three questionnaires. This item asked students to explain the level of agreement they had with the statement that "Reflecting on your learning is important." On Questionnaire #1, the majority of students reported that "reflecting helps you remember what you learned" and "reflecting is good for some people, but not necessary." While the number of students who reported that "reflecting helps you remember what you learned" nearly stayed the same from Questionnaire #1 to Questionnaire #3, the number who reported "reflecting is good for some people, but not necessary" decreased considerably. The number of students who reported that "reflecting helps you know what you

need to still work on and gives you a better understanding of what you learned" was low on Questionnaire #1, but was the second most frequent response on Questionnaire #3.

Table 13 – Students' Explanations about their Rating for "Reflecting on Your Learning is Important"

Statement	Number of students who responded with similar responses for each questionnaire		
	#1	**#2**	**#3**
Reflecting is important	2	1	2
Reflecting can help you with future homework/tests/life	7	6	2
Reflecting helps you remember what you learned	17	12	18
Reflecting helps you know what you need to still work on and gives you a better understanding of what you have learned	4	11	17
Reflecting helps you see what progress you have made	4	5	1
Reflecting is good for some people, but not necessary	14	5	3
I do not think reflection is important	4	5	8
I do not understand what reflecting is	2	1	0
I do not reflect on my learning	2	1	0
Reflection will cause you to second guess yourself	1	0	0
Reflection helps you review your work	0	1	0
Reflecting helps you know what is important.	0	1	0
Reflecting helps you learn from your mistakes	0	7	3
Reflection helps parents and teachers	0	1	0
Reflection gives meaning to learning	0	0	1
Reflection helps you learn about yourself	0	0	1
I don't know, I have no opinion	0	0	1

Table 14 displays the frequency of the types of general statements students wrote on #3 in Part Three of Questionnaire #2/#3. This item asked "Do you feel you have gained confidence in your mathematics abilities since the beginning of the year? Please explain in detail." The student responses were grouped according to similar ideas although the students used different phrases to express their confidence. On Questionnaire #3, approximately 91% of students indicated that they had gained confidence since the beginning of the school year.

Table 14 – Types of Responses Students Reported about their Gain in Confidence

Statement	Number of students who responded with similar responses for each questionnaire	
	#2	**#3**
Yes I have gained confidence (with an explanation)	40	52
Yes, but I had confidence before	1	0
Not really because it has just been review	4	0
Yes and No (with explanations)	8	4
No I have not gained confidence (with an explanation)	4	0
No Response	0	1

Table 15 displays the frequency of the types of general statements students reported for #4 in Part Three of Questionnaire #2/#3. This item asked "What have you discovered about yourself as a mathematics learner throughout the course of the semester?" These responses varied drastically, although some students gave similar answers. Some responses indicated an increase in self-efficacy/confidence. For example, one student stated on Questionnaire #2, "I have learned that I can do math. Before, I would always get frustrated and not want to do it, but now I've learned that if I try new things with an open mind, I can do them better."

Table 15 – Types of Responses Students Reported Describing Themselves as Mathematics Learners

Statement	Number of students who responded with similar responses for each questionnaire	
	#2	**#3**
If I try hard/focus/have enough time, I can understand/am good at math	28	30
If I can see the problem worked out first, then I can understand	4	2
It is important to study and/or review	2	2
I need to practice the problems	2	2
I am not good at word problems	5	2
It takes me a long time to understand math	3	2
I get confused/lost/think I understand but I don't	3	0
I need help/need to ask questions	2	2
Other responses	8	11
Goals and reflection are important	0	1
No response	0	3
Number of statements that indicate increased self-efficacy/confidence	14	11

Chapter Writing Assignments Data

After each chapter, students completed a Chapter Writing Assignment where they were asked to respond to two questions. There are samples of students' Chapter Writing Assignments in Appendix G. Tables 16 and 17 display the information gathered from the first question on the six Chapter Writing Assignments.

The first question required the students to explain if they were currently meeting their semester goals. With each Chapter Writing Assignment, the majority of students indicated they were meeting their goals. Others indicated they were meeting some of their goals, but not all of them. In addition, some students mentioned one or more strategies they could use or continue to

use to help reach their goals. The number of students is reported for each type of response. These results are displayed in Table 16.

Table 16 – Student Responses to Question #1 on the Chapter Writing Assignment

	Chapter Writing Assignment number					
Response	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
Number of students who reported "Yes" they are meeting their goals.	40	38	38	35	28	40
Number of students who reported "Yes and No" to meeting their goals.	17	19	19	22	29	17
Number of students who reported "No" they are not meeting their goals.	0	0	0	0	0	0
Number of students who mentioned a strategy(ies) to do better.	17	22	25	21	27	12
Number of students who mentioned a strategy(ies) to continue.	31	25	21	19	15	10

In addition to reporting if they were meeting their goals, students also explained why they were meeting or not meeting their goals. Due to the varied nature of these responses, similar key phrases were grouped and tallied and are displayed in Table 17. Some students reported more than one key phrase, thus the total number is larger than the numbers reported in Table 16 for Chapter Writing Assignments #2, #3, and #5 for strategies students reported they need to do better and for Chapter Writing Assignment #1 for strategies students reported they need to continue. What some students reported they needed to work on is very similar to what other students said they needed to continue to do. Overall, the most frequent strategies that students reported they needed to work on were getting help/asking questions, working hard, and studying more. Continuing to work hard was also a frequent response on what some students reported they needed to continue doing. Many students also explained they simply needed to continue doing what they were doing to meet their goals by the end of the semester.

Table 17 – Student Reported Strategies in Responses to Question #1

	Number of students who reported each strategy on the given Chapter Writing Assignment						
	#1	**#2**	**#3**	**#4**	**#5**	**#6**	
Key phrases of strategies students reported they need to do better							**Total**
Get help and ask questions	5	5	2	2	4	4	**22**
Study more	3	3	9	5	7	2	**29**
Participate more	1	1	2	0	0	0	**4**
Be more organized	2	1	2	2	1	0	**8**
Listen more/pay attention	1	1	5	2	8	2	**19**
Take my time on my work	2	1	2	0	0	2	**7**
Work/try harder	1	6	1	3	11	0	**22**
Write down assignments	1	0	0	1	0	0	**2**
Stay on task	1	0	0	0	0	0	**1**
Answer questions	0	3	0	0	0	0	**3**
Look over notes	0	1	0	0	0	0	**1**
Finish homework – no late work	0	1	2	6	1	0	**10**
Do not forget things	0	0	1	0	0	0	**1**
Not talk to my classmates	0	0	0	0	0	2	**2**
Total	**17**	**23**	**26**	**21**	**32**	**12**	
	#1	**#2**	**#3**	**#4**	**#5**	**#6**	
Key phrases of strategies students reported they need to continue							**Total**
I need to keep doing what I am doing	9	13	8	14	7	0	**51**
Get help and ask questions	3	0	3	1	1	2	**10**
Answer questions	2	0	0	0	0	0	**2**
Finish homework – no late work	1	2	3	0	2	0	**8**
Work/try hard	7	3	2	1	1	6	**20**
Stay organized	3	0	1	0	0	0	**4**
Come to class alert	1	0	0	0	0	0	**1**
Take my time on my work	1	1	0	0	0	0	**2**
Participate more	1	0	0	0	0	0	**1**
Listen more/pay attention	1	4	2	2	3	0	**12**
Be on time to class	1	0	0	0	0	0	**1**
Good night sleep	1	0	0	0	0	0	**1**
Study hard	0	2	2	1	1	1	**7**
Double check my work	0	0	0	0	0	1	**1**
Total	**31**	**25**	**21**	**19**	**15**	**10**	

The second question on the Chapter Writing Assignments asked students to "Reflect on your learning from this past chapter by looking at your assignments, quizzes, and test. What topics have you mastered? What topics have you struggled with and why? Write a paragraph describing your overall learning." The students provided several pieces of information in their responses. Students described their overall learning in detailed or general terms. Over the course of the study, on each respective Chapter Writing Assignment, 61%-96% of students reported they had mastered or generally mastered material. Students also reported material/concepts they had not mastered or struggled with. Many students explained why they had not mastered or struggled with specific concepts. Some students explained that while they struggled with a specific concept during the chapter, they mastered it by the end. Overall, on each respective Chapter Writing Assignment, 56%-93% of students communicated that they did not master material or explained what material they did not fully understand.

In their responses to Question #2, students identified specific tasks they struggled with and gave explanations as to why they struggled with and did not master the material. Table 18 displays the types of tasks and frequency of students who identified these areas of difficulty. The various types of word problems were the most frequently mentioned area students reported they had not mastered or struggled with.

Table 18 – Tasks Students Reported as Not Mastered or Struggled With

Chapter Writing Assignment	Tasks students reported were not mastered or they struggled with	Number of students
#1		
	Setting up and solving word problems	20
	Translating words into equations and expressions	6
	Opposites	2
	Area and perimeter word problems	1
	Fractions	1
#2		
	Properties of numbers	16
	Solving word problems	8
	Solving equations with fractions	2
	Translating words into equations	1
	With accuracy	1
#3		
	Setting up and solving word problems with charts	37
	Solving equations with variables on both sides	1
#4		
	Solving rate x time = distance word problems with charts	22
	Area and perimeter word problems	5
	Transforming formulas	2
	Foiling	1
	Adding and subtracting polynomials	1
#5		
	Factoring (what process to use and when)	20
	Word problems with area of rectangles	12
	Listing all factors of a number	3
	Finding the value of "k" in factoring	2
	Solving equations by factoring	1
	Solving equations	1
	Prime factorization of numbers	1
	Simplifying	1
#6		
	Adding/subtracting algebraic fractions	6
	Multiplying/dividing algebraic fractions	4
	Find the least common denominator of algebraic fractions	4
	Factoring	3
	Polynomial long division	3
	Solving word problems	2
	Simplifying fractions	2

Table 19 displays the key phrases students used to explain why they struggled with specific material. Overall the majority of students reported struggling with setting up various types of word problems.

Table 19 – Explanations Students Gave about Why They Did Not Master or Struggled with Tasks

Chapter Writing Assignment	Student explanation	Number of students
#1		
	I am confused when setting up word problems	9
	I got things backwards	1
	I didn't understand how to solve it	1
	I have a hard time changing word phrases into equations	1
	I don't understand what the question is talking about	1
#2		
	I was tired and didn't study much	1
	The properties confuse me	1
	I am not taking my time and thinking things through	1
	Word problems are hard because you have to set them up and I don't know it well	1
	I think my answer is right, but it is wrong	1
#3		
	Setting up a chart is hard because it is confusing where to put the information	14
	The wording really confuses me	7
	Writing the question from the chart is confusing	4
	I struggle with long equations because I do not break them down	2
#4		
	Setting up the equation from the word problem is hard	4
	I make dumb mistakes	1
	I do not break down the word problem	1
#5		
	There are a lot of ways to factor and I get confused	5
	I didn't pay enough attention or ask questions	2
	Setting up word problems is hard	2
#6		
	I get confused when there are a lot of steps	2

Table 20 reports the key phrases about overall learning and confidence as reported by students on Question #2 on the Chapter Writing Assignments. Because Chapter Writing Assignment #6 was the last, students were more descriptive with their responses on this one than on earlier assignments.

Table 20 – Students' Descriptions of Overall Learning and Confidence on Chapter Writing Assignments

	Number of students who reported each phrase on the given Chapter Writing Assignment						
	#1	**#2**	**#3**	**#4**	**#5**	**#6**	
Key phrases about overall learning							**Total**
I learned a lot/increased my knowledge	12	2	6	10	5	11	**46**
Doing fine	2	4	0	0	3	8	**17**
I have a good understanding	6	0	0	5	0	13	**24**
I am grasping concepts better than in the past/am doing better	2	1	1	1	0	1	**6**
I have improved on word problems	0	0	1	1	0	1	**3**
I need to do better	0	0	0	0	2	3	**5**
I had my troubles but I worked through them	0	0	0	0	0	2	**2**
	#1	**#2**	**#3**	**#4**	**#5**	**#6**	
Key phrases of confidence reported by students							**Total**
Very confident in what we learned	1	0	1	0	0	2	**4**
I feel more confident	1	0	0	0	1	1	**3**
I feel confident in setting up word problems now	0	0	2	1	2	0	**5**
I feel confident in factoring	0	0	0	0	1	0	**1**

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND DISCUSSION, AND RECOMMENDATIONS

Summary

Research has indicated that self-efficacy influences whether a person will engage in, devote effort to, and persist in task completion (Hackett & Betz, 1989; Linnenbrink & Pintrich, 2002; McCarthy, Meier, & Rinderer, 1985; Miller & Brickman, 2004). Students with positive or high mathematics self-efficacy possess positive attitudes toward mathematics and are more likely to choose future mathematics education and career choices when compared with students with negative or low self-efficacy (Hackett & Betz, 1989). Students with positive or high self-efficacy also utilize effective learning strategies, monitor their work effectively and endure through challenges (Ramdass & Zimmerman, 2008; Zimmerman, 2002) as well as apply and utilize knowledge and skills they have acquired (Pajares & Miller, 1997). They also achieve at higher levels than students with negative or low self-efficacy (Hackett & Betz, 1989; Pajares & Miller, 1997; Ramdass & Zimmerman, 2008; Zimmerman, 2002). Therefore, it is important for mathematics educators to recognize how students feel about their mathematics knowledge because it will influence their self-efficacy and their learning achievement, whether positively or negatively (Lerch, Bilics, & Colley, 2006; Ramdass & Zimmerman, 2008); however, few educators ask students to evaluate their self-efficacy on tasks (Zimmerman, 2002).

Besides self-efficacy, goal setting has also been correlated with increased academic achievement (Linnenbrink & Pintrich, 2002; Miller & Brinkman, 2004; Zimmerman, 2002). Students who set goals and think about and discuss their progress towards the achievement of goals based on evidence will nurture understanding and control their academic success

(Stenmark, 1991). Miller and Brickman (2004) encouraged educators to help students commit themselves to establishing goals, monitoring their goals progression, adjusting their behavior and efforts, and establishing new goals. The National Council of Teachers of Mathematics (NCTM, 1995) advocated that "helping students set and attain goals is at the heart of good teaching" (p. 29) and expressed that setting and monitoring goal progress is unproductive unless educators regularly communicate with students on their progress toward achievement (NCTM, 1995). Yet the number of teachers who have students set goals as a regular classroom routine is limited (Zimmerman, 2002).

In addition to supporting the need for educators to help students set goals, the National Council of Teachers of Mathematics advocated for increased communication in the classroom (NCTM, 2000) and for a shift in assessment practices that enable students to be active participants in evaluating their work (NCTM, 1995). Communicating mathematically enables students to develop concepts, skills, attitudes, and processes (Dougherty, 1996). Writing is one means of communication that helps students to consolidate their thinking (NCTM, 2000). Writing also encourages students to reflect on and synthesize their knowledge so that concepts become their own (Nahrgang & Petersen, 1986; Pugalee, 1997, 2001). Thus, writing can facilitate the development of metacognitive skills and conceptual knowledge (Pugalee, 2001, 2004). Writing serves as an alternative form of assessment because it gives insight into how and what students have learned thus helping teachers diagnose student misunderstanding, reflect on their teaching strategies, and make instructional decisions (Bell & Bell, 1985; Borasi & Rose, 1989; Chapman, 1996; Clarke, Waywood, & Stephens, 1993; Goldsby & Cozza, 2002; Johnson, 1983; Miller, 1992; Miller & England, 1989; Nahrgang & Petersen, 1986; Pugalee, 1997, 2001).

Self-evaluation is another form of alternative assessment that provides students with self-awareness of their performance and offers students and educators valuable feedback that can be utilized to enhance the educational learning environment (Andrade & Valtcheva, 2009; Carr, 2002; Hickman, Quick, Haynie, & Flakes, 2000; Kenney & Silver, 1993; NCTM, 1995; Prescott, 2001). Self-reflection is a type of self-evaluation (Kenney & Silver, 1993). Research has indicated that, through answering self-reflective questions and writing responses, students become better communicators, critical thinkers, and active participants in their learning (Carr, 2002; Chappuis, 2005; Desautel, 2009; Hickman, Quick, Haynie, & Flakes, 2000; Kenney & Silver, 1993; Stallings & Tascione, 1996). Research has also shown that students who self-evaluate and write reflectively show increased confidence (Andrade & Valtcheva, 2009; Lerch, Bilics, & Colley, 2006; Prescott, 2001; Ramdass & Zimmerman, 2008; Stallings & Tascione, 1996).

Self-regulation has been shown to enhance learning through its processes of establishing goals, performing learning tasks, and reflecting upon goals (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Hannula, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). By reflecting on progress toward goal achievement, students enhance their self-efficacy and motivation to continue to improve learning strategies and thus their overall academic achievement is elevated (Andrade & Valtcheva, 2009; Boekaerts & Cascallar, 2006; Desautel, 2009; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Zimmerman, 2002, 2008). While self-regulation has many educational benefits for students, educators are in need of instruments and experiences to incorporate in the classroom that promote the process of self-regulation (Kenney & Silver, 1993; Labuhn, Zimmerman, & Hasselhorn, 2010).

This study was specifically designed to determine what changes occurred in Algebra I students' self-efficacy beliefs when reflection on goal progression and academic achievement was integrated in the classroom. It was also designed to identify any changes in student views towards setting goals and reflecting on their learning. The research questions posed were:

1. What changes in Algebra I students' self-efficacy beliefs occurred when self-reflection on goal progression and overall academic achievement was integrated in the mathematics classroom?
2. How did students' views of setting goals and reflecting on their learning change over the course of the study?

In order to answer these questions, the researcher designed a Semester Goals sheet, Questionnaire #1, Questionnaire #2/#3, and a Chapter Writing Assignment. At the beginning of the Fall 2007 semester, 57 Algebra I students at Bishop Carroll Catholic High School established four course goals: a course grade goal, a participation in class goal, a preparation for class goal, and a personal goal. Writing these four course goals encouraged students to identify areas of needed improvement and establish habits that would lead to achievement in their Algebra I class. After each of the six chapters taught during the course of the semester, students completed a Chapter Writing Assignment which required them to reflect and write about their goal progression as well as their overall learning.

In addition to setting goals at the beginning of the semester, students also completed Questionnaire #1 which asked students to evaluate their self-efficacy on 15 mathematical tasks by rating how confident they were that they could complete the task. Questionnaire #2/#3 contained the same self-efficacy questions that were posed at the beginning of the semester and was given halfway through the semester and again at the end of the semester. Following the

semester, the researcher recorded the raw quantitative data from Questionnaire #1 and Questionnaire #2/#3 so that statistical means and frequencies of the self-efficacy statements could be compared. The means showed an increase from the beginning of the semester to the end of the semester in self-efficacy for 13 of the 15 mathematical tasks.

In addition to the self-efficacy questions, Questionnaire #1 and Questionnaire #2/#3 also contained two questions asking students to write about how goals and reflection affected their learning. Students indicated how strongly they agreed or disagreed with each statement and were able to explain their choice. The first statement was "Setting and monitoring personal goals is important." The second statement was "Reflecting on your learning is important." Calculated means for these two items showed an increase from the beginning of the semester to the end of the semester in how strongly students agreed with the importance of goal setting and reflecting on their learning.

Qualitative data was also gathered from open-ended items from Questionnaire #1 and Questionnaire #2/#3 on Part Three regarding the importance of goals and reflecting on learning. Part Three #1b asked students to explain why they strongly agreed or disagreed with the statement "Setting and monitoring personal goals is important." On Questionnaire #1, the top three general statements by students explaining the importance of goals included the following: goals help you work harder and motivate you to succeed; goals are important, but are not completely necessary or important for me to succeed; and, I do not think goals are that important, I do not think we should have to write goals. On Questionnaire #3, the top three general statements were the following: goals help you strive for something/try for something; goals are important, but are not completely necessary or important for me to succeed; and, goals give you a path to follow and goals will help you do better and be successful. Thus, while one statement

remained common from students' responses on Questionnaire #1 to Questionnaire #3, there was otherwise a shift in student views. Likewise, there was also a shift in student views on the importance of reflecting on their learning. Students explained why they agreed or disagreed with the statement "Reflecting on your learning is important." On Questionnaire #1, the top three general statements by students included the following: reflecting helps you remember what you learned; reflecting is good for some people, but not necessary; and, reflecting can help you with future homework/tests/life. On Questionnaire #3, the top three general statements were the following: reflecting helps you remember what you learned; reflecting helps you know what you need to still work on and gives you a better understanding of what you have learned; and, I do not think reflection is important. While it was not mentioned on Questionnaire #1, several students on Questionnaire #2 reported that reflecting helps you learn from your mistakes.

Qualitative data were gathered from Questionnaire #2/#3 on Part Three #3 and #4 as well. Part Three #3 asked students "Do you feel you have gained confidence in your mathematics abilities since the beginning of the year? Please explain in detail." On Questionnaire #2, 40 students responded with the general statement "Yes I have gained confidence" and wrote an explanation of why. On Questionnaire #3, 52 students responded with this same general statement. On Questionnaire #2, four students reported "No I have not gained confidence" and wrote an explanation. However, on Questionnaire #3, no students responded in this way. Questionnaire #2/#3 Part Three #4 asked students, "What have you discovered about yourself as a mathematics learner throughout the course of the semester?" The responses to this question varied greatly. However, on Questionnaire #2, 28 students responded with a statement similar to "If I try hard/focus/have enough time, I can understand/am good at math." On Questionnaire #3, 30 students responded with a similar statement. Also, on Questionnaire #2, 14

students' responses indicated increased self-efficacy/confidence levels and on Questionnaire #3, 11 students' responses indicated the same when students described their growth as a mathematics learner throughout the semester. For example, one student wrote, "I have discovered I am not as bad at math as I thought I was. I know I'm not the best but I do know that I have become better!"

Conclusions and Discussion

1. Over the course of the study, changes in students' self-efficacy and overall confidence levels varied according to the type of mathematical tasks when reflection on goal progression and overall academic achievement was integrated in the Algebra I classroom. Calculated means showed an increase in self-confidence levels for 13 of the 15 mathematical tasks. The students also expressed an overall increase in confidence throughout the semester as evident through their written responses on the questionnaires. Ramdass and Zimmerman's (2008) results are relevant to this conclusion. They supported the idea that self-reflection as part of the self-regulation cycle is important to students' academic achievement because students' self-efficacy is strengthened with indicators of improvement.

Changes in students' self-efficacy throughout a semester can be attributed to a variety of factors. Students are unique persons and while their learning environment and classroom experiences are common, their achievements are distinctive due to a variety of factors including, but not limited to, their individual motivation, understanding, participation in the classroom, and previous experience with concepts. These factors could have contributed to both the increase and decrease in self-efficacy for the 15 mathematical tasks students evaluated. By integrating reflection on goal progression and overall academic achievement after each chapter, students were provided with the opportunity to stop and think about their classroom experiences and

concepts they had learned. The mere experience of thinking about self-efficacy likely contributed to the increase and decrease in self-efficacy as students reflected on aspects of their learning they may not have otherwise considered.

Two tasks saw a decrease in self-efficacy. These statements asked students how confident they were that they could set up and solve word problems and apply mathematics in their daily life. For the statement about word problems, the mean began at 3.70 and decreased to 3.26 and then to 3.12. For the item about applying mathematics in everyday life, the mean began at 3.95 and decreased to 3.81 and then to 3.79. While there is no other data to explain why applying mathematics in daily life was a concern for students, the Chapter Writing Assignments provide a plethora of data that explain why word problems appeared to be a concern for many students. A large number of students identified "word problems" as a concept they struggled with on all six Chapter Writing Assignments and many explained what aspect of the word problem solving process they did not understand. It is also worth noting that while the mean for the statement about setting up and solving word problems decreased, the self-efficacy statement "Translate words into algebraic symbols and equations" decreased from 4.02 to 3.86 and then increased to 4.07 throughout the semester. Translating words into algebraic symbols and equations is part of the problem solving process; therefore the mean for an element of the problem solving process did see an increase during the study.

The students' experiences with reflecting on their learning contributed to the change in the students' self-efficacy on their ability to "Describe your own mathematical thinking in words." At the beginning of the semester, the mean for this item was 3.19. It increased to 3.33 and then 3.47 by the end of the semester. Although this item had the second lowest rating at the end of the semester, it also showed the second highest increase in the change of mean from the

beginning to the end of the semester. The students' experiences of completing the Chapter Writing Assignments at the end of each chapter provided an avenue for students to practice communicating through expressing what they understood as well as what they found confusing about concepts taught in class. Often, students were able to explain why they did not understand a mathematical task or were able to describe the aspect in the solving process that confused them.

The last self-efficacy question on the questionnaires asked students to rate their "Overall ability in mathematics." The mean of this item began at a 3.72 and increased to a 3.75 and ended at 3.93; thus there was an overall increase of .21 which was the fifth largest gain of all the self-efficacy statements. This is supported by the increase in confidence as evident on written responses from the questionnaires where students also expressed an overall increase in confidence. Half-way through the semester 40 students, or 70% of the students, stated they had gained confidence in their mathematics ability since the beginning of the semester. At the end of the semester, 52 students, or 91% of the students, stated they had gained confidence during the semester.

2. The students' perceptions of the value of setting goals and reflecting on learning increased over the course of the semester. When asked how strongly they agreed or disagreed with the statement "Setting and monitoring goals is important," the mean value of student responses increased from a 4.14 to a 4.25 from the beginning to the end of the semester. The qualitative data also supports this increase. At the beginning of the semester, five students reported that "I do not think goals are that important; I do not think we should have to write goals." Only one student responded in this way at the end of the semester.

Similarly, the students' perceptions of the value of reflecting on learning increased over the course of the semester. When asked how strongly they agreed or disagreed with the statement "Reflecting on your learning is important," the mean value of student responses from the beginning to the end of the semester increased from 3.81 to 4.02. The qualitative data also supports this increase. While 14 students initially responded "Reflecting is good for some people, but not necessary" at the beginning of the year, three students had the same response at the end of the semester. Four students responded that "Reflecting helps you know what you need to still work on and gives you a better understanding of what you have learned" at the beginning of the semester and 17 students had the same response at the end of the semester.

3. The Semester Goals sheet and the Chapter Writing Assignment served as effective instruments in providing an opportunity for students to write goals and then reflect on their goal progression and overall learning during the semester. The Semester Goals sheet provided students with the opportunity to form four goals for themselves and explain why these goals were important to them. It also served as a reference when students were asked to reflect on their goal progression.

While the Chapter Writing Assignment took 10 to 15 minutes of time during class six times during the semester, it provided the students with a voice in explaining how they perceived they were doing in the Algebra I course. With regards to reflecting on their goal progression, students identified which goals they were achieving and which goals still needed work. Students also considered academic behaviors that were supporting their goal achievement and those behaviors that needed to be re-directed.

The Chapter Writing Assignment also offered students the opportunity to explain in detail what they were struggling with and why. This in turn provided the teacher/researcher with an

opportunity to address these concerns both with the individual and the entire class when a common concern was apparent. This conclusion is similar to what Miller (1992) and Miller and England (1989) discovered when they investigated students' written responses to in-class writing prompts and found this process of writing offered an abundance of information that teachers could utilize to plan future instruction and address individual and class misunderstanding of concepts. Pugalee (2001) also noted that students' writings provide teachers with information on how students learn and what they think about mathematics.

Recommendations

The following recommendations will be shared with the mathematics department at Bishop Carroll Catholic High School. They may also be of interest to mathematics educators, researchers, and other educators who are searching for ways to increase students' self-efficacy.

1. Students should be provided with structured opportunities to reflect on their learning and share their strengths and struggles with their teachers. In this study, students were given six Chapter Writing Assignments which required them to think about the concepts they had learned and write about their overall academic achievement. The Chapter Writing Assignments gave students a voice and their responses provided the researcher with insights into what students felt they had mastered and concepts with which they had difficulty. Providing the opportunity for students to assess and write about their learning is in line with the curriculum endorsed by the National Council of Teachers of Mathematics (NCTM) in their 1995 publication of *Assessment Standards for School Mathematics*, where they expressed a need for a shift in assessment practices, and in their 2000 publication of *Principles and Standards for School Mathematics*, which advocated for an enhancement of communication by students in the classroom. This

recommendation is also supported by Desautel (2009) who recommended that curriculum should include self-reflection as a means of increasing students' self-awareness as learners.

2. Students should set goals and sub-goals for their academic achievement and periodically review their progress on reaching their goals. In this study, students set four goals for themselves at the beginning of the semester and reflected and wrote about their goal progression six times during the semester. This provided the students with an opportunity to stop, think, and re-direct their future behavior so that they could achieve their goals by the end of the semester. This recommendation is in alignment with the National Council of Teachers of Mathematics (1995) emphasis on monitoring students' progress through setting and evaluating mathematical goals as outlined in *Assessment Standards for School Mathematics*. It is also endorsed by proponents of the self-regulation process (e.g., Boekaerts & Cascallar, 2006; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008; Schunk & Zimmerman, 2007; Zimmerman, 2002, 2008).

3. Similar studies to this one should be considered. This study occurred in a private school in an Algebra I class. A similar study should be conducted at both higher and lower mathematics classes to see if the results of this study would be true at other levels. A similar study at a public urban or rural setting should also be considered to see if the results are consistent within other educational settings.

4. Finally, a longitudinal study should be considered to see if having students reflect on goal progression and overall learning will increase their self-efficacy over the course of a year or several mathematics courses. This study only occurred over a semester. A larger increase in students' self-efficacy might be seen in a longer timeframe.

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Appendix A

Blank Semester Goals Sheet

Name:_____ Hour:_____

Semester Goals

Directions: For each of the following categories, formulate a goal. You must write in complete sentences. Describe *why* you selected your goal and *what* you will need to do throughout the semester to accomplish it.

1. Course Grade Goal

2. Preparation for Class Goal

3. Participation in Class Goal

4. Personal Goal

Appendix B

Sample Semester Goals Sheets from Students

Name.

Hour: 2

Semester Goals

Directions: For each of the following categories, formulate a goal. You must write in complete sentences. Describe *why* you selected your goal and *what* you will need to do throughout the semester to accomplish it.

1. **Course Grade Goal**

My Course Grade Goal is to maintain at least an A- average all year. I selected this goal because I want to excel greatly in algebra this year. I will have to finish all homework and study for all tests to accomplish this.

2. **Preparation for Class Goal**

My goal is to always be prepared for class with all materials, including finished homework. This way I will have no latework or zeros. I will have to be quick between classes and finish assignments

3. **Participation in Class Goal**

My goal is to always complete my job or role when working in groups or on teams. This will allow me to get to know more people in my class. I will have to be friendly in order to do this.

4. **Personal Goal**

My personal goal is to always work hard, so I can excel in algebra this year. I need to study for tests more than one night before & complete all homework.

Name: Hour: 10

Semester Goals

Directions: For each of the following categories, formulate a goal. You must write in complete sentences. Describe *why* you selected your goal and *what* you will need to do throughout the semester to accomplish it.

1. Course Grade Goal

My course grade goal is to get anything better than a C because that is above average and I really want to do the best I can

2. Preparation for Class Goal

My Preparation for class Goal is to always study ~~at~~ or at least review what needs to be. In order to do this I will leave time open for this & think about what needs to be done.

3. Participation in Class Goal

My Participation in class goals are to try and answer questions if I know the answer or to ask questions if needed. I selected this because I am not always comfortable asking question

4. Personal Goal

My Personal Goal is to try my best and do whatever I can to get the best grade possible. In order to do this I will need to ask questions.

Appendix C

Parent Consent Form

Approved by the Human Subjects Committee Lawrence Campus, University of Kansas. Approval expires one year from 8/8/2007.

Dear Parent,

Welcome to the new academic year! The following information is a description of a study that I plan to conduct first semester to complete my master's degree at the University of Kansas. The information is provided so that you may decide whether you wish to have your child participate. If you sign the form and later change your mind, you may withdraw your child at any time. Please know that choosing not to participate will not hurt your child's grade or place him or her at any kind of disadvantage.

Purpose

The purpose of this study is to investigate whether establishing and reflecting on goals as well as overall academic achievement will affect a student's mathematics self-efficacy. Educational research has reported that establishing and reflecting upon goals forces students to ask themselves three key questions: Where am I going? Where am I now? How can I close the gap? This in turn allows students to develop avenues for achievement of their goals. In addition, reflection allows students to become more aware of how they think and learn thus empowering them with a greater knowledge of self. Reflection also has been shown to enhance students' learning. This study would show if this is true in our educational setting as well as provide an opportunity to investigate if there is a change in students' self-efficacy (their confidence in completing specific mathematical tasks) as an effect of goal setting and reflecting on learning.

Procedures

As outlined in the course syllabus and as part of the normal class routine, all students will establish course goals and complete written assignments after each chapter. These assignments will ask students to reflect on their progress towards meeting their goals and briefly describe their learning from the chapter. Communicating mathematically enables students to organize, analyze, synthesize, and evaluate their thoughts thus developing concepts, skills, attitudes, and processes. It also provides a means of communication between the students and teacher. Student goals and information gathered from these reflections will only be used as data for this study from students who are participating in the study.

To measure students' mathematical self-efficacy, data will be collected via a questionnaire that will be given at the beginning of the year, after the first nine weeks, and before semester finals. The questionnaire will consist of three parts. Part One will ask the students to answer demographic information regarding their gender, grade level, whether they have taken pre-algebra, and if they have had prior experience with writing, goal setting, and reflecting in the mathematics classroom. Part Two will ask the students to evaluate their confidence about completing specific mathematical tasks as well as their overall mathematics confidence. Answers will be given in the form of a numerical value. Part Three will ask the students to assess their personal view about the value of goals and reflection by rating how strongly they agree or disagree with statements about goals and reflection. They will also be answering a few open-ended questions about how goals and reflection have affected their learning.

Benefits
If the data collected in this study show that goal setting and reflection aids in increasing students' self-efficacy, these learning strategies could be incorporated in other mathematics courses. Teachers continue to search for avenues to build student confidence in mathematics and the results of this study will provide further information that is specific to our school.

Confidentiality
The Department of Curriculum and Teaching at the University of Kansas supports the practice of protection for human subjects participating in research. This study involves no risk to the participants. Students' names will not be associated with findings in the research study. If specific students are referred to, they will be assigned a random number (for example Student 1, Student 2, etc) or described in general terms, such as two female freshmen.

Your child's participation is encouraged although voluntary. By signing this form you are giving permission for the data collected to be used in completion of this study.

If you have any questions about the procedures of this study, please feel free to contact me or Mrs. Harshberger at 316-722-2390. You may also email us at schippersjessica@bcchs.org or harshbergerv@bcchs.org.

Thank you,

Jessica Schippers

_____

Participant Certification:

I have read this consent form. I have had the opportunity to ask and have received answers to any questions about this study. If I have additional questions regarding my child as a research participant I may call (785) 846-7492 or (785) 864-7385 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045, or email dhann@ku.edu or mdenning@ku.edu.

I agree that my child's responses can be part of the information collected for this research study. With my signature I affirm that I have received a copy of this consent form to keep.

_____ _____

Print Student's Name Date

_____

Parent/Guardian Signature

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Appendix D

Questionnaire #1

Questionnaire #1

Student ID number:_____

Part One
Directions: Circle the appropriate response.

Gender: Male Female

Grade level: Freshman Sophomore

Where did you go to middle school? _____

Have you previously taken a Pre-Algebra course? Yes No

Have you previously taken an Algebra I course? Yes No

In the past, have you written in a mathematics class? (for example, writing in a journal or explaining your thinking in words)? Yes No

In the past, have you had a mathematics teacher require you to set goals for yourself? Yes No

In the past, have you had a mathematics teacher require you to reflect on your learning? Yes No

Part Two
Directions: The following questions ask you to estimate your confidence in completing the mathematical tasks listed. On a scale of 1 to 5, how confident are you that you can perform each task on your own? Circle your response.

How confident are you that you can……	***Not at all Confident***				***Very Confident***
1. Follow the order of operations to simplify expressions	1	2	3	4	5
2. Use formulas given values of variables	1	2	3	4	5
3. Translate words into algebraic symbols and equations	1	2	3	4	5
4. Add, subtract, multiply, and divide Integers	1	2	3	4	5
5. Solve equations for unknown variables	1	2	3	4	5
6. Use the rules of exponents	1	2	3	4	5
7. Add, subtract, multiply, divide, and simplify Fractions	1	2	3	4	5

How confident are you that you can……	*Not at all Confident*				*Very Confident*
8. Find the least common dominator given two fractions	1	2	3	4	5
9. Find equivalent fractions	1	2	3	4	5
10. Find the factors of a number	1	2	3	4	5
11. Set up and solve word problems	1	2	3	4	5
12. Describe your own mathematical thinking in words	1	2	3	4	5
13. Learn something new in mathematics	1	2	3	4	5
14. Apply mathematics in your daily life	1	2	3	4	5
15. Overall ability in mathematics	1	2	3	4	5

Part Three
Directions: Questions 1 and 2 ask you to rate on a scale of 1 to 5 how strongly you agree or disagree with a statement. Circle your response. Then explain your choice thoroughly in the space provided. Use personal examples where appropriate.

	Strongly Disagree				*Strongly Agree*
1a. Setting and monitoring personal goals is important.	1	2	3	4	5
1b. Explain your choice.					
2a. Reflecting on your learning is important.	1	2	3	4	5
2b. Explain your choice.					

Appendix E

Questionnaire #2/#3

Questionnaire #2/#3

Student ID number:_____

Part One
Directions: Circle the appropriate response.

Gender: Male Female

Grade level: Freshman Sophomore

Where did you go to middle school? _____

Have you previously taken a Pre-Algebra course? Yes No

Have you previously taken an Algebra I course? Yes No

Part Two
Directions: The following questions ask you to estimate your confidence in completing the mathematical tasks listed. On a scale of 1 to 5, how confident are you that you can perform each task on your own? Circle your response.

How confident are you that you can…….	***Not at all Confident***				***Very Confident***
1. Follow the order of operations to simplify expressions	1	2	3	4	5
2. Use formulas given values of variables	1	2	3	4	5
3. Translate words into algebraic symbols and equations	1	2	3	4	5
4. Add, subtract, multiply, and divide Integers	1	2	3	4	5
5. Solve equations for unknown variables	1	2	3	4	5
6. Use the rules of exponents	1	2	3	4	5
7. Add, subtract, multiply, divide, and simplify Fractions	1	2	3	4	5
8. Find the least common dominator given two fractions	1	2	3	4	5
9. Find equivalent fractions	1	2	3	4	5
10. Find the factors of a number	1	2	3	4	5
11. Set up and solve word problems	1	2	3	4	5

How confident are you that you can……	*Not at all Confident*				*Very Confident*
12. Describe your own mathematical thinking in words	1	2	3	4	5
13. Learn something new in mathematics	1	2	3	4	5
14. Apply mathematics in your daily life	1	2	3	4	5
15. Overall ability in mathematics	1	2	3	4	5

Part Three

Directions: Questions 1 and 2 ask you to rate on a scale of 1 to 5 how strongly you agree or disagree with a statement. Circle your response. Then explain your choice thoroughly in the space provided. Answer questions 3 and 4 in detail. Use personal examples where appropriate.

	Strongly Disagree				*Strongly Agree*
1a. Setting and monitoring personal goals is important	1	2	3	4	5
1b. Explain your choice.					
2a. Reflecting on your learning is important.	1	2	3	4	5
2b. Explain your choice.					

3. Do you feel you have gained confidence in your mathematics abilities since the beginning of the year? Please explain in detail.

4. What have you discovered about yourself as a mathematics learner throughout the course of the semester?

Appendix F

Blank Chapter Writing Assignment

Name:_____ Chapter _____
Hour: _____

Chapter Writing Assignment

Directions: Read each description and answer the questions thoroughly in complete sentences.

1. Answer the following questions in paragraph form: What were your four course goals? Are you currently meeting your goals? What do you need to change or continue during the next chapter to help reach your goals by the end of the semester?

2. Reflect on your learning from this past chapter by looking at your assignments, quizzes, and test. What topics have you mastered? What topics have you struggled with and why? Write a paragraph describing your overall learning.

Appendix G

Sample Chapter Writing Assignments from Students

Name:
Hour: 1

Chapter 4

Chapter Writing Assignment

Directions: Read each description and answer the questions thoroughly in complete sentences.

1. Answer the following questions in paragraph form: What were your four course goals? Are you currently meeting your goals? What do you need to change or continue during the next chapter to help reach your goals by the end of the semester?

I have been prepared every day, I'm not sure about my grades, but I hope I have a B or better, I've payed attention, and I have learned a lot this chapter, I need to continue these habits so I can learn a lot this chapter. One thing I didn't do well is getting my assignments done. This chapter I'll do the assignment as soon as I get home so I finish it.

2. Reflect on your learning from this past chapter by looking at your assignments, quizzes, and test. What topics have you mastered? What topics have you struggled with and why? Write a paragraph describing your overall learning. I didn't do well on adding and subtracting polynomials, but I did really well on multiplying (esp. FOIL). Last year, I didn't understand why or how you decided to put in a plus or minus sign, but I know now that it depends on if the product is negative or positive. This chapter, I understood (finally) a lot of stuff I didn't last year. Yay!

Name:
Hour: 2

Chapter 4

Chapter Writing Assignment

Directions: Read each description and answer the questions thoroughly in complete sentences.

1. Answer the following questions in paragraph form: What were your four course goals? Are you currently meeting your goals? What do you need to change or continue during the next chapter to help reach your goals by the end of the semester?

My goals were to maintain a good grade, be prepared, understand what we are learning, and to ask questions and respond. Some of the stuff is confusing, so some of it I had trouble with, but my other goals are filled. Asking questions has helped me better understand what I'm doing.

2. Reflect on your learning from this past chapter by looking at your assignments, quizzes, and test. What topics have you mastered? What topics have you struggled with and why? Write a paragraph describing your overall learning.

I pretty much got the chapter, but some of the rate/distance/time charts were hard. It's difficult to figure out what goes where in the chart. It's hard for me to figure out the equation. Once I have the equation I can solve, but it's just hard for me to figure out what goes where.

Name:
Hour: 1

Chapter 5

Chapter Writing Assignment

Directions: Read each description and answer the questions thoroughly in complete sentences.

1. Answer the following questions in paragraph form: What were your four course goals? Are you currently meeting your goals? What do you need to change or continue during the next chapter to help reach your goals by the end of the semester?

To get higher than a B in this class, to have things ready before the bell rings, to answer & ask questions, and to finish freshman year with good grades. No I'm not, only some of them. I need to be getting better grades on tests

2. Reflect on your learning from this past chapter by looking at your assignments, quizzes, and test. What topics have you mastered? What topics have you struggled with and why? Write a paragraph describing your overall learning.

I really haven't mastered any of them. I have struggled with I think all of them because I begin doing the work and if I mess up on a step I lose track and have trouble. My overall learning has been good. But in this chapter, I've had the hardest time.

Appendix H

Frequency Comparison Table for Self-Efficacy Statements on the Questionnaires

Frequency Comparison Table for Self-Efficacy Statements on the Questionnaires

Note: 1 was associated with "not at all confident" and 5 was associated with "very confident."	**Number of Students who responded in Questionnaire #1**	**Number of Students who responded in Questionnaire #2**	**Number of Students who responded in Questionnaire #3**
Statement #1: Follow the order of operations to simplify expressions			
1	0	0	0
2	0	0	0
3	3	1	4
4	16	17	11
5	38	39	42
Statement #2: Use formulas given values of variables			
1	0	0	0
2	1	2	1
3	10	12	6
4	28	18	28
5	18	25	22
Statement #3: Translate words into algebraic symbols and equations			
1	0	1	2
2	2	6	1
3	12	15	12
4	26	13	18
5	17	22	24
Statement #4: Add, subtract, multiply, and divide Integers			
1	0	0	0
2	0	1	0
3	11	4	7
4	18	23	16
5	28	29	34
Statement #5: Solve equations for unknown variables			
1	1	1	1
2	1	1	2
3	11	8	4
4	20	14	23
5	24	33	27

	Number of Students who responded in Questionnaire #1	Number of Students who responded in Questionnaire #2	Number of Students who responded in Questionnaire #3
Statement #6: Use the rules of exponents			
1	0	1	0
2	4	0	1
3	12	11	4
4	26	18	21
5	15	27	31
Statement #7: Add, subtract, multiply, divide, and simplify Fractions			
1	0	0	0
2	7	7	2
3	14	11	13
4	18	21	20
5	18	18	22
Statement #8: Find the least common denominator given two fractions			
1	1	1	1
2	4	6	3
3	14	14	10
4	19	21	30
5	19	15	13
Statement #9: Find equivalent fractions			
1	1	0	1
2	5	3	2
3	13	15	8
4	21	20	27
5	17	19	19
Statement #10: Find the factors of a number			
1	0	1	0
2	5	2	0
3	9	8	12
4	21	24	21
5	22	22	24

	Number of Students who responded in Questionnaire #1	Number of Students who responded in Questionnaire #2	Number of Students who responded in Questionnaire #3
Statement #11: Set up and solve word problems			
1	1	4	5
2	4	11	10
3	16	13	20
4	26	24	17
5	10	5	5
Statement #12: Describe your own mathematical thinking in words			
1	1	0	1
2	13	7	7
3	22	26	16
4	16	22	30
5	5	2	3
Statement #13: Learn something new in mathematics			
1	1	0	0
2	1	3	0
3	8	9	6
4	15	18	24
5	32	27	27
Statement #14: Apply mathematics in your daily life			
1	0	1	0
2	5	4	5
3	10	16	14
4	25	20	26
5	17	16	12
Statement #15: Overall ability in mathematics			
1	0	0	0
2	4	2	1
3	15	18	11
4	31	29	36
5	7	8	9

Appendix I

Frequency Comparison Table for Goals and Reflection Statements on the Questionnaires

Frequency Comparison Table for Goals and Reflection Statements on the Questionnaires

Note: 1 was associated with "strongly disagree" and 5 was associated with "strongly agree."	**Number of Students who responded in Questionnaire #1**	**Number of Students who responded in Questionnaire #2**	**Number of Students who responded in Questionnaire #3**
Statement #1a: "Setting and monitoring personal goals is important."			
1	0	0	1
2	3	1	1
3	9	11	7
4	22	21	22
5	23	24	26
Statement #2a: "Reflecting on your learning is important."			
1	1	0	1
2	5	4	4
3	17	11	10
4	15	22	20
5	19	20	22