ABSTRACT

Title of Document: THE IMPACT OF TEACHER INTERACTION ON THE ACHIEVEMENT AND SELF-EFFICACY OF STUDENTS WITHIN A COMPUTER-BASED, DEVELOPMENTAL MATHEMATICS COURSE

Kristy M. Vernille Blocklin, Ph.D., 2008

Directed By: Dr. James T. Fey
Dr. Anna O. Graeber
Education Curriculum and Instruction

A concern of our nation's universities and colleges is the number of students entering with what are considered to be sub-standard mathematics skills. According to the National Center for Education Statistics (NCES, 2001), in the fall of 2000, 24% of entering freshmen in 4-year institutions, and 53% of entering freshmen at 2-year institutions were enrolled in a developmental mathematics course.

Since developmental educators are increasing their use of technology to "re-teach" this population of students, understanding the role of the instructor in such a setting can inform developmental educators about the needs of the students, thereby potentially increasing the success rate in such courses. Success in developmental mathematics courses could lead to an increase in college-level retention rates and increase students' learning and achievement in credit-bearing mathematics courses.

The purpose of this study was to examine if teacher initiated interaction with developmental mathematics students studying in a computer-based classroom has an effect on their achievement or self-efficacy in mathematics. The study seeks to explore whether the role the instructor assumes is a factor in student success. Many theorists and researchers believe that teacher-student interaction and support/motivation provided by teachers are critical to students' mathematical achievement.

Through the use of a quantitative, experimental design, the researcher attempted to gain insight into the role of a developmental mathematics teacher, the achievement of students enrolled in a computerized class, as well as their feelings of self-efficacy toward mathematics. Six sections of an existing computer-based developmental mathematics course was the setting at a four-year research university in the mid-Atlantic area. The treatment provided by the teacher included: conducting brief initial interviews to obtain background information; initiating interaction and encouragement in every session; monitoring student progress; setting intermediate goals; e-mailing about absences; and verbalizing feedback on tests.

The repeated measure ANOVA results of this study indicated that there were significant improvements in student achievement, confidence, and attitude toward teacher when pre- and post- scores were compared in both the control and treatment group. However, no statistically significant difference occurred in achievement or self-efficacy when the classes were analyzed between groups; treatment group vs. control group.

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By

Kristy M. Vernille Blocklin

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Advisory Committee:
Dr. James Fey, Co-Chair
Dr. Anna Graeber, Co-Chair
Dr. Sharon Fries-Britt
Dr. William Sedlacek
Dr. Elizabeth Shearn

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DEDICATION

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CHAPTER ONE: INTRODUCTION

This study seeks to understand whether enhanced teacher initiated interaction within a developmental, computer-based mathematics classroom plays a significant role in student achievement or student sense of self-efficacy in mathematics. Since developmental educators are increasing their use of technology to "re-teach" this population of students, understanding the role of the teacher in such a setting can inform developmental educators about the needs of the students, thereby potentially increasing the success rate in such courses. Success in developmental mathematics courses could lead to an increase in college-level retention rates and increase students' learning and achievement in credit-bearing mathematics courses. This study addresses an issue, of national concern, identified by the National Research Council (2003) for improving the effectiveness of instruction in lower-division college courses in science, technology, engineering, and mathematics. According to the Council, "pressures are mounting from within and beyond academe (e.g., state boards of regents and legislatures, business and industry) to improve learning, particularly in introductory and lower-division courses. These calls also request accountability in academic departments, including a new emphasis on improved teaching and enhanced student learning through curriculum revision and collegial peer mentoring" (p. XI).

Background and Rationale

A concern of our nation's colleges and universities is the number of students entering with what are considered to be sub-standard mathematics skills. According to the National Center for Education Statistics (NCES, 2001), in the fall of 2000, 24% of entering freshmen in 4-year institutions, and 53% of entering freshmen at 2-year institutions were enrolled in a remedial mathematics course. At the research university where this study was conducted, approximately 16% of admitted students in the fall registration were placed into a remedial-level mathematics course (W. Schildknecht, personal communication, May 29, 2008). All students at this university are required to take at least one mathematics credit-bearing course, regardless of the major they select. Students who are required to take a remedial, sometimes referred to as a developmental, mathematics courses do not meet the college pre-requisites or agreed upon standards for credited mathematics courses (Merisotis & Phipps, 2000). These students are lacking "the foundation and skills required for rigorous college curriculum" (Smittle, 2003, p. 10). As a consequence, these students are required to pass a developmental, usually non-credit bearing, course before registering for a mathematics course required for their major or university credit.

Higher-education institutions have recognized the need for developmental programs for almost 200 years. They have accepted the fact that some students do not meet their standards, and the institutions attempt to find ways of meeting the needs of their diverse learners (Casazza, 1999). Today, individuals taking developmental courses include students who have taken Advanced Placement (AP) courses in high school, are returning adults, have disabilities, took the minimum number of mathematics courses required for high school graduation, are of both genders, and represent all ethnicities. There is no stereotype for a developmental student. A developmental student can be a student who scored over a 1200 on their SAT's or a student for whom English is a second language (Hardin, 1988, 1998).

Remedial vs. Developmental

It has been argued that the meaning of the word "remedial" is not the same as that of developmental (Ross, 1970). Since the term "remedial" has tended to have a negative connotation, or implies a deficiency (Spann & McCrimmon, 1998), some people might think it is merely a matter of "political correctness" to say developmental (Maxwell, 1979). However, at least according to Ross (1970), remedial instruction refers to the teaching of pre-requisite skills necessary to successfully complete a course. Non-credit courses teaching pre-college material are usually referred to as remedial courses (Boylan & Bonham, 2007). Developmental instruction, on the other hand, assists a student in obtaining a stated objective. Therefore, according to the definitions and Ross (1970), we can label a course as remedial or developmental but we can only label a student as developmental, not as remedial.

For the purposes of this study, students will be referred to as developmental students, in a developmental course, receiving developmental instruction. This term has been adopted because the interaction within the classes will encompass more than just the teaching of mathematics skills. The following section will offer additional reasons why the term developmental was adopted for this study.

Characteristics of the Students Enrolled in Developmental Courses

Developmental education is often thought of as courses designed exclusively for underprepared students. This idea can be thought of as a naïve one. Students placed or enrolled in a developmental course generally have the ability to achieve, but they are lacking in some fundamental skills, understandings, or dispositions, that lead to high achievement in mathematics. Developmental theorists, such as Hardin (1998), suggest that "most students in developmental courses may be underprepared, [but] this does not equate to being incapable or ineducable" (p. 22).

Students in developmental courses often have been found to have low motivation, lack of confidence, or do not know or how to use proper study skills (Higbee & Thomas, 1999; Yaworski, Weber, & Ibrahim, 2000). It is not because they do not have the intelligence to be in a "regular" class; these students need to learn certain content or adopt more productive learning attitudes or skills in order to be successful and ultimately achieve a college degree. Affective variables such as motivation, anxiety, self-esteem, and cognitive variables such as learning styles and critical thinking skills, must be considered when trying to identify the specific skills, concepts, or attitudes developmental students must learn (Higbee & Thomas, 1999).

Some behavioral patterns are also commonly found in this student population. Sagher, Siadat, and Hagedorn (2000) summarized the findings of multiple researchers as examples of behaviors that were destructive to learning. These behaviors were: short attention spans, little or no attention to assigned homework, procrastination, failure to learn from mistakes, passivity, poor attendance patterns, and low self-esteem.

There are multiple reasons why a student might be placed in developmental courses. For example, a student might never have received a consistent and proper foundation in mathematics. Alternatively, if an individual had to move several times throughout elementary and/or secondary school, the material covered in mathematics classes might have been drastically different from one school to the next. Therefore, a student might have missed very important concepts that are considered “building blocks” from one topic to another, or even from one year to another. Mathematics is often referred to as hierarchical, meaning, one must have certain knowledge and skills to be able to move onto the next topic or “stage” of mathematics. If a student is not exposed to a basic skill early on, their later success can be compromised.

Another reason that a student might be on a path to developmental mathematics courses is that the teachers they have had in some of their K-12 mathematics classes may have been ineffective. Unfortunately, not all mathematics teachers are certified for the grade or even sometimes the subject they teach. It has been reported (NCES, 2004) that in schools with a high minority enrollment, as many as 23.0% of public middle school mathematics teachers, and 10.1% of public high school mathematics teachers have neither a major nor certification in the field of mathematics (these percents tend to be lower in schools with low minority enrollment). This ultimately leads to a wide range of experience and knowledge the teachers possess, and can result in lower student achievement.

Parental influence can be another explanation for a student’s lower mathematics achievement and negative feelings for mathematics (Wang, Wildman, & Calhoun, 1996). It is not out of the ordinary to hear a student say that their parent(s) claimed that they themselves were never good in mathematics so the pressure of success was never placed on them.

It is often the case that a poor mathematics student can cite the exact time or event that caused them to begin to fall apart in their mathematics classes. Many participants interviewed during this study stated:

> "I was always told that since I was a girl, I couldn't be good in mathematics."
>
> "My elementary teacher liked to teach more reading than math."
>
> "I lost a whole year of math because my teacher didn't teach. He told us to do whatever we wanted."
>
> "I just hated Geometry. The teacher was horrible."
>
> "We actually did Sudoku puzzles in math class my senior year."
>
> "The school's basketball coach was our math teacher."
>
> "I had the same horrible math teacher for three years."
>
> "My sixth grade math teacher insulted the students."

This negativity towards their mathematics teacher(s) could influence their attitudes towards the subject of mathematics and ultimately hinder the development of a productive disposition toward mathematics.

The Goals of Developmental Education

In order to help these students succeed, developmental education has evolved into more than just noncredit courses offered by the university. According to the National Association of Developmental Education (NADE), the goals of developmental education include developing students' "skills and attitudes necessary for the attainment of academic, career, and life goals" (NADE, 2008).

Developmental education also refers to services that have been developed and organized in order to retain this student population and help them achieve their educational goals (Boylan & Bonham, 2007). These services include offering study skills integrated with course material or just courses teaching only study skills, tutoring resources, workshops, learning assistance centers, as well as workshops offered to advanced students hoping to take the Graduate Record Exam (GRE) or Law School Admission Test (LSAT). Developmental education is not limited to students at risk of failing out of school (Boylan & Bonham, 2007; Casazza, 1999).

If postsecondary institutions want to retain as many students as possible, these institutions need to promote both affective and cognitive growth for all learners, at all levels, and focus on both a student's social and emotional development (Casazza, 1999). According to Boylan (1999, p. 5), there are principles that institutions must follow in order to promote good developmental education. He believes good developmental education:

- Is provided through well-educated professionals; a masters or doctoral degree does not automatically qualify a developmental educator.
- Is student-oriented. It encourages students to use their current knowledge as a building block for their future knowledge.
- Is based on stated objectives and goals that are connected to the college curriculum.
- Incorporates critical skills (i.e., metacognitive and study strategies) into all courses and activities.

Who Will Teach These Students?

Institutions need to have a plan of action in place for educating their population of developmental students. A major goal of most developmental education programs is to help underprepared students improve their mathematics skills so that they have the same likelihood of graduating from college as do students not required to take developmental courses (Penny & White, 1998). Therefore, a question mathematics educators should be asking themselves is: “How can we make these students better mathematics learners and how can we help them to develop positive attributions, increase self-efficacy and motivation, and develop essential learning strategies toward the subject of mathematics?”

Another question that is pondered by college and university mathematics departments is “Who is going to teach this developmental population?” While most upper-level mathematics courses are taught by tenured faculty, lower-level courses are frequently assigned to graduate assistants and adjunct faculty, many of whom have neither a great deal of teaching experience nor education in pedagogy (Penny & White, 1998; Wheland, Konet, & Butler, 2003). And, as previously noted by Boylan (1999), developmental educators need to be well-educated. In addition to having content knowledge, researchers have suggested that developmental instructors must have pedagogical content knowledge (knowledge of content-specific pedagogy, general pedagogy, and student development), provide structure for the students, encourage the students, and help students to grow both personally and independently (Smittle, 2003; Wambach & Brothen, 2000). Students in developmental courses tend to have a number of characteristics that are different from, say, students in a calculus course, to which the instructors are rarely alerted. So that students are not put at an immediate disadvantage depending on the mathematics instructor they choose, all developmental educators need to be well informed about this population so they can bring this new understanding into the classroom (Boylan, 1999).

In the past, developmental mathematics classes were taught as lecture classes. Today, because of the rapid advances in technology, colleges and universities are opting to use computers to teach their developmental students (Kinney & Robertson, 2003). There are a variety of reasons why a university might choose this option (i.e., cost, convenience, facilitation of self-paced instruction, etc.). However, this raises even more questions: “What is the effectiveness of a computer-based class?” and “What kind of faculty-student interaction, if any, is taking place in these computer-based classes?”

Computer based instruction (CBI), or as others would call it computer-mediated instruction, is seen in many forms. Some CBI classes occur over the internet where students do not have to attend an actual mathematics class. They can do their mathematics from their dorm room or from many states away. Other CBI classes are held in a computer lab with just a computer technician present. While others, like the one in this study, are held at a specific time and location with an instructor present. The programs used can vary as well. Some CBI involves lessons, videos, and practice problems that do not change from one student to another, while other CBI can vary the presentation from one student to the next, depending on their ability level. For example, say two students were working on the same problem, but one student got it wrong, while the other got the correct solution. Some CBIs will present a more challenging problem to the student who answered correctly and a problem similar or easier than the original problem to the student who answered the problem incorrectly.

Interaction has been identified as a critical factor in the success of developmental students (Cooper & Robinson, 1991). All students require feedback, motivation, and a sense of confidence that they can achieve their learning goals. Developmental mathematics students might, however, need a classroom environment that provides more feedback and encouragement since most of the students that make up this population have experienced more failure than most "average" students and have lower self-efficacy (Hall & Ponton, 2005; Higbee & Thomas, 1999; Wambach & Brothen, 2000). The negative emotions and poor classroom experiences that many of these students carry with them are often difficult to overcome (Ironsmith, Marva, Harju, & Eppler, 2003). Developmental mathematics instructors can likely help improve a student's attitude, motivation, or confidence by bringing more to the classroom than just mathematics content. Explicit teaching of study skills and cognitive learning processes, as well as self-regulation training are among the techniques cited as useful for improved student achievement (Schraw, Crippen, & Hartley, 2006; Smittle, 2003; Young & Ley, 2003).

Statement of Purpose

The purpose of this study is to examine if teacher initiated interaction with developmental mathematics students studying in a computer-based classroom has an effect on their achievement or self-efficacy in mathematics. The study seeks to explore whether the role the teacher assumed was a factor in the students' success. Many theorists and researchers believe that teacher-student interaction and support/motivation provided by teachers is critical to students' mathematical achievement (Cooper & Robinson, 1991). Noddings (2001) expressed the idea that a teacher should show care towards his/her students. Caring teachers provide attention, encouragement, and are receptive to the needs of the ones that are being cared-for (Noddings, 2001). According to Mayeroff (1971), "to care for another person, in the most significance sense, is to help him grow and actualize himself" (p. 1).

Since increasing numbers of developmental classrooms are using technology to "re-teach" developmental students (McCoy, 1996; Wadsworth, Husman, Duggan, & Pennington, 2007), explaining the role of the instructor in such a setting can help educate developmental instructors as to the needs of the students, potentially increasing the success rate of students placed into such classes. This might then set students on the road to success in their future, credit-bearing mathematics courses.

Overall Methodology

Through the use of a quantitative, experimental design, I attempted to gain insight into the role of a developmental mathematics teacher, the achievement of students enrolled in a computerized class, as well as their feelings of self-efficacy toward the field of mathematics. At a four-year research university in the mid-Atlantic area, data was collected using students' mathematics placement test scores (pre- and post-) and a modified version of the Fennema-Sherman Mathematics Attitudes Scale (Fennema & Sherman, 1976). Three sections of an existing computer-based developmental mathematics course were the setting in which the teacher provided initiated interaction and encouragement, monitored student progress, set intermediate goals, responded to absences, and verbalized feedback on tests. Three other sections of the same course were provided with teacher interaction available upon student request and written feedback on corrected exams. All six sections met in the same semester, on the same days, within the middle part of the day, and accessed instruction from the same computer program. Each of the six sections had an assigned Teaching Assistant (TA) who was given instructions as to how to interact with their particular section. At each of the three time slots, one section was randomly assigned to the treatment group and one to the control group. The enrollment of the two groups was 72 and 57, respectively. (Two students assigned to the treatment group and five students in the control group declined participation in the study).

Research Questions

This study is guided by two research questions. They are as follows:

1. Does teacher initiated interaction affect students' mathematics achievement?
2. Does teacher initiated interaction have any effect on students' sense of self-efficacy?

Answering these questions could provide direction for structuring future computer-based mathematics classes and how to attend to the students' needs within these classes.

Theoretical Framework

The following section will briefly outline the theories that were influential to the underlying premise of this research study. The theoretical frameworks and their related research will be discussed more in depth in Chapter Two.

Self- Efficacy Theory

Self-efficacy is defined as a person's confidence in their ability to perform a task (Bandura, 1986). This belief of personal competence influences the choices one makes and the course of action they pursue (Pajares, 1996). According to Pajares (1996), "efficacy beliefs help determine how much effort people will expend on an activity, how long they will persevere when confronting obstacles, and how resilient they will prove in the face of adverse situations" (p. 544). A mathematics student who has a lower sense of self-efficacy, which is often the case in developmental students, will tend to give less effort to a task and show less motivation or even give up when presented with a challenging problem or situation. This type of student believes that they do not have the ability to overcome difficult tasks. Therefore, a lower self-efficacy can hinder student achievement (Young & Ley, 2001).

Self-efficacy theory has been explored in studies and has been identified as having a relationship with attribution theory (Schunk, 1991) and with self-regulation theory (Zimmerman, Bandura, & Martinez-Pons, 1992). Thus, the literature review also includes attention to these two theories.

Attribution Theory

Attribution theory states that a person (in this case student) believes that their past successes or failures will influence their future achievement (Weiner, 1980). In other words, they attribute a cause to a behavior or outcome. The roots of this theory date back to Heider (1958) who proposed a psychological theory of attribution. From this, Weiner and his colleagues (1974) developed a theoretical framework that indicated that students generally attribute their achievements to their ability, their effort, the difficulty of the task, or to luck. Attribution theory is related to motivation efficacy beliefs. A student who is a low achiever will often tend to avoid tasks because they doubt their ability and assume that they have bad luck. Therefore, they will show little or no motivation or perseverance toward a particular activity or subject in which they have previously failed.

Attributions can also be classified along three causal dimensions. These three dimensions are locus of control (internal vs. external), stability (stable or unstable), and controllability (Weiner, 1980). Developmental mathematics students tend to have an external locus of control. This means that they tend to identify factors external to themselves as causes for their failure, for example, a poor teacher or textbook. They also tend to attribute failures to stable and uncontrollable factors. In other words, one's failure on a test would be attributed to one's ability.

Self- Regulation Theory

Self-regulation refers to the degree in which students are motivationally, behaviorally, and metacognitively regulators of their own learning process (Zimmerman, 1986). Zimmerman, Bandura, and Martinez-Pons (1992) state that in terms of a social cognitive perspective, self-regulated learners set challenging goals for themselves, select strategies to achieve these goals, and by "enlisting self-regulative influences that motivate and guide their efforts" (p. 664). A student that has better self-regulation skills than another can "typically learn more with less effort and report higher levels of academic satisfaction" (Schraw, Crippen, & Hartley, 2006, p. 111).

Significance

The purpose of this study is to help inform future developmental educators, particularly those teaching within a computer-based developmental mathematics course. Theory suggests developmental students need structure, encouragement, and more attention than the average mathematics student. It is the intent of this study to investigate whether increased teacher attention to these factors can have a profound effect on students' sense of self-efficacy and achievement. Improvement of instruction and increased student self-efficacy and achievement will promote both affective and cognitive growth for all learners; a goal of developmental education.

Limitations

There are several obvious limitations of this study. The first is that this study is limited to the developmental mathematics program of only one university, though it seems reasonable to expect that the findings may also be typical of other similar large universities. A second important limitation is that the study was conducted in classes during the fall semester. Past experience in undergraduate teaching suggests that there are often significant differences between the students enrolled in this course in the fall and spring semesters. The majority of the students enrolled in the fall semester are typically first-semester freshmen, where as in the spring semester, there is an increase in the number of transfer students and those repeating the course. A third limitation of the study is that the investigator carried out the treatment. There is always a concern that an investigator who is performing the treatment can have an emotional tie to the experiment resulting in a chance of bias. A similar limitation, and maybe the most important, is the teacher. A teacher's education, previous experience, knowledge of the student population, personality, and commitment to the students vary from one teacher to the next. Since the "personal touch" of the teacher is such an important part of the treatment being tested, those factors are a particular threat to generalizability. The same concerns can also be raised about the teaching assistants. Their experience working in the classroom and their education (number of courses taken in the mathematics and/or education department) can have a huge impact on how they handle themselves as well as interact with the students in this type of course. A final limitation is that the class sizes were not the same. One lab holds more students than the other, and since three sections were assigned to a treatment group, and the remaining three were assigned to the control group, it was impossible for equal number of students in each group.

Definition of Terms

In order to have a better understanding of how data was collected, presented, and analyzed throughout the course of this study, several terms that will be used throughout this paper are defined as follows:

Developmental Student – a student who is placed into a non-credited mathematics class because they have not demonstrated mathematics skills/understandings considered sufficient for success in a university credit bearing course.

Computer-Based Course – students main source of information is presented to them (in a self-paced manner) through a computer, not an instructor.

Placement Test – a mathematics skills test required of all students before registering for classes at the university. Depending on score, students can be placed into one of five non-credit mathematics courses or one of six credit bearing mathematics courses.

Module – one of four curriculum tracks the developmental students at the university can follow to prepare for one of four credited mathematics courses.

CHAPTER TWO: REVIEW OF LITERATURE

Over the last several decades, mathematics education has evolved into a distinct discipline that contains its own theoretical frameworks and research (Sowder, 1989). Previous to this evolution, mathematics educators drew on theories and research methodologies from other areas, such as developmental psychology and sociology (Lesh, Lovitts, & Kelly, 2000).

Prior to the 1960's, researchers focused most of their attention on the cognitive theories and factors of students and their learning. In other words, research was more concerned with how students process information and retain it. Educators were focused on skill performance and learning procedures with understanding (Kilpatrick, Swafford, & Findell, 2001). In the 1960's, researchers began studying affective factors within cognitive theories. Such work can be traced back to the work of Schacter and Singer (McLeod, 1992). Cognitive psychologists, such as Lazarus (1982) and Mandler (1975) also included affect in their theories, and hypothesized how it might apply to the teaching and learning of mathematics (McLeod, 1992). Affective issues, such as beliefs, attitudes, and emotions, "play a central role in mathematics learning and instruction" (McLeod, 1992, p. 575). Emotions and attitudes, such as anxiety and frustration, and beliefs, such as self-efficacy and confidence, are all factors that play an important role in a mathematics classroom. McLeod (1992) noted three major components of the affective experience of mathematics students. These three components were: "Students hold certain beliefs about mathematics and about themselves," "Students will experience both positive and negative emotions as they learn mathematics," and "Students will develop positive or negative attitudes toward mathematics" (p. 578). If educators understand affective factors and the three previously stated components, they can help students to become better mathematics learners.

Pintrich, Marx, and Boyle (1993), drawing on more general psychological studies, emphasized that a classroom learning community can contribute positively or negatively to students' motivational beliefs and thus to conceptual change or learning. They created a conceptual framework that details how cognitive, motivational, and classroom factors can interact with one another to promote positive conceptual change. Classroom factors, such as teacher scaffolding and methods of evaluation, can contribute to a student's involvement and success on a mathematical task. For example, if a classroom setting is created where there is a great deal of interaction occurring between both the students and the teacher, the students could have an increased chance of witnessing their peers struggle though more challenging mathematics. This is more likely to result in having a "positive effect on the observers' efficacy and learning" (Pintrich, Marx, & Boyle, 1993, p. 187).

Much more recently, the authors of the book, *Adding It Up*, identified five inter-related strands that contribute to students' mathematics proficiency (Kilpatrick, Swafford, & Findell, 2001). These five strands include: conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently, and appropriately), strategic competence (ability to formulate, represent, and solve mathematical problems), adaptive reasoning (capacity for logical thought, reflection, explanation, and justification), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with the belief in diligence and one's own efficacy) (p. 116). The first four, conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning, are chiefly related to the cognitive domain. Productive disposition, on the other hand, can be classified under the affective domain. This strand focuses on students' attitudes, beliefs, and motivation toward mathematics. Students with a productive disposition believe that mathematics is useful and worthwhile, that they can learn and complete mathematical tasks, and that effort in learning mathematics has benefits (Kilpatrick, Swafford, & Findell, 2001). By providing the student with opportunities to make sense of mathematics, encouraging them to contribute effort and perseverance in learning mathematics, and to believe that they can be an effective learner of mathematics by experiencing rewards of their efforts (Kilpatrick, Swafford, & Findell, 2001) will likely increase students' sense of self-efficacy and therefore improve their academic success.

Students' disposition towards mathematics is related to their educational success, and teachers play a critical role in supporting students' development of a productive disposition (Kilpatrick, Swafford, & Findell, 2001). It has been argued that failure to develop a productive disposition in early school years may have negative consequences for students once they get into high school and college. Such students may not choose to engage in more challenging mathematics courses (Kilpatrick, Swafford, & Findell, 2001). Students who enter high school disliking mathematics, tend to take only those mathematics courses required to graduate, and this can have an effect on their college performance and lead to enrollment in developmental courses. Researchers have identified mathematics as "the subject most essential to students' choice in determining a college major and ultimately to success in attaining a college degree" (Hall & Ponton, 2005, p. 26). Therefore, developing a positive productive disposition and encountering teachers that foster such a disposition can be essential for a students' mathematical success and endeavors.

Acknowledgement of the role of affective factors, such as motivation, beliefs, and attitudes is reflected in research on mathematics education and developmental education. This chapter highlights previous research studies, especially those concerning the affective dimension, that have been influential to this study's theoretical perspective and research questions. The chapter will begin with a very brief overview of research involving developmental education and remedial mathematics courses. Studies involving self-efficacy, and related theories of attribution and self-regulation theory, will be explored in the theoretical framework, the second part of the chapter. A third section will discuss the instrument used in this study that analyzed some of the affective factors identified in the three theories. Finally, the last section will explore the role of discourse, faculty interaction, and caring within a classroom. The chapter will conclude by identifying how previous research influenced the present study.

Theoretical Framework

Numerous studies have been performed on developmental education within both 2-year and 4-year postsecondary institutions. Studies range from investigations in remedial mathematics, reading, and writing classes, with comparisons between remedial and non-remedial college students (Hagedorn, Siadat, Fogel, Nora, & Pascarella, 1999; Young & Ley, 2001), supplemental instruction and its effectiveness (Wright, Wright, & Lamb, 2002), the impact of faculty (Penny & White, 1998; Wheland, Konet, & Butler, 2003), learning assistance centers and their role at the institution (Boylan, 1999; Casazza, 1999), and cooperative learning (Higbee & Thomas, 1999; Smittle, 2003). While all of these studies have important issues to reveal about developmental students and developmental education, only those few studies that pertain more specifically to this research study will be highlighted in this chapter. I will limit the studies reviewed to be those involving developmental mathematics students in a computer-based or lecture based course, and the impact and role of teachers within these settings. The findings from these studies are reported in the discussion of self-efficacy theory, attribution theory, and self-regulation theory. These studies will be categorized in the remaining sections of this chapter.

The following section of this chapter details the theoretical frameworks as well as the relevant research that has been done in this area that served as a guide to this study. The theories that will be described are self-efficacy theory, attribution theory, and self-regulation theory. Although they are three separate theories, it will be apparent to the reader that they are not all independent of one another, as some concepts are common to several of these theories.

Self- Efficacy Theory

Self-efficacy, as defined by Bandura (1986), is an individual's personal beliefs about their abilities to perform a task. In mathematics, this could be a student's confidence on solving a problem, succeeding in a specific mathematics course (e.g., calculus), or persistence when faced with a challenging task. Self-efficacy theory suggests that students will often appraise their own efficacy based on their performance as well as the performance of others (Schunk, 1991). According to Schunk (1991), “observing similar peers perform a task conveys to observers that they too are capable of accomplishing it” (p. 208). Therefore, observations of peer success and one’s own success will raise one’s efficacy and help develop a strong sense of self-efficacy, which will be resistant to occasional failures (Bandura, 1986).

It is important to note that a high sense of efficacy will not result in a higher proficiency if there is a lack of skills and knowledge (Schunk, 1994, as cited in Young & Ley, 2001). Self-efficacy involves self-judgments of one’s capabilities and, when researched, is assessed before a student is asked to perform a task (Hanlon & Schneider, 1999).

Bandura (1993) believed that there are four major processes that are affected by self-efficacy beliefs. These four processes are: cognition, motivation, selection, and affective responses. Efficacy beliefs help determine the goals one might set for oneself, how much effort one will give to a certain activity, how long they will persevere if they confront a challenging task, and how resilient they are to failures (Bandura, 1993; Pajares, 1996). Researchers have found that persistence on mathematical tasks can significantly contribute to achievement (Miller, Green, Montalvo, Ravindran, & Nichols, 1996). Similarly, motivation, which has been identified as “one of the most pervasive explanations for success or failure in academics” (Kinney, Stottlemyer, Hatfield, & Robertson, 2004, p. 18), can be a threat to effort and persistence if it is too low, which can hinder success in mathematics (Kloosterman, 1997; Meyer, Turner, & Spencer, 1997).

In an academic learning environment, initial self-efficacy varies depending on one's aptitude and past experiences. Factors such as goal setting, cognitive processing, and teacher feedback affect a student while they are working (Pintrich, 1994; Schunk, 1991). Self-efficacy researchers have argued that students need to have feedback on their progress and that when the feedback is positive, students will develop a greater sense of their ability in order to succeed at learning tasks (Wambach & Brothen, 2000). Positive teacher feedback has been shown to enhance self-efficacy, however, if the student was not successful on the performance, its effects are lessened (Young & Ley, 2001). Based on these factors, students will develop a sense of how they are performing, and if they are making progress, their sense of self-efficacy will heighten and thus lead to an improvement in their motivation (Schunk, 1991).

Students who have a stronger sense of self-efficacy tend to participate more readily, give greater effort, and persist longer at tasks than those with low self-efficacy (Pajares, 1996; Young & Ley, 2001). "Heightened self-efficacy sustains motivation and improves skill development" (Schunk, 1991, p. 213). Students who believe they are capable at performing a task are more likely to exert more effort and use deeper thinking and studying strategies in order to process information (Pintrich, 1994; Schunk, 1996). Similarly Snow, Como, and Jackson (1996) note that self-efficacy is hypothesized to affect individuals' activity choice and persistence along with amount of effort.

Two other aspects of self-efficacy theory that influence academic motivation are students' goal orientation and their sense of task value (Elliott & Dweck, 1988; Ray, Garavalia, & Murdock, 2003). Goal orientation describes a person's goals for learning in a specific context (Ray, Garavalia, & Murdock, 2003). There are two types of goal orientation: intrinsic and extrinsic.

The first is intrinsic, or learning goal, orientation. Learning goals help students to focus on developing their ability over time and increasing their competence (Dweck & Leggett, 1988). Intrinsically motivated students "engage in academic tasks because they enjoy them" (Middleton & Spanias, 1999, p. 66), tend to be more confident, possess a positive affect, and are not defeated by failure (Elliott & Dweck, 1988; Middleton & Spanias, 1999). Failure might signal to them that the task may require more effort and "ingenuity for mastery" (Dweck & Leggett, 1988, p. 261). Dweck and Leggett (1988) found that, in general, students who adopted a learning goal orientation had a higher perception of their self-efficacy and had more success in their courses.

The second goal orientation is referred to as extrinsic, or performance goals. Students with this type of goal orientation focus more on external rewards (e.g., grades), engage in academic tasks to avoid punishment (Middleton & Spanias, 1999), and are concerned with the extent of their ability. They tend to have a negative affect and succumb to failure (Elliott & Dweck, 1988; Ray, Garavalia, & Murdock, 2003). Therefore, a student with a lower sense of self-efficacy is likely to adopt a performance goal orientation. They are more likely to avoid challenging tasks that have a threat of failure (Dweck & Leggett, 1988). In a study of at-risk college students, Yaworski, Weber, and Ibrahim (2000) found that these students have behaviors that resembled a performance goal orientation. They tended to skip class, not complete assignments, and not take responsibility for their own learning. They believed that effort, perseverance, and good study habits were all related to academic success, they just chose not to engage in these behaviors.

Task value is another aspect of motivation. Task value is defined as how one values the importance of the task (or course content), one's interest in the task, and how useful the task is perceived to be (Ray, Garavalia, & Murdock, 2003). According to Brophy (1999), students need to feel that the subject they are learning has a purpose and value for the future endeavors. Academic performance (Pintrich & Schrauben, 1992) and long term engagement in mathematics (Wigfield & Eccles, 1992) has been found to be correlated with task value. Developmental mathematics college students whose past academic achievement was low, might report low levels of interest and usefulness for mathematics tasks. This low task value could be detrimental to their future academic achievement. In a study conducted by Yaworski, Weber, and Ibrahim (2000), the researchers talked with developmental students in an attempt to assess why some students succeeded while others failed. One important finding was that low achieving students chose not to attend class or complete coursework because they had a lack of interest in their course. Therefore, they had low task value, which resulted in a decrease in their motivation and low academic achievement.

Efficacy beliefs can also influence affective factors such as emotional attitudes and beliefs which influence achievement. A student with low self-efficacy will tend to have less confidence, more anxiety and stress, and avoid challenging tasks that they feel might lead to failure (Pajares, 1996; Schunk, 1991). According to Bandura (1993), people with a high self-efficacy "attribute failure to insufficient effort or deficient knowledge and skills that are acquirable" (p. 144). Research has found that a person's expectation of mathematics self-efficacy are positively correlated with mathematics ability, while being negatively correlated with mathematics anxiety (Fennema & Sherman, 1976). In other words, when a student has a positive sense of their self-efficacy, their mathematics ability will increase, therefore leading to an increase in mathematics performance. However, if a student has a low perception of their self-efficacy, the more anxious that student will become, which will hinder their mathematics achievement.

Research has found significant differences between the self-efficacy of college students in credited courses compared to the students in developmental mathematics courses (Hall & Ponton, 2005). Teachers can influence the development of students' efficacy especially in the developmental mathematics population. It has been suggested that teachers of developmental mathematics courses need to find a way to create a learning environment that helps foster self-efficacy, but at the same time keeps the course rigorous and comparable to other mathematics courses (Hall & Ponton, 2005). Teachers can create this environment by encouraging students to ask questions, giving students many opportunities for success, helping them to set goals for themselves, allowing them to observe the success and failure of their peers through interaction, and providing them with positive feedback (Hall & Ponton, 2005; Schunk, 1991).

Self-efficacy theory suggests that students' attitudes, beliefs about mathematics, motivation, goal orientation, and task value affects students' efficacy which can influence mathematical achievement. Researchers also suggest that teachers play an influential role on fostering efficacy and improving student achievement and retention in mathematics. The treatment outlined in Chapter Three was intended to influence some aspects of developmental students' self-efficacy beliefs. For example, the teacher worked with students to set short-term (weekly and semester) goals and understand students' mathematical background. The teacher also provided each student with attention by giving them a progress report and some feedback at each class meeting. On the other hand, the treatment did not attempt to alter task value. The computer program used for all sections of the course provided students with explanations of why mathematical topics are important and how they can be used in life.

Attribution Theory

There are several theories that are related to self-efficacy theory, and one of them is attribution theory (Schunk, 1991). Attribution theory suggests that students possess attitudes and beliefs about the sources of their success or failures that affect their motivation and learning outcomes (Weiner, 1980). Since students' attributions affect their motivation, attribution theory can be related to self-efficacy theory. For example, some students believe that their past performance has an influence on their future achievement. If a student has had multiple failures in past mathematics courses, they may feel that their future attempts at mathematical tasks will also lead to failure and thus be less motivated to work hard.

Weiner (1980) had found that students tend to attribute their success or failure to their ability, effort, task difficulty, and luck. Therefore, he built off of the work of earlier researchers (e.g., Heider (1958), Rotter (1966), and Kelly (1967)) to propose a theory for the attribution of causation of success and failure. Weiner's model proposed that the factors for success and failure exist on three different dimensions (Smith & Price, 1996): locus of control, stability, and controllability.

The first dimension, locus of control, concerns the cause to which students assign blame or credit for their failure or success (Rotter, 1966). Pintrich (1994) argued that locus of control beliefs can be internal, external, or unknown. A student with an internal locus of control will credit or blame their success or failures on themselves. For instance, they might think they failed a test because they did not study enough. Conversely, a student with an external locus of control will credit or blame everything but themselves. They might say they failed a course because they had a poor teacher. Lastly, students that cannot say who or what is responsible for their success or failure have an unknown locus of control. Students who do not distinguish between their behavior and the outcomes are often labeled as evidencing learned helplessness. Learned helplessness is defined as "a stable pattern of attributing many events to uncontrollable causes" (Pintrich, 1994, p. 29). These students experience anxiety, lack of effort, lower achievement, and feel that no matter how hard they try, they will always fail (Dweck & Reppucci, 1973; Kloosterman, 1984; Pintrich, 1994). Researchers (Pascarella, Edison, Hagedorn, Nora, & Terenzini, 1996) have found that first year college students who have an internal locus of control have higher academic success and more motivation. These students feel that they are in control of their learning, and that their effort will lead to more success (Moore, 2007).

The second dimension of Weiner's (1980) model is stability. A student who attributes a success or failure to a stable factor, such as ability, will then have the same expectations for their future endeavors as they did the past ones. According to Middleton and Spanias (1999), "by the time they reach college, students generally have formed stable attributions regarding their successes in mathematics" (p. 70). Ability is considered an internal and uncontrollable cause. On the other hand, a student who attributes successes or failures to unstable factors, such as effort, will more easily change their expectations (Smith & Price, 1996). In order to increase academic success, teachers need to help students to stop blaming their failure on their internalized lack of ability (Weiner, 1980).

Lastly, the third dimension is controllability. Controllability is whether a situation or action is in your control or not. According to Smith and Price (1996), "of all of causal attributions, the only one completely under our control is effort" (p. 2). Therefore, students need to associate failure with a lack of effort (Weiner, 1980).

Researchers believe that attribution theory has implications for developmental education (Kloosterman, 1984; Smith & Price, 1996). Attribution theory researchers have described some of the ways locus of control, stability, and controllability play into developmental students' failures. The first thing they noted was that developmental students typically have an external locus of control which can be linked to a passive learning style (Smith & Price, 1996). A student with a passive learning style does not take an active part in their learning. In a typical mathematics class, a passive student would simply take notes on what the teacher writes on the board and tries to restate that information on homework and exams. Not much more thought goes into learning the material and how it relates to previously taught concepts. Some (Smith & Price, 1996) speculate that passive students attribute their failure to external causes so that they can keep a positive self-perception. Developmental educators may be able to impact a student's sense of control by helping them to assume responsibility for their learning (Mercer, 1991). Such students need to accept the fact that some teachers are better than others or that one textbook might have more examples and clearer explanations than others, but that these things cannot be the sole determinant of their success or failure. The student has to take control of their learning situation and motivate themselves to succeed no matter what obstacles they face. In a study conducted on students enrolled in a developmental program, the researchers found that this student population tended to blame their past high school failures on external factors. These factors included the difficulty of tasks, luck, the amount of work assigned, and the quality of their teachers (Smith & Price, 1996). Therefore, these students were not willing to accept responsibility for their past failures.

Researchers have also found that developmental students attribute outcomes to stable factors as well as noncontrollable factors (Smith & Price, 1996). Again, developmental educators need to enable students to become aware and reflect on their actions and how it relates to their success or failure (Mercer, 1991), since it has been claimed that some students "lack the ability to identify factors that limit their success" (Hall & Ponton, 2005, p. 26). A student's perception of why they succeeded or failed at a task can be a prediction as to how they will do on future tasks (Kloosterman, 1984). As stated previously, the only thing completely in one's control is effort. Educators need to help students "understand the role of effort in their successes and failures" (Smith & Price, 1996, p. 4). It has been found that students who exert a high degree of effort will have more success than students that do not (Kloosterman, 1984).

Although developmental students frequently share similar characteristics, teachers must always remember that each student is unique. That is why educators should take the time to also get to know their students individually so that they know which students require a little more motivation and attention (Merisotis & Phipps, 2000). Developmental educators need to have effective teaching strategies as well as effective support services (Penny & White, 1998). In order to understand the participants involved in this study, the researcher conducted individual interviews that provided insight into the students' mathematical background, including their likes and dislikes of their mathematical experiences, their motivation toward the subject, and on their short and long-term goals.

Self-Regulation

Self-regulation theory is another theory that is closely related to self-efficacy theory, as well as attribution theory. Self-regulated learning refers to the metacognitive, motivational, and behavioral processes a student uses when they attempt to monitor and regulate their own constructive learning process (Zimmerman, 1986). It is related to self-efficacy theory and attribution theory in that it addresses the degree of motivation a student will afford to monitoring and changing their behavior in order to achieve academic success. In order to attain their personal learning goals, a student will self-generate feelings, thoughts, and actions to be able to achieve their goals (Kinney, 2001; Zimmerman, 2001). A self-regulated learner is one who will analyze and set attainable goals for specific tasks, monitor and control their progress during the activity, and assess their progress and change their behavior depending on this assessment (Pape, 2002). Effective self-regulation has been said to "depend on students developing a sense of self-efficacy for learning and performing well" (Schunk, 1996, p. 5).

Although there are many models for self-regulated learning, there are some basic assumptions that appear throughout the various models. Pintrich (2000) created a framework containing four common assumptions. The first assumption he called the "active, constructive assumption" (p. 452). This assumption views all learners as active, not passive recipients of information, who are constructive participants in their own learning process (Pintrich, 2000; Pintrich & Schrauben, 1992). The individual student sets their own goals and strategies from both their internal and external environment.

The second assumption concerns the potential for control (Pintrich, 2000). Many models of self-regulation suggest that learners have the ability to monitor, control, and regulate certain features of their own cognition, motivation, behavior, and even their environments (Schunk, 1996; Zimmerman, 2001). There are biological, developmental, contextual, and individual difference constraints that can interfere with individual efforts of regulation (Wambach & Brothen, 2000).

A third common assumption is the “goal, criterion, or standard assumption” (Pintrich, 2000, p. 452). All regulation models assume that there is some type of standard to which a student compares their present performances (Pintrich, 2000; Schunk, 1996). Students assess their performance against these criteria to determine whether if any modifications should be made in their learning. Individuals set goals, examine their progress, and modify and regulate their cognition, motivation, and behavior in order to achieve these set goals. Learning goals also allow students to focus their attention on the processes and strategies they have to endure in order to obtain their competencies (Schunk, 1996).

The last assumption that most regulation models assume is that “self-regulatory activities are mediators between a student’s personal and contextual characteristics and actual achievement or performance” (Pintrich, 2000, p. 453). In other words, students’ self-regulation of their behavior, motivation, and cognition mediates the relationships between themselves, their environment, and their over-all achievement.

Researchers (Wambach & Brothen, 2000) suggested that students who are self-regulating have more of an ability to identify areas in which their skills are weak and try to find the ways in which they can improve them. Self-regulating students also have the ability to observe aspects of their behavior and judge them against the goals in which they have set for themselves. This will then allow the students to react in a positive or negative way (Schunk, 1996). Pintrich and De Groot (1990) found that in seventh graders, goal orientation and task value were strongly related to self-regulation. They found that a student who possessed an intrinsic goal orientation and believed their school work was interesting were more cognitively engaged, persisted in their efforts, and were more likely to be self-regulating.

Self-regulating students take responsibility for their own learning by seeking feedback on their performances, monitoring their successes and failures, predict their level of math skill, and utilize support systems when necessary (Kinney, 2001; Schoenfeld, 1987). Garcia and Pintrich (1994) found self-regulatory strategies to be closely tied with self-efficacy and attributions. They noted that lower achieving students found themselves on many occasions feeling helpless when trying to motivate themselves to regulate their academic behavior. Similarly, Zimmerman (1990) observed that self-regulated learners tended to exhibit a high degree of effort and persistence during learning, and that they reported higher self-efficacy, self-attributions, and intrinsic motivation. Finally, students who found value in the mathematical tasks they were performing, tended to become self-regulating (Miller et al., 1996).

In order to help students' development of self-regulation, the teacher of the treatment sections in this study modeled and enforced ideas such as goal setting, progress review, and seeking feedback with each student. It was the intent of the teacher to improve motivation, and help students become more active and responsible learners, which would have an impact on their over-all mathematics achievement and attitudes towards the subject.

Instrumentation

One of the goals of this study was to assess the impact of a treatment on students' self-efficacy. The instrument that was used to assess students' self-efficacy both prior to and after the treatment, was a modified version of the Fennema-Sherman Mathematics Attitudes Scale (Fennema & Sherman, 1976). Other instruments were considered for this study, however, the Fennema-Sherman was chosen because of its popularity in mathematics education research over the last 30 years (Tapia & Marsh, 2004) and because it can be answered by college-level students. For the current study, the survey was modified to gather information on five of the nine dimensions of the original instrument. The first dimension is the "Attitude toward Success in Mathematics." This dimension measures the extent to which students anticipated negative or positive consequences resulting from success in mathematics. The second dimension, "Confidence in Learning Mathematics," measures students confidence in one's ability to learn and be successful in mathematics. The third dimension, "Effectance Motivation," measures how much students range from lack of involvement to active participation and seeking a challenge within mathematics. The fourth dimension measured on the survey is "Mathematics Usefulness." This category measures students' perceptions of their current and future mathematics and how useful they feel it will be in their lives. It can be argued that these dimensions are all related to self-efficacy theory, and are also influenced by attribution and self-regulation theory. As previously mentioned, self-efficacy is related to a person's confidence to perform a task (Bandura, 1986) and how resilient a person can be when confronted with obstacles or adverse situations (Pajares, 1996). Therefore, a student's motivation to persist in difficult situations can be affected by the student's level of confidence and their perception on how useful a task will be to their life. Thus, a student with low confidence, or the view that learning mathematics will have no effect on their future, could cause them to have less motivation toward achieving a goal.

The fifth and final dimension measured by the Fennema-Sherman Mathematics Attitudes Scale is the "Teacher Scale." These questions are intended to measure students' perceptions of their teachers' attitudes towards them as learners of mathematics, and includes areas such as teacher's interest, encouragement, and confidence in student's abilities (Fennema & Sherman, 1976). Both the domain of mother and father, as well as "Mathematics as a Male Domain" were omitted since they were not central to the questions intended to be investigated in this study.

The Influence of a Teacher

Learning theorists and researchers have suggested that a student's experience in a classroom can be one of the most important factors affecting that student's growth and success (Volkwein & Cabrera, 1998). In a computer-mediated environment, teachers play a small role in the students' cognitive learning since the software is the primary source of instruction. Therefore, teachers of these courses can vary considerably as to the amount of attention and support they provide their students. According to Kinney, Stottlemyer, Hatfield, and Robertson (2004), "the teacher's role in a computer-mediated class is to develop a course structure that promotes student success, to provide feedback to students regarding their understanding of the course content and progress in the class, and to provide individual or small group assistance as requested" (p. 15). Researchers have found that a computer-based classroom with no teacher interaction during the learning process has been found to be less effective than computer-based classrooms where teacher interaction is a critical part of the course (Hasselbring, 1986). Therefore, the way teachers approach and interact with their students could be considered a critical element of the classroom environment, especially if it is a computer-based environment.

As previously stated, the development of a productive disposition is a major factor in determining students' mathematical success. A productive disposition requires a student to view mathematics as useful, to believe that effort and perseverance can pay off, and to believe that one can learn and perform mathematical tasks (Kilpatrick, Swafford, & Findell, 2001). Teachers may provide structure, encouragement, and motivate students to keep a positive attitude toward mathematics in their classroom. Teachers who are encouraging, patient, and supportive can help students feel less anxious and have positive attributions with mathematics (Middleton & Spanias, 1999).

With encouragement comes the notion of care. According to Noddings (2001), the word *caring* can refer to an attitude or can describe a relationship. One can show that they care by encouragement, being attentive, receptive, and by showing support. Therefore a teacher that listens to his/her students, respects their interests, and shares their own wisdom with their students is thought to be a caring teacher (Noddings, 2001). Caring is not just an attitude. It is wanting what it best for your students and recognizing poor behavior and low achievement and conveying that message to the person (persons) you are caring for (Noddings, 2001). A caring teacher could convey this message by establishing clear and realistic expectations, and by getting to know their students on an individual basis so that they can assess where they are in their learning (Lumpkin, 2007).

Nodding's (2001) idea of caring is the main focus of this study. It is the intent of the investigator to try to create a warm, supportive, friendly, and safe environment to help foster student growth and achievement. It is the hope of the investigator that this caring and interactive environment will create positive attitudes, increase motivation, and show a significant increase in students asking for assistance and positive attributions toward mathematics in general.

In order to establish the idea of caring, it is important that the teacher learn what each students' individual attributions are, since developmental students often have more failures and negative feelings toward mathematics in their past than non-developmental college students (Higbee & Thomas, 1999; Ma & Kishor, 1997). Chapter Three outlines the methodology of this study and one aspect of the study was to interview some of the students individually and obtain an over-all sense of their feelings towards mathematics. Once the teacher can show this initial response of caring through an individual interview, this notion of caring can be carried through the rest of the semester. Giving positive feedback, motivating students, and setting personal goals, are teacher behaviors that might enhance students' self-efficacy, allow students to have more positive and internal attributions, and develop the use of self-regulation.

CHAPTER THREE: METHODOLOGY

The overall purpose of this study was to explore the effects of enhancing computer-based developmental mathematics classes with teacher initiated practices that provide a more caring and supportive experience for students. A quantitative experimental design was used to compare the effects of several specific instructional interventions on students' achievement and self-efficacy in mathematics. These comparisons were analyzed in two ways: comparing pre- and post- mathematics test scores, and comparing responses to a survey of student attitudes and beliefs that was administered at both the beginning and the end of the semester

Three sections of a developmental algebra course were assigned to a treatment involving monitoring, structure, feedback, and enhanced interaction, while the other three sections received the standard structure of the course, which did not involve regular daily check-ins, due-dates on homework, or one-on-one sessions with the teacher. The researcher was the teacher of record for all six sections. The data collected over a period of one semester included mathematics placement test scores, final test scores, two sets of responses on one attitude survey, and twelve sets of observation data on the amount and type of interaction that occurred in each class. The research setting, participants, and procedures are described in the first section of this chapter, while the data sources and data analysis are explained in the second half of the chapter.

Setting and Participants

The study took place in a computerized developmental mathematics course at a large university in the mid-Atlantic region. All of the participants involved in the study placed into this remedial mathematics course. The mathematics department at the university assigned students to this course based on their score on a mathematics placement test. The students who did not score well enough on the placement test for enrollment in a credited mathematics course were instructed to register for this developmental course. Slightly more than 96% of the students involved in this study took the placement test before the semester began. Almost all of the remaining enrollees were students whose self-assessment was that they would test into this course given the number of years that had passed since their last mathematics class. University policy specified that students who elect not to take the placement test be placed in this developmental course.

Students chose which section of the course they wanted to enroll, based on their semester schedule. The students had no prior knowledge of the instructor teaching their class, unless they registered within a week of the beginning of the semester. In this particular semester, over 87% of the students involved in this study registered for their mathematics course prior to the date on which instructors' names were released.

Total enrollment for all sections of this course was 357 students. The enrollment of the six study sections was 129, where 72 were assigned to the treatment classes and 57 were assigned to the control classes. Only two students in the treatment and five students in the control classes declined participation in the study.

The students enrolled in this course can be classified as a heterogeneous mix when considering their gender, age, class standing, race, and major. The student demographics of the study population as well as the other course population are summarized in the following table:

Table 1: *Student Demographic Information*

	Other Population N = 204	Study Population	
		Treatment group N = 70	Control group N = 52
Gender			
Male	38.7%	40.0%	28.8%
Female	61.3%	60.0%	71.2%
Class Standing			
Freshmen	76.0%	55.7%	46.1%
Sophomore	16.7%	25.7%	28.9%
Junior	6.8%	11.4%	23.1%
Senior	0.5%	7.2%	1.9%
Age			
Under 18	5.9%	2.9%	1.9%
18-20	75.5%	72.8%	65.4%
21-23	9.3%	10.0%	23.1%
24+	9.3%	14.3%	9.6%
Race/Ethnicity			
African American	39.7%	38.6%	44.2%
Asian	1.5%	4.3%	5.8%
Caucasian	30.9%	35.7%	34.6%
Other Latino	7.8%	4.3%	5.8%
Puerto Rican	2.5%	1.4%	1.9%
Other	3.4%	1.4%	1.9%
Foreign[a]	14.2%	14.3%	5.8%
Other Information			
Native Student	60.8%	52.9%	44.2%
Transfer Student	39.2%	47.1%	55.8%
Repeating the Course	8.3%[b]	12.7%	5.36%

[a]Students in this category responded to two or more races
[b]11.7% did not respond

At the beginning of the semester, each student was assigned to one of four instructional modules. Depending on their major, the students can prepare for one of the following credited courses: “Elementary Mathematical Models,” “College Algebra with Applications,” “Introduction to Probability,” or “Pre-calculus.” The credited course for which they are preparing determined their module. The modules were ranked in the given order to reflect the increasing number of needed skills and understandings and thus facilitate advising. In other words, if students prepare for an “Introduction to Probability” module and change their major to one that only requires the completion of “College Algebra with Applications,” those students can move “down” into that class since the “College Algebra” module is considered less demanding. However, if students prepare with the “College Algebra” module and later determine that they are required to take “Introduction to Probability” for their major, those students are not permitted to move up to that class unless they complete the “Introduction to Probability” module. The distribution of students enrolled in each module in each section of the course in shown in Appendix A.

Three of the participating sections, each populated by approximately 15 students, met in one computer lab, while the other three sections, each populated by approximately 30 students, met in a different computer lab. The class length was one hour and fifty minutes, and all sections met three times per week. The six sections involved in the study met during one of three time periods, 10-11:50 am, 12-1:50 pm, or 2-3:50 pm, with two sections of the course meeting at the same time. Within each time period, one of the two sections was randomly assigned to the treatment group and the other to the control group. The instructor (in this case the investigator) spent half of the class time with one class and then traveled to the other section where she spent the second half of the class period with the other group of students in the other section. Each participating section had its own teaching assistant (TA) present for the entire class period so assistance was always available even during the time the instructor was not present. The six teaching assistants included five undergraduates and one graduate student. Most of the teaching assistants were mathematics or mathematics education majors, however all were given the position since they had successfully completed at least two semesters of calculus and possessed good communication skills. Only two of the six teaching assistants were new to the course. The others had been teaching assistants in the course for more than two semesters.

The TAs and I had an opportunity to meet as a group prior to the first day of class. This meeting gave me the opportunity to give them the background and details of the study. The meeting was also the time for me to explain their role in the study and to get a sense of how they felt about participating in it. All of the TAs were interested in the study and agreed to their assigned roles. Their roles will be discussed in greater detail later in this chapter.

Computer Program and Class Policies

The *Lifetime Library* computer program was used in all classes (Liafail, Inc., 2006). The topics ranged from basic mathematics (e.g., addition and subtraction) to concepts and skills of intermediate algebra. The computer lab was only open to students taking this particular mathematics course, so no other students from the University were permitted in the lab. The computers were equipped with only the

Lifetime Library program, so that the use of the internet or other word processing programs was not a distracter for the students.

All but one of the students in the study followed the regular progression of topics in the course – elementary algebra through intermediate algebra. The one exception, a student who had a very limited mathematics background and struggled with the subject, followed the instructor's advice and started with the pre-algebra section of the computer program.

The computer program has instructional material organized into chapters. The students were provided with a module guide for all of the chapters they were required to master in order to complete the course. Modules contained anywhere from 41 to 57 different chapters. Each chapter included instruction, both in writing and with video segments, as well as interactive questions that provided the student with feedback as soon as a solution was entered. After a student finished a chapter, there were 10 practice problems from the chapter material that the students were required to complete before moving on to the next chapter. A student needed to obtain a score of 80% or higher in order to move on to the next chapter. If the student scored less than an 80%, they need to revisit the chapter and re-take the practice problems. There was one exception to this class standard. Some students in the class were preparing for a theoretical pre-calculus course and they were required to score 90% or higher on the computer exercises in order to progress. The computer provided the student with solutions to the practice problems so they could assess where they made their errors. After a student finished the material in what the program defined as a "book" (usually four chapters), and all of the associated practice problems, a book final test was given (five questions per chapter). The instructors focused most of their attention on monitoring the completion of book final tests, since the computer did not provide the students with hints or solutions in these tests. The instructors had access to computer records that detailed how long students spent on a test and how many times they took a test. If a student spent an extremely long amount of time on the book final test, or repeated it multiple times, an instructor would typically instruct the student to spend more time within the lessons and practice problems. Poor performance on a book final test was usually an indication that a student was not going through the program in the way that was intended.

The students were required to purchase a course workbook at the beginning of the semester. The course workbook contained homework exercises, approximately 10 supplemental lessons, suggestions on study skills, and review sheets for the three written exams. All the sections of this course used the same workbook. The workbook was written to follow the computer program. Students were encouraged to complete the homework exercises corresponding to the chapters they completed during their lab time. All students must have all of the required homework completed and turned in before they were permitted to take one of the three written pencil and paper exams for each module. The module guide that the students referred to everyday indicated when a student was ready, or eligible, to take a written exam. There were three intermediate written exams throughout the semester that had to be completed before a student was eligible to take the course final exam.

The grading system for all sections of this course was S (satisfactory) or F (fail). If a student completed the class with a 70% average or better, they were given an “S” for satisfactory and were granted eligibility into the credited mathematics course for which they were preparing. Final computation of grades was based on completion of all required chapters and practice tests on the computer (10%), class attendance (5%), homework completion (10%), scores on three written exams (45%), the score on a pre-final test, which was an older version of the university placement test (5%), and the score on a final written exam (25%).

The class was self-paced, so some students finished the course prior to the end of the semester. After a student had completed all required computer lessons, homework, and written exams, the student was eligible to take the final exam. The students did not have to wait until the official university final exam date at the end of the semester. In fact, students were permitted to take the course final exam as early as five weeks into the semester. Other students may need to enroll in the course for multiple semesters.

Procedures

Pilot studies conducted over two semesters, one in a fall semester and one in the spring, preceding the main study, helped shape the research procedures described below. It was important to conduct a pilot study in both fall and spring semesters since it has been observed that the number of students and background of the students are significantly different from one semester to the next. The studies revealed promising results. In both semesters that the pilot studies were conducted, the success rate of completing the developmental course in the treatment groups was higher than the control groups. In the spring semester pilot, it was also observed that the attendance rate of the treatment group at the end of the semester was more than 20% higher than that of the control group. Additional insights attained from the two pilot studies are noted in the remaining sections of this chapter and also detailed in Appendix B. The pilot findings helped shape the final procedures and the data sources that are described below.

Treatment Group

Within each time period, one of the two sections was randomly assigned to the treatment group and the other to the control group. For example, there were two 10-11:50 am sections, a treatment group that met in one lab and the second, a control group, that met in another lab. Thus, each of the three time periods had a randomly assigned treatment group and control group. The principal difference between the treatment and control instructional approaches was the extent to which the instructor and the teaching assistants initiated contact with students. The purpose of the contact was to evidence interest in the students and help structure the pacing of their work by checking on their daily and over-all progress on the computer-based materials and homework, providing encouragement, monitoring attendance, and giving specific instructional assistance and feedback beyond that which the computer program provided. All of this additional attention and structure was an attempt to enhance the students' sense of self-efficacy, foster high achievement, and help model how one might self-regulate.

In the treatment sections, I attempted to create a warm and personally supportive environment in numerous ways. For example, I began the personal touch treatment early in the semester by interviewing each individual student. The interviews provided me with the opportunity to get to know each student's mathematics background and helped me to identify any students who might need more attention than others. The interview questions (Appendix C) consisted of background information such as the types of mathematics courses previously taken and their degree of success in those courses. These questions allowed me to get an over-all impression of the students' attribution and sense of self-efficacy in relation to mathematics. Each initial interview lasted approximately 5-10 minutes, depending on how much the student was willing to share with me.

The students in the treatment group also received individual attention during each class period. I made sure to check-in with each individual student each day regardless of whether I was present for the first or second half of the class. In each encounter I asked how everything was going, checked their progress, gave positive feedback to those who were on track, and provided encouragement and suggestions to those who were falling behind. I also asked each student if they had any questions regarding the material they were learning or had previously learned. It has been my experience in this course that students tend to ask questions more readily when they are prompted by the instructor.

Attendance was closely monitored within the treatment groups. If a student had missed two class days without giving me prior notice of their absence, I sent an e-mail to the student to inquire about the absence. The e-mail provided me with the opportunity to let the student know that their absence did not go unnoticed and that attendance in the course was critical in order for them to complete the computer work and exams in one semester.

In one of the pilot studies performed, only four times out of a total of 14 e-mail contacts made after absences did a treatment student not return to class the next day or contact me after an e-mail was sent to them regarding their missed classes. This result made me realize that e-mail contact was an efficient and effective way of letting the student know that I cared about their performance, and similar observations were reported in a study by Jacobson (2005).

The participants of the treatment group were also required to review each day's progress with the teaching assistant or me before leaving the classroom. This gave us the opportunity to monitor the individual student's progress and give a small amount of feedback to them as they left for the day. In this review, each student was given an appropriate homework assignment and reminded of any homework due dates. This check-out routine was carried out to reflect Smittle's (2003) belief that "developmental students need to know exactly what is expected of them and when it is due" (p. 11). The guideline for assigning homework was once the student had completed the computer lessons for a book, the student had two class days to turn in the homework required for that book (a book of homework usually covered four chapters of material). If a student was struggling with a homework assignment and asked questions about it, I gave them the option of an extension until the next class period so that they could have more time to work on it. An extension was only given if the student approached us with their questions. I did not announce to the class at any time during the semester that an extension could be received. This was to benefit only the students who were working diligently on their homework, not to reward someone who simply "did not do it." In general, all sections of the course required students to hand in all homework before they take a written exam; however, in all non-treatment sections, no due dates were given.

The assignment of due dates was an attempt to provide the students with structure and give the students an opportunity to self-regulate their learning by developing the skill of pacing their work (Smittle, 2003). This same idea was used in the pilot treatment sections. In the pilot studies I gave the treatment students due dates, but did not give the control students such dates. I observed that the students who did not receive due dates, procrastinated, and turned in their homework at the very last opportunity. This resulted in more unanswered questions and lower homework averages than those of the treatment students.

I provided four mini-lectures to the treatment group students on topics that experience has shown to be particularly troublesome. Each mini-lecture was presented at that point in the semester when most students had studied the material prior to the lecture so they had some exposure to the topic. These mini-lectures lasted approximately 20 minutes and were held at the chalkboard in each lab. The students were encouraged to bring questions and work through some problems with the instructor. The instructor would usually present a short 10 minute presentation on the topic while working through a problem or two. Students were then given an opportunity to work on a problem or two on their own. The students were allowed to interact with one another and shared their solutions as a group. All students had these mini-lectures lessons typed up in their course workbook. The students in the treatment group were able to view the supplemental instruction in their books as well as at the board with the instructor.

Students were seated at a computer in a section along with students assigned to the same module. On the second day of class, seats were assigned so that those students who were placed in the same module were seated close to one another. It was the hope of the teacher that students working within the same module would interact with one another if they were seated in the same area. Some students did sit in that same area of the computer lab throughout the semester, while others moved into other areas. The seating assignment was not enforced.

The students in the treatment group had the opportunity to review their written exams with me on an individual basis. Self-efficacy theory suggests that students need feedback on their learning progress and when feedback is positive, this can result in an increased sense of their ability to master learning tasks (Bandura, 1997). Since developmental students tend to doubt their skills and have a lower self-efficacy, giving immediate feedback is essential for this population (Smittle, 2003). In this review I was able to describe in detail where the student errors occurred and suggested some ways to improve their knowledge on the particular topic before they took the course final exam. The individual sessions provided me with another opportunity to discuss the student's progress in the course, explore the student's study habits, and give suggestions on some strategies that might be helpful to improve (if necessary). Each test review lasted approximately 5-10 minutes.

The pilot studies provided me with guidance for this study. I learned that tracking interactions with over 100 students can be quite overwhelming, so I needed to keep a record of the interactions I had with each student. These records allowed me to keep track of which students had taken tests and if they did or did not review their test. Not all students requested the results of their exams, so for the treatment participants in particular, I had to be careful to track them down and discuss their results with them.

Finally, the students in the treatment groups received feedback on their pre-final exam. Before the student took the course final exam, I sent the student an e-mail listing any topics that the student showed weakness on in the pre-final exam. This e-mail gave the student an over-all sense of how prepared they were for the final.

The role of a TA assigned to a treatment section was to mimic the strategies the instructor used. They were encouraged to initiate any kind-of contact, whether math related or not, and also instructed to maintain an open and friendly environment as much as they could. I also asked the treatment group TAs to keep me informed on any students who were struggling when I was not in the classroom. We usually had a brief meeting before or after each class to discuss any issues that were occurring in the classroom.

Control Group

The students in the control groups were expected to rely more heavily on the computer instruction, unless assistance from myself or the TA was requested. There were no attempts to be cold or unfriendly in any of these sections. The TAs for these groups had explicit instructions not to be unpleasant in any way. However, we did not make an effort to initiate substantive personal or academic interaction with the students beyond those the students specifically requested or were required. The TAs of a control class were instructed to walk around the classroom in order to be seen without making initial contact with the students. If a student were to ask the TA a question, the TA was to help the student in any way possible. The control students were responsible for initiating all contact in the class. If the student asked for assistance on a problem, we were fully responsive as requested. No student was ever denied assistance.

The syllabus given out to all students on the first day of class contained my e-mail address and the projected dates for written tests. All students were encouraged to contact me if they had to miss a class and to keep the written test dates in mind in order to complete the course within one semester. On occasion, a broadcast was sent out to the students through their computers to remind them of the upcoming test dates outlined in their syllabus.

The students in this group were not interviewed individually, I simply had them fill out the standard class questionnaire. A daily check-in was not performed every day, as opposed to the treatment group. Most days I would walk around the classroom and observe which book they were working on. Only when the students were close to taking a written exam would I ask them when they intended on setting up the exam date and inquire about the amount of homework they had completed. This was the only time I initiated contact with the individual student.

The students' absences and tardiness were documented, but I never approached any of the students regarding any failure to attend class. The students were not contacted by e-mail about their attendance. However, if a student did contact me with a reason for an absence, this was recorded.

The students were allowed to leave the class without checking out with me and showing me their day's progress. I, or the TA, was always available to answer any questions as they left the room, but we made sure not to approach the students about their day's work. They were also not given due dates for their homework. They were occasionally reminded that all homework must be turned in before a written exam and they were also reminded that they could not turn in an excessive amount of homework to the TA at one time.

These groups did not have any mini-lectures during class. Every lecture that I provided to the treatment participants was written up in their course workbook. A reminder was announced several times during the semester to read the supplemental material provided in their homework book, for it might provide more insight on or a different approach to the more difficult concepts.

Following the completion of a written exam, I worked out, directly on the exam paper, the questions the student had missed and allowed the student to see their errors. I did not discuss any details of the exam one-on-one unless the student asked a specific question about their errors or the corrections I had made. I also did not provide feedback on the pre-final exam unless a student asked me specifically about their results. For the majority of the students, I simply told them whether they showed improvement or not from the beginning of the semester. If the students had any more specific questions, I was more than happy to answer them.

Data Sources

The pilot studies, conducted over two previous semesters, provided information about the need for additional data. The main purpose for piloting this study was to perfect the research methodology and to become aware of any difficulties that may arise. I learned several things from these two pilots. The most important thing I learned was the need for outside observers to come in and document any interaction that was occurring within the classroom, especially during the time I was not present. This helped for three reasons; first, it allowed me to see how much interaction was taking place. When I kept a tally of my own interactions during class (in the pilot studies), I would sometimes forget to jot down when a student asked me a question because I was so involved with the students, not thinking about the check-sheet I had in my hands. Second, an outside observer was able to witness the types of interactions that were occurring. It allowed me to expand on the observer checklist (Appendix D). Finally, having an observer in my class provided feedback on my behavior as well as my TA's behavior. If the observer witnessed me initiating a great deal of interaction with my control group (or my TA), I was able to address that issue. Therefore, the first data source, observations, was to help monitor the implementation of the intended treatments.

The observer checklist (Appendix D) was completed once a week over the course of the semester (for 12 of the 15 weeks) by one of three graduate research students. They observed a randomly chosen class (from among the six) for the entire duration, and kept a tally on how much interaction was involved in a specific category while I was present and while the TA was on their own. An observer recorded a tally when a student or I initiated contact. If a student or I asked multiple questions in one encounter, this was still recorded as one tally or one interaction. The observers had no contact with any of the students, they just recorded the behaviors they witnessed. The purpose of collecting this data was to help in checking the fidelity of implementation for the treatment, to record the amount of interaction happening in each of the classes, and to also control for TA interaction.

A second data source was the students' university mathematics placement test scores (generally taken before a student's initial semester on campus). A student's placement scores were obtained from the mathematics department once written permission was granted by the student. These placement test scores were collected in order to be compared to the pre-final exam scores, which was the third data source. The pre-final exam was merely a parallel form of the placement test, so pre- and post-test scores were comparable.

The fourth data source was the student background information sheet (Appendix E). This data provided by the students on the first day of class allowed me to make comparisons within and among groups in terms of gender, race, major, math background, and class standing. I was also able to use this information to find out if a student was repeating the course or not and if they were a native student to the university.

The fifth and sixth data source came from a modified version of the Fennema-Sherman Mathematics Attitude Survey (Appendix F) that students were asked to fill out at the beginning of the semester and once again at the end of the semester. The survey was modified to gather information on five of the nine dimensions of the original instrument. As previously mentioned in Chapter Two, the dimensions being measured in this study included the following scales:

Attitude toward Success in Mathematics,

Confidence in Learning Mathematics,

Effectance Motivation,

Mathematics Usefulness, and

Teacher Scale.

The survey was given once at the beginning of the semester and then again at the end of the semester (or when a student finished the course). The survey allowed me to explore which aspects of student attitude were affected differently by the treatment and control instructional scheme.

To summarize, I have outlined the previous section in Table 2.

Table 2: *Purposes of Data Sources*

Data Source	Purpose
Instructor/Student Interaction Check-list	To measure the amount and types of interaction occurring between the treatment and control groups
Placement Test Scores	To measure initial student achievement
Pre-Final Exam	A parallel from the Placement Test given to measure achievement when the student had completed their required module and written exams.
Student Background Information	To document the demographics and mathematics background of the students in my sections
Fennema-Sherman Attitude Survey	To measure students' self-efficacy at the beginning of the course and when the student has completed their required module and written exams. (Note: The end of the course survey contained six additional questions, and one open-ended question pertaining to the different aspects of this course to get an understanding of their feelings toward the teacher and class in this particular semester.)

Data Analysis

The graduate research students came to the computer lab to make observations once per week over a twelve week period. The observations were intended to serve two purposes. First, the observers' feedback afforded me the opportunity to check in on both my TA's, and my interaction. If an observation revealed that I was being too interactive with my control group, it allowed me to adjust my involvement. Likewise, if a TA was not providing enough interaction in a treatment group, or if a TA was initiating too much interaction in a control group, this weekly check allowed me the opportunity to consult with the TA. Second, the observations intended to document the activity being produced by the students. The observations showed that there was a clear distinction between the two treatments that were given to the participants of the study.

The second and third data sources analyzed were the students' pre- and post-placement test scores. The scores were analyzed using a repeated measure ANOVA design using a treatment and control factor. The design is mixed in that it has one between-subject factor (treatment vs. control) and one within-subject (or repeated measure) factor (pre-test vs. post-test). This analysis allowed me to compare the achievement gained between each group as well as observe any interactions in the pre- and post-test scores within the treatment and control groups. The scores were also analyzed taking a students' module into consideration to determine whether any significant differences occurred between the two groups because of the differences in module representation. By introducing module, this created a mixed design with two between-subject factors along with the same one within-subject factor.

The remaining data sources came from the responses on the modified version of the Fennema-Sherman survey. A test of reliability for the instrument was performed using a Pearson correlation. The survey reliability resulted with Pearson correlation of 0.599, which is significant at the 0.01 level. The survey was coded from -2 (strongly disagree) to 2 (strongly agree). Since some of the items were negatively worded, for example, "Math is not important in my life," the values of these items were negated so that if a student answered "strongly disagree" which would normally receive a value of "-2," this was negated to a "+2." This way, when the results were analyzed, the answers had consistency.

A mixed, repeated measure design was also conducted on this data. First the data was separated into the five dimensions (attitude, confidence, motivation, usefulness, and teacher) and dimensions scores were obtained and analyzed. Second, the total survey was analyzed using a repeated measure ANOVA. This allowed me to analyze the entire instrument and make comparisons between the two groups.

Timeline

The table listed below is the actual timeline for this study:

Table 3: *Timeline of Study*

Task	Date
Assignment of sections to treatment/control	8/28
Training of TAs	8/28
Administer Fennema-Sherman survey	8/29
Request student participation in study	9/5 – 9/7
Obtain initial placement test scores	9/10
Interview treatment students	9/10 – 9/21

Task (cont).	Date (cont.)
Monitor implementation including observations by graduate students	Weekly between the 3rd-14th week of classes
Administer post Fennema-Sherman and give post placement test (to obtain second placement test score)	Student's second to last day of class (if they finished early); otherwise, last day of class (12/10)*

*Note: Students who did not finish course requirements (3 written exams) prior to the last day of class completed only the post-survey on the last day of class (they did not take the post-placement test)

CHAPTER FOUR: RESULTS

The purpose of this study was to test the hypothesis that enhanced teacher interaction in a computer-based, developmental mathematics course would have a positive effect on student achievement and sense of self-efficacy in mathematics. This chapter provides evidence that the treatment with enhanced teacher interaction occurred as intended and an analysis of the impact of that treatment on student achievement and attitudes.

Observation Results

In order to document the actions of the course teacher and teaching assistants, three graduate research assistants observed randomly selected treatment and control classes over a twelve week period. Each individual class was observed on two different dates for the entire length of the class. The observers did not have contact with anyone in the classroom, they simply recorded the amount and type of teacher-student interaction on an observer checklist (Appendix D).

The rate of teacher-student interaction (the number of occurrences/the number of students present) was calculated for each of six categories: (1) personal contact; (2) responding to a mathematics related question; (3) responding to a non-mathematics related question; (4) following up on mathematics understanding; (5) following up on mathematics goals; and (6) teacher initiated content questions to struggling students. The personal contact with the treatment groups occurred at the beginning of the class or when the teacher arrived to the class. This contact usually involved asking the students how they were doing (in general), and following up on personal matters (i.e., winning a game, feeling better from illness, etc.). In the control groups, the teacher tried to limit such interaction by responding to a student's greeting only if the student initiated it. The fourth, fifth, and sixth categories (as listed above) were also interactions that the teacher tried to utilize in the treatment groups. The teacher, along with help from the TA, made note of struggling students and the areas in which they struggled, and attempted to follow-up on their difficulties with them individually. This would include asking a student for understanding on a specific topic, and if necessary, sitting down with them at their work station for a review and a check for comprehension. All students, struggling or not, had several opportunities during the semester to re-assess their goals for the class with the teacher. Table 4 and Figure 1 detail the rates of interaction in the treatment and control classes.

Table 4: *Rate of Classroom Interaction*

Type of Interaction	Treatment Group	Control Group
Personal Contact	0.735	0.124
Responding to a student's content related question	2.479	1.640
Responding to a student's non-content related question	0.909	0.871
Follow up to a student's questions (Content related)	0.350	0.127
Follow up to a student's question (Non-content related)	1.608	0.407
Teacher initiating content questions	0.438	0.109

The attendance patterns of both the control and treatment group can be found in Appendix G. The patterns were very similar to each other, therefore, the number of students present in each group were consistent with one another. And taken together with the data in Table 4, the attendance suggests that comparable groups of students were present to receive the intended treatment.

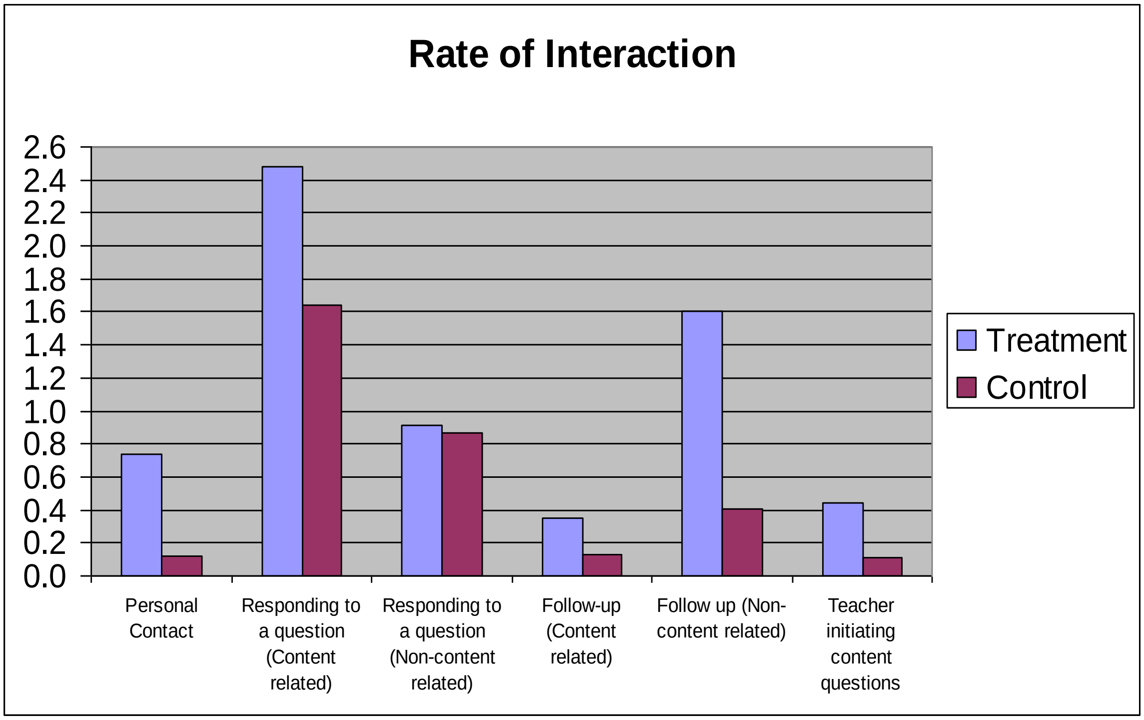

Figure 1: *Rate of Classroom Interaction*

The observation data confirm that in the categories where the teacher was initiating contact (i.e., personal, follow up, content questions), the rate at which the teacher would make such contact with the students in the treatment group was three or more times that of the rate in the control group. The two categories that involved "responding to a question" were categories in which the students were in control of the rate of interaction. Similar to the results of the teacher-initiated interaction categories, the number of questions students asked in the treatment group was higher than the number of questions students asked in the control group. It can be argued that the students in the treatment group felt more comfortable asking questions concerning either the content of the course or other class related matters, than did the students in the control groups.

The data provides evidence that the treatment outlined in Chapter Three was in fact enacted. The results of both the pre- and post-achievement test and attitude survey will be described in the rest of this chapter.

Research Question 1

Does teacher initiated interaction affect students' mathematics achievement?

The study participants had completed the university's mathematics placement test prior to the first day of class and took a parallel form of that test at the end of the semester. Only the scores of those students who took both the placement test before the beginning of the semester and completed the course were analyzed. Therefore, the treatment group consisted of scores from 59 (of 70) students and the control group consisted of scores from 49 (of 52) students.

The placement test consisted of three different sections. The first section tested students' understanding and skill in arithmetic, the second section was a test on elementary algebra, and the third section consisted of intermediate algebra questions. The student scores are reported by section, so the achievement of the treatment and control groups could be compared on the three individual sections as well as on a total score.

The scores were analyzed using a repeated measure ANOVA. The analysis was a mixed design with the between-subject factors being the treatment and control groups, and the within-subject factors consisting of pre-test and post-test scores.

Overall Test Score Results

The descriptive statistics show that the mean total score of the pre-test for the control group was 19.143, where the treatment group's average was 18.610. The maximum number of possible points for the entire test was 52. The mean total score of the post-test for the control group participants was 29.939, and the treatment group's mean total score was 28.864. Conducting a split-plot repeated measure ANOVA revealed, through the test of the two-way interaction, that the pre-post change did not differ statistically significantly across groups (p = 0.666). These results are shown in Tables 5 and 6.

Table 5: *Descriptive Statistics for Total Scores*

	Class	Mean	Std. Deviation	N
Pre-test Total	Control	19.143	5.6310	49
	Treatment	18.610	5.4489	59
Post-test Total	Control	29.939	5.5430	49
	Treatment	28.864	6.7580	59

Table 6: *ANOVA for Pre- and Post-Total Scores*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre/Post Test	5930.686	1	5930.686	283.615	.000
Pre/Post * Class	3.927	1	3.927	.188	.666
Error	2216.573	106	20.911		

Arithmetic Score Results

The first part of the mathematics test assessed proficiency with arithmetic procedures. Although most of the material covered in this particular course was algebraic, some arithmetic skills were taught within the computerized course material (e.g., order of operations). A maximum of 11 points could be obtained in this section of the test. The mean part one score for the control group in the pre-test was 8.082, where the treatment group's mean part one score was 7.424. The mean part one score on the post-test for the control group was 8.163, and the treatment group had a mean of 8.203. Although the treatment group did have a greater gain than the control group, the difference between the pre- and post-test scores was not significant between the two groups ($p = 0.107$) at the $\alpha = 0.05$ level. Tables 7 and 8 detail the statistical results.

Table 7: *Descriptive Statistics for Part One Scores*

	Class	Mean	Std. Deviation	N
P1 Pre-test	Control	8.082	1.778	49
	Treatment	7.424	2.191	59
P1 Post-test	Control	8.163	1.841	49
	Treatment	8.203	1.873	59

Table 8: *ANOVA for Pre- and Post-Test Scores (Part One)*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-P1 vs. Post-P1	9.929	1	9.929	4.034	.047
Pre/Post-P1 * class	6.521	1	6.521	2.650	.107
Error	260.905	106	2.461		

Elementary Algebra Score Results

The second part of the mathematics placement test included 18 questions related to elementary algebra. All of the students in the course had the same exposure to the elementary algebra topics within the computer assisted material, with the exception of a few topics. Although the module A students, the students who have chosen majors not requiring mathematics beyond the university requirement, are not required to complete the lessons on some topics (e.g., completing the square, imaginary numbers), they were not at a disadvantage on the post-achievement test as these topics did not appear on the test.

The results of the scores indicate a mean part two pre-test score of 5.837 for the control students and 5.831 for the treatment participants. For the post-test of this section, the control group had a mean score of 11.490, while the treatment group had a mean score of 11.051. The ANOVA analysis indicated that there was no significant difference between the two groups ($p = 0.466$) at the $\alpha = 0.05$ level. Tables 9 and 10 detail the results of the statistical analysis.

Table 9: *Descriptive Statistics for Part Two Scores*

	Class	Mean	Std. Deviation	N
P2 Pre-test	Control	5.837	2.649	49
	Treatment	5.831	2.780	59
P2 Post-test	Control	11.490	2.161	49
	Treatment	11.051	2.642	59

Table 10: *ANOVA for Pre- and Post-Test Scores (Part Two)*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-P2 vs. post-P2	1582.432	1	1582.432	337.760	.000
Pre/Post-P2 * class	2.506	1	2.506	.535	.466
Error	496.619	106	4.685		

Intermediate Algebra Score Results

The third and final section on the mathematics achievement test contained 23 questions on topics from intermediate algebra. Of the three test sections, this section contained the most variation in scores, since the exposure students had to intermediate algebra topics varied by their chosen module. A student in one of the upper modules (B, C, or D) can be expected to score higher than a student studying in module A. Therefore, it was important to compare the percent of students in the treatment and control groups by module. Table 11 details the module distribution of the students completing the course (the students who took the post-achievement test) and whose test scores were represented in the analysis.

Table 11: *Module Distribution of Students Analyzed in Achievement*

	Treatment		Control	
	Frequency	Percent (%)	Frequency	Percent (%)
Module A	10	16.9	13	26.5
Module B	12	20.3	13	26.5
Module C	6	10.2	4	8.2
Module D	31	52.5	19	38.8

The percent of students in module A and D had a larger difference between the two groups than those in module B and C. To make sure that the lower percent of module A's did not give the treatment group an advantage and therefore result with a significant difference in test scores on this section, a 2x4x2 repeated measure ANOVA was performed to confirm any significance within the modules. The between subjects variables were the two groups (treatment vs. control) and the four modules. The within subjects variables were the pre- and post-tests. The repeated measure ANOVA confirmed that there was no significant difference on the pre- and post-test scores among the modules ($p = .198$) or between the two groups ($p = .744$) at the $\alpha = .05$ level. Therefore, a student's module had no significant effect on the group they were in. (The results are detailed in Appendix H.)

The descriptive statistics for each group indicate that on the pre-test for part three, the mean of the control population was 5.225 and the mean for the treatment population was 5.356. For the post-test, the mean of the control group was 10.286 and the mean of the treatment group was 9.610. An ANOVA analysis concluded, at

$\alpha = 0.05$ level, that differences of the two group means were not statistically significant ($p = 0.356$). The results are represented in Tables 12 and 13.

Table 12: *Descriptive Statistics for Part Three Scores*

	Class	Mean	Std. Deviation	N
P3 Pre-Test	Control	5.225	4.214	49
	Treatment	5.356	2.802	59
P3 Post-Test	Control	10.286	3.536	49
	Treatment	9.610	3.686	59

Table 13: *ANOVA for Pre- and Post-Test Scores (Part Three)*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-P3 vs. Post-P3	1161.457	1	1161.457	114.418	.000
Pre/Post-P3 * Class	8.716	1	8.716	.859	.356
Error	1076.001	106	10.151		

Research Question 2

Does teacher initiated interaction have any effect on students' sense of self-efficacy?

The participants in both groups answered a 62 question attitude survey, a modified Fennema-Sherman Attitude Scale, on the first day of the semester. Only the students who agreed to participate in the study and who were still present at the end of the semester (or took their final exam early), were asked to answer the same 62 item attitude survey along with six additional course Likert Scale type questions and one open-ended question (see Appendix F). The total number of surveys completed by the treatment participants was 58, while the total completed by the control participants was 44. However, since some of the participants left a question unanswered here and there, the number of surveys analyzed will be different in each analysis.

The modified Fennema-Sherman Attitude Survey was coded from -2 (strongly disagree) to 2 (strongly agree). Since some of the items are negatively worded, for example, “Math is not important in my life,” the values assigned to responses for these items were negated so that if a student answered “strongly disagree” which would normally receive a value of “-2,” this was negated to a “+2.”

The survey was analyzed as a whole, as well as by the five different dimensions. These dimensions included attitude toward success in mathematics, effectance motivation, confidence in learning mathematics, mathematics usefulness, and teacher. The following tables (14- 18) describe the questions and item numbers contained in each dimension.

Table 14: *Attitude Toward Success in Mathematics Survey Items*

Item no.	Statement
3	It would make me happy to be told I was an excellent math student.
7	It would make people like me less if I were a really good math student.[a]
8	I don’t like people to think I am smart in math.
10	If I had good grades in math, I would try to hide it.[a]
15	It would be really great to win a prize in math.
16	If I got the highest grade in math I wouldn’t want anyone to know.[a]
28	It would be great if other people thought I was smart in math.
29	Winning a math prize would make me feel uncomfortable.[a]
46	People would think that I was a student who worked too hard if I got high grades in math.
47	I would be proud to be first in a math contest.
54	I’d be happy to get top grades in math.
61	I’d be proud to be the outstanding student in math.

[a]Statement was reverse coded (-2 = Strongly Agree, -1 = Agree, 0 = Undecided, 1 = Disagree, 2 = Strongly Disagree).

Table 15: *Effectance Motivation Survey Items*

Item no.	Statement
1	I like mathematics.
2	Math is very interesting to me.
6	I like to work on math problems I can't understand immediately.
11	The challenge of math problems does not appeal to me.[a]
12	If I can't solve a math problem right away, I stick with it until I do.
23	I think about unanswered questions after math class is over.
26	I do as little work in math as possible.[a]
27	I don't understand how people can enjoy spending a lot of time on math.[a]
30	Figuring out math problems does not appeal to me.[a]
35	Once I start trying to work on a math puzzle, I find it hard to stop.
37	Math puzzles are boring.[a]
44	Math is fun and exciting.
56	I would rather have someone give me the solution to a hard math problem than to work it out for myself.[a]
58	I like math puzzles.

[a]Statement was reverse coded (-2 = Strongly Agree, -1 = Agree, 0 = Undecided, 1 = Disagree, 2 = Strongly Disagree).

Table 16: *Confidence in Learning Mathematics Survey Items*

Item no.	Statement
4	I think I can handle more difficult mathematics.
5	I know I can do well in math.
13	I am sure that I can learn math.
24	I am sure of myself when I do math.
32	Most subjects I handle o.k., but I just can't do a good job with math.[a]
33	Math has been my worst subject.[a]
36	I can get good grades in math.
38	Math is hard for me.[a]
42	I'm not the type to do well in math.[a]
43	I don't think I could do advanced math.[a]
50	I am sure I can do advanced work in math.
60	I'm no good in math.[a]

[a]Statement was reverse coded (-2 = Strongly Agree, -1 = Agree, 0 = Undecided, 1 = Disagree, 2 = Strongly Disagree).

Table 17: *Mathematics Usefulness Survey Items*

Item no.	Statement
9	Doing well in math is not important for my future.[a]
17	I'll need a good understanding of math for my future work.
19	I don't expect to use much math when I get out of school.[a]
20	I will use mathematics in many ways as an adult.
25	Math is not important for my life.[a]
34	I see mathematics as something I won't use very often when I get out of college.[a]
40	I study math because I know how useful it is.
45	I'll need mathematics for my future work.
52	Taking math is a waste of time.[a]
53	Knowing mathematics will help me earn a living.
55	Math is a worthwhile and necessary subject.
57	Math will not be important to me in my life's work.[a]

[a]Statement was reverse coded (-2 = Strongly Agree, -1 = Agree, 0 = Undecided, 1 = Disagree, 2 = Strongly Disagree).

Table 18: *Teacher Scale Survey Items*

Item no.	Statement
14	I have had a hard time getting teachers to talk seriously with me about math.[a]
18	It's hard to get math teachers to respect me.[a]
21	I feel that math teachers ignore me when I talk about something serious.[a]
22	Math teachers have made me feel that I have the ability to go on in mathematics.
31	My teachers have been interested in my progress in math.
39	My teachers have wanted me to take all the math I can.
41	My teachers have thought that I am the kind of person who could do well in math.
48	My teachers think that advanced math will be a waste of time for me.
49	My teachers have encouraged me to study more math.
51	I would talk to my math teachers about a career which uses math.
59	My teachers would not take me seriously if I told them I was interested in a career in science and mathematics.[a]
62	Getting a teacher to take me seriously in math is a problem.[a]

[a]Statement was reverse coded (-2 = Strongly Agree, -1 = Agree, 0 = Undecided, 1 = Disagree, 2 = Strongly Disagree).

The statistical results of the repeated measure ANOVA of all six analyses will follow, with an overall summary to conclude.

Total Attitude Survey

The total survey consisted of 62 questions. Twenty nine students in the control group and 36 students in the treatment group answered every question, therefore only their results were in the statistical analysis. The potential range of scores for the 62 question survey is -124 to +124. Tables 19 and 20 illustrate the results for the total 62 question survey.

Table 19: *Descriptive Statistics for Total Attitude Survey*

	Class	Mean	Std. Deviation	N
Pre-Total	Control	21.897	26.991	29
	Treatment	13.694	35.950	36
Post-Total	Control	28.862	24.839	29
	Treatment	21.361	33.870	36

Table 20: *ANOVA Results for Total Attitude Survey*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre- vs. Post	1719.394	1	1719.394	12.956	.001
Pre/Post * Class	3.948	1	3.948	.030	.864
Error	8360.483	63	132.706		

Total Survey Results

The descriptive statistics for the total survey indicate that the control group had a mean score of 21.897 for the first survey and a 28.862 for the second survey. The treatment group, on the other hand, had a mean of 13.694 for the first survey and a 21.361 for the second survey. The results of the repeated measure ANOVA analysis for the total survey show that there was no statistically significant difference between the two groups. With $\alpha = 0.05$, the p-value was 0.864.

Dimension Results

The following section separates the total survey into five separate dimensions and shows the results for each dimension. Table 21 outlines the descriptive statistics for the five dimensions.

Table 21: *Descriptive Statistics for the Five Attitude Dimensions*

	Treatment Group			Control Group		
	Mean	Std. Deviation	N	Mean	Std. Deviation	N
Attitude Toward Success						
Pre-total	8.216	4.268	51	9.659	4.794	41
Post-Total	8.745	4.707		9.610	4.770	
Effectance Motivation						
Pre-Total	-.922	12.23	51	-.590	9.904	39
Post-Total	-1.510	10.314		1.026	10.579	
Confidence in Learning						
Pre-Total	-.292	11.030	48	2.341	9.611	44
Post-Total	2.354	9.318		4.705	8.846	
Usefulness of Mathematics						
Pre-Total	6.377	10.685	53	7.805	9.770	41
Post-Total	6.623	9.161		8.000	8.062	
Teacher Scale						
Pre-Total	5.196	6.636	51	6.262	5.700	42
Post-Total	5.961	7.985		8.238	5.378	

The statistical repeated measure ANOVA analysis for each individual dimension can be found in Appendix I.

Attitude Toward Success Dimension

The 12 questions in this dimension investigated the feelings that students had toward being a successful mathematics student. The questions varied from how a student feels about being successful (e.g., getting good grades, winning a math contest, etc.) to how their peers might judge them based on their success. The range of responses could be from -24 to +24. The repeated measure AVOVA revealed that there was no statistical difference (p = .459) between the treatment and control groups on this dimension of attitude.

Effectance Motivation Dimension

The second dimension of the attitude survey focused on effectance motivation. The 14 questions in this dimension can be viewed as an assessment of a student's motivation toward the field of mathematics. The different questions focused on students' interest in the field of mathematics, as well as their persistence on working through challenging tasks. The responses could range from -28 to +28. The statistical repeated measure ANOVA indicated no significant difference (p=.107) between the two groups on this dimension of attitude.

Confidence in Learning Mathematics Dimension

The third dimension contained 12 questions aimed at investigating the students' confidence in mathematics. The questions focused on students' confidence in handling more difficult mathematics classes and tasks, along with their confidence on getting good grades and understanding the subject. The range of points that could occur in this dimension is from -24 to +24. The statistical ANOVA analysis indicated that there was no significant difference (p = .829) between the two groups on this dimension of attitude.

Usefulness of Mathematics Dimension

The fourth dimension of the attitude survey focused on students' perception of how useful mathematics will be for their everyday lives. This is similar to the concept of task value that was introduced in Chapter Two. The 12 questions in this dimension probed the degree to which the student thinks mathematics is worthwhile, being successful in the subject is important, and that mathematics will be used in their future career and everyday living. The range of points that could occur in this dimension is -24 to +24. There was no statistically significant difference (p = .969) between the treatment and control groups on this dimension of attitude.

Teacher Scale Dimension

The fifth, and final dimension is the Teacher Scale. The purpose of these 12 questions was to get a better understanding of the students' perception of their teachers. The questions focused on how much encouragement and interest their past teachers have had in their mathematics ability, progress, and future work. The range of points that could occur in this dimension is from -24 to +24. The statistical analysis indicated that there was no significant difference (p = .225) between the two groups on this dimension of attitude.

Additional Questions

The participants who filled out the end-of-the-semester survey were also asked six additional questions and one open-ended question that pertained to this specific course. Since the questions in the survey, especially those relating to teacher, can be answered with any past teacher in mind, the additional questions were specific to the teacher/TA of this course. The results indicate that the treatment group responded slightly higher compared to the control group on questions 65 and 68, however, after performing an independent t-test, no statistically significant difference between the two groups was found among the six questions The results are shown in Tables 22, 23, and 24.

Table 22: *Comparing Means of Additional Questions Added to Attitude Survey*

	Treatment		Control	
Question No.	Mean	N	Mean	N
63. Learning from a computer improved my overall algebraic understanding.	0.220	59	0.457	46
64. The ability to move at my own pace made me feel comfortable in this class.	1.203	59	1.327	46
65. The amount of interaction with the teacher was critical to my success.	1.000	59	0.913	46
66. I feel I am prepared for my credited math class.	1.138	58	1.239	46
67. I felt comfortable asking my teacher questions.	1.407	59	1.413	46
68. This math class has been a good experience.	1.339	59	1.217	46

Table 23: *Independent t-test Results for Additional Questions*

Question No.	t	df	Sig,(2-tailed)	Mean Difference
63.	.975	100.079	.332	.236
64.	.715	99.679	.476	.12270
65.	-.449	88.102	.654	-.087
66.	.663	97.579	.509	.101
67.	.042	89.376	.967	.006
68.	-.719	88.247	.474	-.122

Table 24: *Results of Open-Ended Question (What was most helpful?)*

	Treatment		Control	
	Frequency[a]	Percent	Frequency[a]	Percent
Self-pacing of course	20	37.0%	18	40.9%
Computer program	11	20.4%	12	27.3%
Workbook/Homework	2	3.7%	3	6.8%
Teacher/TA	24	44.4%	21	47.7%
Lectures [b]	3	5.6%		

[a] Some students had multiple responses that fell in 2 or more categories

[b] Lectures were only provided to the treatment group.

CHAPTER 5: SUMMARY AND DISCUSSION

The intention of this study was to explore the effects of enhanced teacher-student interaction in a computer-based developmental mathematics course on students' achievement and self-efficacy in mathematics. This study drew on research from developmental education, self-efficacy theory, attribution theory, and self-regulation theory to identify cognitive and affective factors likely to influence learning in this particular student population. The investigator designed and developed an experimental teaching treatment to optimize application of insights from the literature. The effectiveness of the experimental treatment was tested by analyzing pre- and post-mathematics achievement scores and pre- and post-self-efficacy scores of university developmental mathematics students in treatment and control groups.

This final chapter provides a summary discussion of the treatment and major findings of the study, and the relationships of those findings to the theoretical framework and prior research discussed in Chapter Two. The chapter concludes with some implications of this research for computerized developmental mathematics courses and suggestions for future research.

Overview of Treatment

Six sections of a self-paced developmental mathematics course at a large university were broken into two separate groups; treatment and control. Both groups completed all of the basic requirements of the course-computer lessons, computer tests, homework from the course workbook, three written exams, and a written final exam. The instruction took place in a computer lab on campus with a teaching assistant present for the entire duration of each class meeting and the teacher present for half of each class period. The teacher/TA presence allowed the students to get their mathematical questions answered without having to seek outside help.

Students in the treatment sections were required to have an informal interview with the teacher at the beginning of the semester and to review their progress at the end of each class meeting with either the teacher or the TA. The treatment group students were given due dates for homework assignments and were penalized points for late homework. They were prompted by an e-mail inquiry if they missed two or more consecutive classes without consulting the teacher, in order to remind them that attendance is critical to successful completion of the course. The teacher also provided treatment group students with mini-lectures on topics that are known to be difficult, and she reviewed results of each written test with individual students to discuss mathematical errors and study skills.

The sections were randomly assigned to either the control group or the treatment group. When students registered for the course at the beginning of the semester, they had no knowledge of the teacher assigned to each of the sections. The classes were held during the middle part of the day and each time period had one treatment group and one control group occurring at the same time, just in two separate locations.

Outside observers visited both control and treatment classes once every week for twelve weeks to monitor the type and amount of student/teacher interaction that was occurring in each class. The observations confirmed that the experimental treatment was indeed being delivered as intended; that there was a significant amount of special student/teacher interaction occurring in the treatment sections.

Summary and Discussion of Findings

The two central research questions of the study dealt with treatment effects on student learning and attitudes toward mathematics.

Research Question 1

Does instructor initiated interaction affect students' mathematics achievement?

The first research question pertained to the students' mathematics achievement. The students took a mathematics placement test prior to the first day of class and took a similar one at the point at which they had completed their three written exams. Students who did not complete the course in one semester were not part of this analysis.

The statistical test for the total test revealed the students' post-test scores were significantly different from their pre-test scores when data from all students was analyzed. It can be concluded that both groups made progress in learning the material. However, when the achievement scores were separated into the two groups, treatment vs. control, the repeated measure ANOVA revealed that the gain scores of the two groups were not statistically significantly different. Likewise, the two groups did not differ significantly in gains on any of the three individual sections of the test.

Research Question 2

Does instructor initiated interaction have any effect on students' sense of self-efficacy?

A modified version of the Fennema-Sherman Mathematics Attitudes Scale was given to the participants on the first day of class and before they took their final exam (some students finished the course in as little as five weeks). The survey was comprised of five different dimensions; Attitude toward Success in Mathematics, Effectance Motivation, Confidence in Mathematics, Usefulness of Mathematics, and a Teacher Scale. The first four dimensions can be argued to be aspects of self-efficacy theory.

It is important to note that the results from the pre- to post-attitude surveys for the total survey ($p = .001$), the teacher dimension ($p = .007$), and the confidence dimension ($p = .000$), were the only domains that resulted in a statistically significant difference for students in all six sections (e.g., when group was not taken into consideration). In the domains of attitude toward success ($p = .538$), effectance motivation ($p = .450$), and usefulness ($p = .732$), there was no significant difference among all the students from the pre-survey to the post-survey.

The repeated measure ANOVA results indicated that no statistically significant difference occurred between the treatment and control groups on the total survey responses or in any of the individual five dimensions. One can conclude that the enhanced interaction with a teacher had no special effect on the students' sense of self-efficacy as measured by the scale used.

The students pre- to post- responses on the teacher dimension should be viewed with some caution. The questions in this dimension were a little vague with respect to what teacher or teachers are being considered. A student could have taken different teachers into consideration when answering this item at the beginning and at the end of the semester. For example, one of the questions asks, "My teachers have been interested in my progress in math." In the beginning of the semester it is unclear what teacher(s) the student considered when responding. However, at the end of the semester, it is likely that the student might be referring to the teacher of this course when answering the question. Therefore, their responses could be referenced to two (or more) totally different mathematics teachers. Since the attitudes toward teacher did show a significance difference pre-to-post-survey among all students, we have to make the assumption that the teacher of this course most likely did not cause this significant pre/post difference on the teacher dimension. It is to the teacher's credit that their attitudes towards teacher did improve over the course of the semester.

Understanding the Results

This study explored the hypothesis that increased teacher interaction with students would have a significant impact on the achievement and the attitudes of students. This hypothesis is backed by research and theory suggesting that the teacher remains an important part of a student's learning experience in a computerized course (Hasselbring, 1986; Kinney & Robertson, 2003). However, results of this study suggest that exceptional efforts to provide teacher cognitive and affective support for students may not yield significant improvements in student learning or self-efficacy.

In a computerized, developmental mathematics course at a large university, the heightened level of care, structure, involvement, and interest in the students did not have a significant effect on those receiving the extra attention. Given the existing research and theory on developmental education, it is unlikely that teacher-student interaction has no impact on students' self-efficacy or achievement. Rather, the results of the current study may lead one to speculate that some minimal amount of interaction, as was provided in the control group, is in fact necessary to improve developmental students' sense of self-efficacy and achievement. However, exceeding this necessary amount of the interaction will not necessarily yield greater increases in self-efficacy and achievement.

The findings of this study lead us to think of alternative explanations as to why the research hypothesis was not supported, especially when two pilot studies had results that showed promise in the claim. These explanations are given in the following paragraphs.

The most significant and major limitation of this study was the number of participants involved. Some students did not finish the course on time, or simply dropped out, so the number of students taking the post-achievement test at the end of the semester was small (N=108). Also, the number of students dropping out of the course and leaving a question blank here and there on the attitude survey, caused the numbers to fall. For the total survey, the number of student responses compared was 65, and in the analysis of the five dimensions, the number of responses compared ranged from 90-94, depending on the dimension. Since the n's were so small, there was significantly less power, the ability of a test to detect an effect given that the effect exists, in the statistical analysis and the chances for a Type II error was greater. A Type II error is defined as accepting the null hypothesis that states that no differences exists between the two groups when the null hypothesis is false (Isaac & Michael, 1981).

Failure of the treatment group to achieve the expected greater mathematical achievement than the control group leads one to look for explanations of the counter-intuitive results. There are several plausible factors at work in this particular test of the hypothesis which states that enhanced student/teacher interaction should yield greater student learning. The descriptive statistics describing the student achievement in the study reveal that the treatment group started out with lower means than the control group on all but one section of the pre-test. Although the differences in means were not statistically significant, one might speculate why the control group may have started the semester with a higher mean. This observation led to an investigation of the students' previous mathematics experience and the results are displayed in Table 25.

Table 25: *Previous Course Experience*

	Treatment	Control
Repeating the course	12.68%	5.36%
Took mathematics in their senior year	70.42%	71.43%
Transferred in AP credits	7.14%	8.93%
Last mathematics class taken		
At another college/university	26.76%	35.09%
Calculus in high school	1.41%	10.53%
Pre-Calc in high school	12.68%	19.30%
Statistics in high school	16.90%	7.02%
Algebra II	19.72%	15.79%
Consumer Math/Discrete	4.23%	3.51%

Note: Percentages of last mathematics course taken do not add up to 100% since some students failed to answer this question

We can observe that the experience of taking higher-level mathematics courses (i.e., a course at another college, calculus, and pre-calculus) was higher for the control population (64.92%) than it was for the treatment population (40.85%). This is a plausible explanation of why the control group had a higher mean on the total pre-test score than the treatment group. It might also explain why the control group students appeared to be able to be successful in the computer-based self-paced course without the enhanced teacher support and interaction provided in the treatment. It is possible that if the students in the treatment group did not have the enhanced faculty interaction, structure, support, and feedback that they received, their rate of achievement could have been a lot less than the control group.

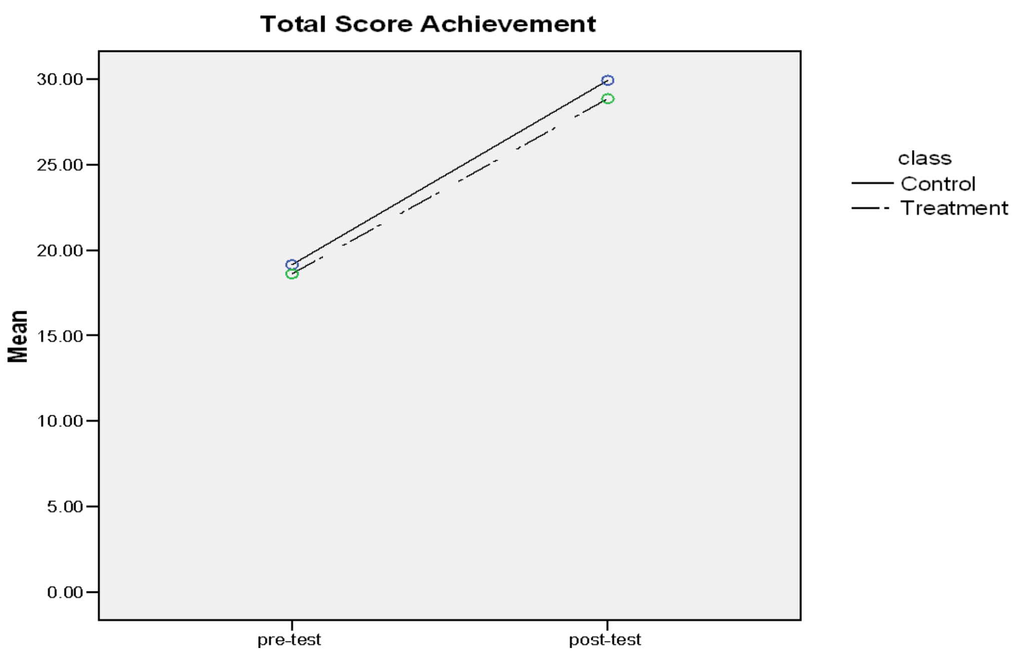

Figure 2: *Total Test Score Comparison*

A third plausible explanation for the lack of difference between the two groups is the limited duration of the treatment. The study was only conducted over a

15-week period. Many of the students coming to this course expressed having experienced repeated failures or had negative attitudes from previous mathematics courses. It seems improbable that a 15 week experience (and in 12.86% of the cases, 10 weeks or less) with a caring, involved teacher could make multiple years filled with feelings of anxiety, failure, and frustration change so dramatically. Referring back to the literature on productive disposition, attribution theory, and developmental education, students who develop negative feelings towards mathematics early on tend to keep these feelings throughout high school and college (Kilpatrick, Swafford, & Findell, 2001). They tend to blame external factors, such as bad teachers, and lack of ability for their failures (Smith & Price, 1996; Weiner, 1980). A 15-week period is not nearly long enough to change these negative emotions that some students have formed so early in their academic career.

Another explanation for the non-significant difference between the two groups could have been the treatment itself. The students in the treatment group were given more structure, more deadlines, more accountability, and more progress reports. Although the teacher intended to demonstrate how to be a more self-regulated learner by helping them to set goals and assess their own progress, it is possible the teacher became an enabler. In other words, the students in the treatment sections came to rely on the teacher assessing their progress for them and helping them to change their behaviors (study habits) in order to achieve their goals (Kinney, 2001; Pape, 2002; Zimmerman 2001), thus leading them to become less self-regulating. The students in the control group, on the other hand, could have become slightly more independent learners by relying more on the computer program, creating their own structure, and motivating themselves to successfully complete the course. In the descriptive statistics outlined in Chapter Four, we actually found the treatment students to decline in their reporting of motivation from the pre-survey to the post-survey. Similarly, the responses to the additional six questions (Table 22) added to the post-survey indicated that the control group responded slightly higher to the use of the computer, the self-pacing of the course, and the sense of feeling prepared to move on to a credited course. This data can lead us to speculate that improving self-efficacy and self-regulation skills is a very difficult task in a computerized setting and could even change in a negative way.

The mathematical backgrounds of the students could have also affected the results of the study. As previously mentioned, students in developmental mathematics classes are a heterogeneous mix. The course contains returning students, transfer students, native freshmen, students who took higher level mathematics courses (e.g., pre-calculus, calculus), and students who have the bare minimum university requirements. Therefore, even though results from the pilot studies showed promising results, the demographics and mathematical abilities of the students from one semester to another can vary. In some semesters, there will be students who finish the course in as little as five weeks, while in others, the students are in the course until the very last day of the semester, or even need an extra semester. In this particular semester, 20.75% of the control group finished early (within 10 weeks), while only 12.86% of the treatment group finished early. Since more students in the control group were transfers and had higher levels of mathematics previous to this course, we can suggest that the students in the control group were able to work more independently and not need as much guidance and support from the teacher.

A final possible explanation of the failure to find statistically significant differences between the two groups is the setting of the course. The course was held in a computerized mathematics lab. Students had the freedom to attend extra lab hours when other teachers were holding their sections of the course. The students had the opportunity to interact with the teachers and teaching assistants of these sections if they requested assistance. Although the teachers do not typically reach out to unknown students, if a particular student attended a section of an attentive teacher, they could have received enhanced teacher interaction that way.

Implications

Although a statistically significant difference was not found between the control group and the treatment group, this study does not imply that a lack of teacher interaction is sufficient for postsecondary, computerized, developmental mathematics courses. As stated by Kinney and Robertson (2003), the instructor "remains an important component [of a computer mediated classroom] by providing students with individual or small group assistance as requested, along with providing feedback about students' progress in the course" (p. 317). The findings of this study, along with the information obtained from the pilot studies, suggest that these courses tend to contain a heterogeneous mix of students, and what may not be helpful for one, can be very helpful and encouraging for another. The students in these courses have different levels of confidence, have taken different levels of mathematics courses, and possess different levels of independence. Some students prefer a computerized mathematics course because it gives them the opportunity to review the concepts they are weak on in more depth and browse quickly through the concepts they remember from high school. Being on a computer also provides privacy, and to those who fail more often than others are able to hide these failures while working on a computer, and not allow them to appear dumb or incompetent to their peers.

This study may call into question what some theorists have to say about the teachers of developmental students. Developmental theorists claim that using graduate students, adjunct faculty, or instructors that have little experience with the developmental population are perceived inhibitors to mathematics success and are not effective enough to reach this population without some kind-of professional development (Penny & White, 1998; Wheland, Konet, & Butler, 2003). They claim the importance of knowing and understanding the developmental population is critical to their success (Boylan, 1999). Theorists also claim that structure, encouragement, and feedback are critical to the success of the students in these courses (Smittle, 2003; Wambach & Brothen, 2000). This study challenges some of these theories, at least when it comes to an instructor of a computerized, developmental mathematics course. The results of this study suggest that a college or university might not have to make special efforts to ensure that an instructor of a computerized mathematics course is experienced in enhancing student effort and motivation or is familiar with the developmental population.

Directions for Future Research

The first, and maybe most obvious, suggestion for future research on a developmental population in a computer-based setting would be to study a significantly larger group of students. This would enhance the statistical power of the study and might even result in some significant differences.

Another suggestion for a future study would be to study the effects of enhanced teacher interaction over an extended period of time. Since college and universities typically teach a course within 15 weeks, an extended study might not be possible at the postsecondary level. This could suggest a study to be done at a middle or high school level, possibly with first year algebra students, and could be conducted over the course of 10 months.

On a similar note, it may be possible to conduct the same study in a short, one semester, period of time by phasing out the treatment during the semester. For instance, the enhanced support, structure, and interaction could be given in the first half of the semester, and then the investigator could phase out the treatment gradually over the second half. The investigator could then assess whether the students were able to self-regulate (i.e., monitor their progress, set goals, etc.) their behavior without the assistance of the teacher.

A fourth suggestion for future investigation would be to investigate if such enhanced teacher interaction would result in different effects on achievement and self-efficacy for a minority population (Penny & White, 1998) or different effects based on the gender of the population. Much research has been done on minority group achievement (Johnson, 1989; Treisman, 1985) and the achievement of females versus males (Fennema & Carpenter, 1998). Because the sample size in this student population was small, race and gender comparisons were not made.

A similar study could be executed at college or university that is not as selective as the one used for this study, such as a community college. Perhaps the students enrolled in developmental courses at less selective postsecondary institutions would have different mathematical backgrounds and needs than those of the participants in this study.

Another suggestion for a future study might be to use another instrument to compare the self-efficacy of the students at the beginning of the semester to the their beliefs at the end. While the Fennema-Sherman Attitudes Scale seemed to be an attractive instrument because of its design for mathematics, other instruments used with mathematics students could have provided a more fitting measure of self-efficacy.

A last suggestion for a future study would be to track the students the semester after the enhanced treatment and even to follow them through to graduation. It would be interesting to follow their progress; gathering data to see if and how they self-regulated their behavior, what grades they earned in their credited mathematics course, and if they stayed with the major they intended on studying when they entered in the developmental course.

APPENDIX A: DISTRIBUTION OF STUDENTS ACROSS THE FOUR COURSE MODULES

	Elementary Mathematical Models	College Algebra with Applications	Introduction to Probability	Pre-calculus
Treatment Group	19.7%	18.3%	54.9%	7.1%
Control Group	21.1%	24.6%	45.6%	8.7%
Students from other sections	28.7%	24.9%	34.5%	11.9%

APPENDIX B: PILOT STUDY RESULTS

The first pilot study took place in the fall semester of 2006. Four sections of the developmental course were involved in the study, where two sections were assigned to a treatment group, and the other two were a control group. The number of students in the treatment group was 47, and the number of students in the control group was 51.

The results in the table below show the treatment group had a higher percentage of students completing the class and being eligible to move into a credited math course, and a lower percentage of students failing the developmental course. The students in the treatment group also attended class more frequently. The table also shows the results from Spring 2007, the semester the students took a credited mathematics class. The treatment students show a higher percent in passing the class and a lower percent for those who failed the course and withdrew mid-semester.

Table B-1: *Fall 2006 Pilot Study Outcomes*

Outcome Observed	Treatment Group	Control Group
Passing/completing the class and eligible to move on into a credited math class	72.3%	66.7%
Passing the class but not completing program	6.4%	7.8%
Failing the class	21.3%	25.5%
Average attendance throughout the semester	79.2%	74.7%
Students' grade in credited course:		
C or better	60%	50%
D or F	22%	28%
Withdrew/Audited	9%	17%
Students who did not take a math class the next semester	9%	5%

The second pilot study took place in the spring semester of 2007. Again, four sections of the developmental course were involved in the study, where two sections were assigned to a treatment group, and the other two were a control group. The number of students in the treatment group was 27, and the number of students in the control group was 42. The only difference from the data obtained in this pilot study from the previous one was comments to an open-ended question at the end of the survey.

The results in the table displayed below show that during the semester, more students in the treatment group attended class, and passed/completed the course receiving eligibility to move on to a credited-level course. They also thought the teacher and teaching assistant was the most helpful resource in regards to their success. The control group, on the other hand, attributed their success to the self-pacing of the computer program more than the help from the teacher/TA.

Table B-2: *Spring 2007 Pilot Study Outcomes*

Outcome Observed	Treatment Group	Control Group
Passing/completing the class and eligible to move on into a credited math class	78%	57%
Passing class but not completing program	7%	10%
Failing the class	15%	33%
Average attendance throughout the semester	80.95%	70.76%
Commented on Teacher/TA being most helpful to them in terms of success	62%	38%
Commented on the self-pacing of the program being most helpful to their success	33%	66%
Students' grade in credited course:		
C or better	38.10%	58.33%
D or F	19.05%	12.50%
Withdrew/Audited	9.52%	4.17%
Students who did not take a math class the next semester	33.33%	25%

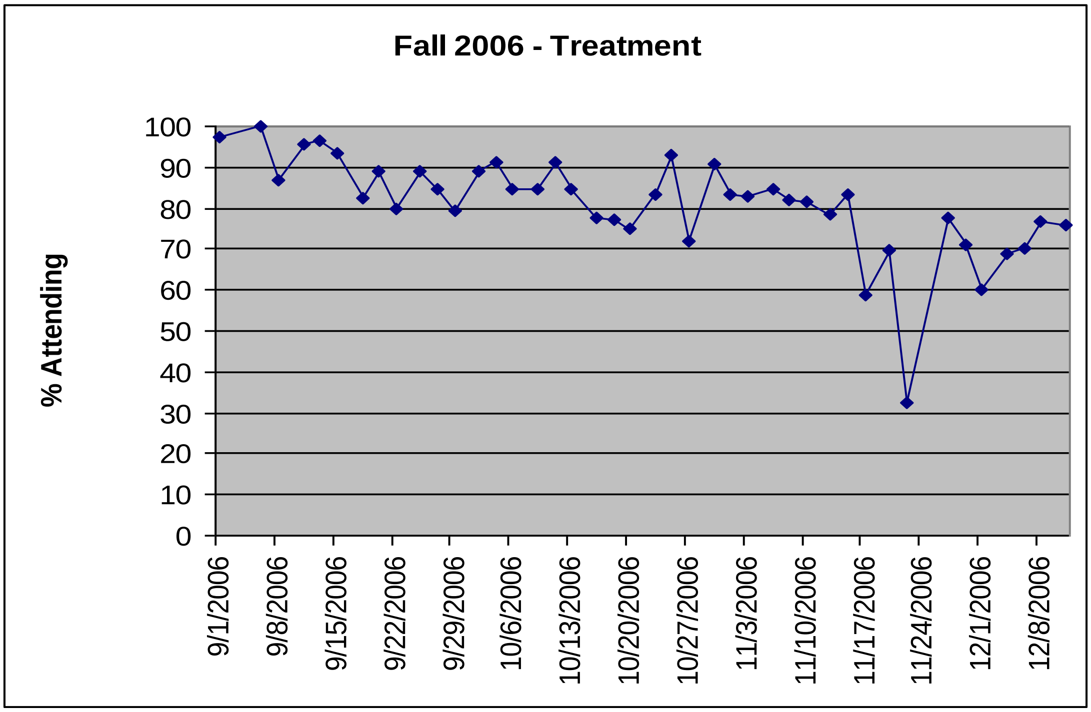

Figure B-1: *Fall 2006 Pilot Study Attendance Pattern (Treatment)*
Average Attendance = 79.22%
3 students stopped attending = 6.38%

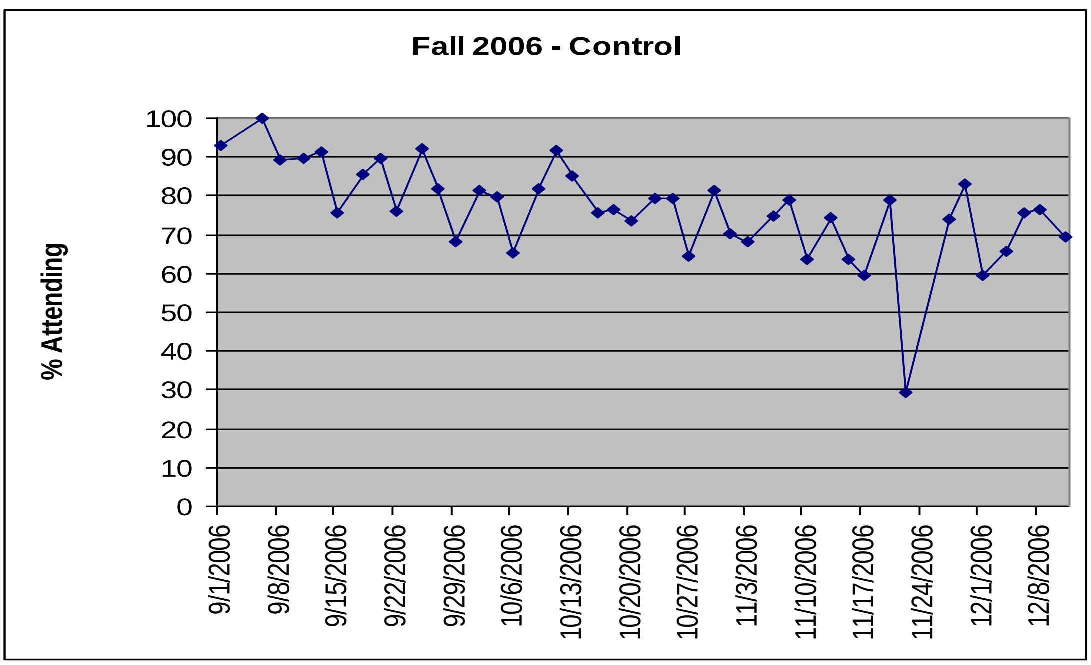

Figure B-2: *Fall 2006 Pilot Study Attendance Pattern (Control)*
Average Attendance = 74.69%
5 students stopped attending = 9.80%

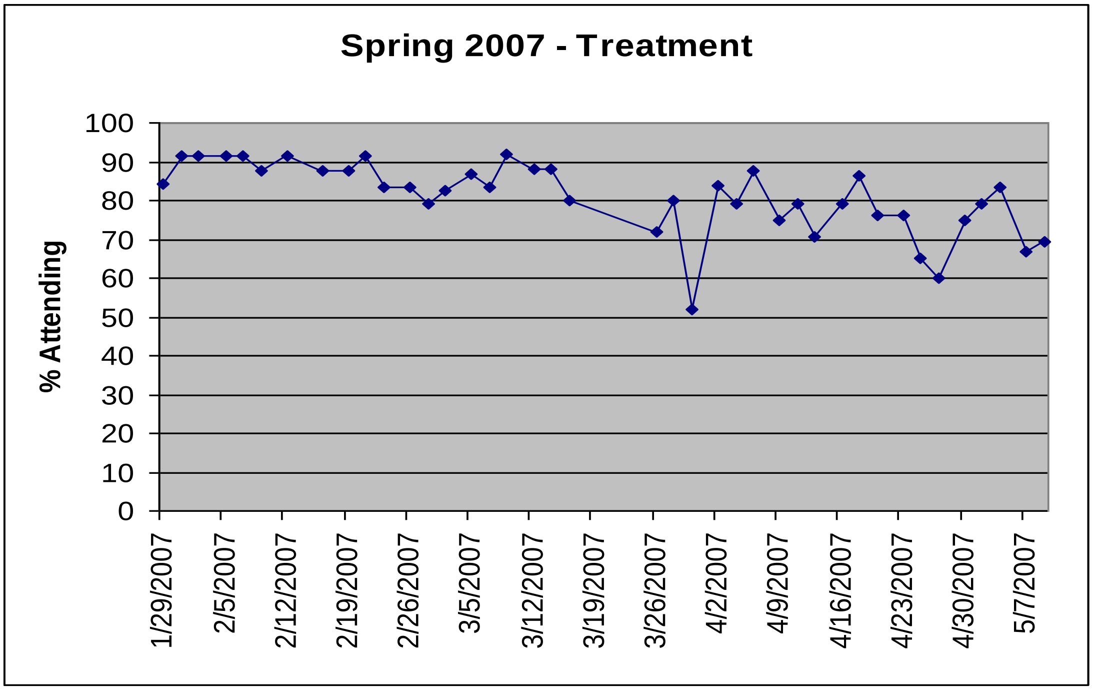

Figure B-3: *Spring 2007 Pilot Study Attendance Pattern (Treatment)*
Average Attendance = 80.95%
5 students stopped attending = 15.38%

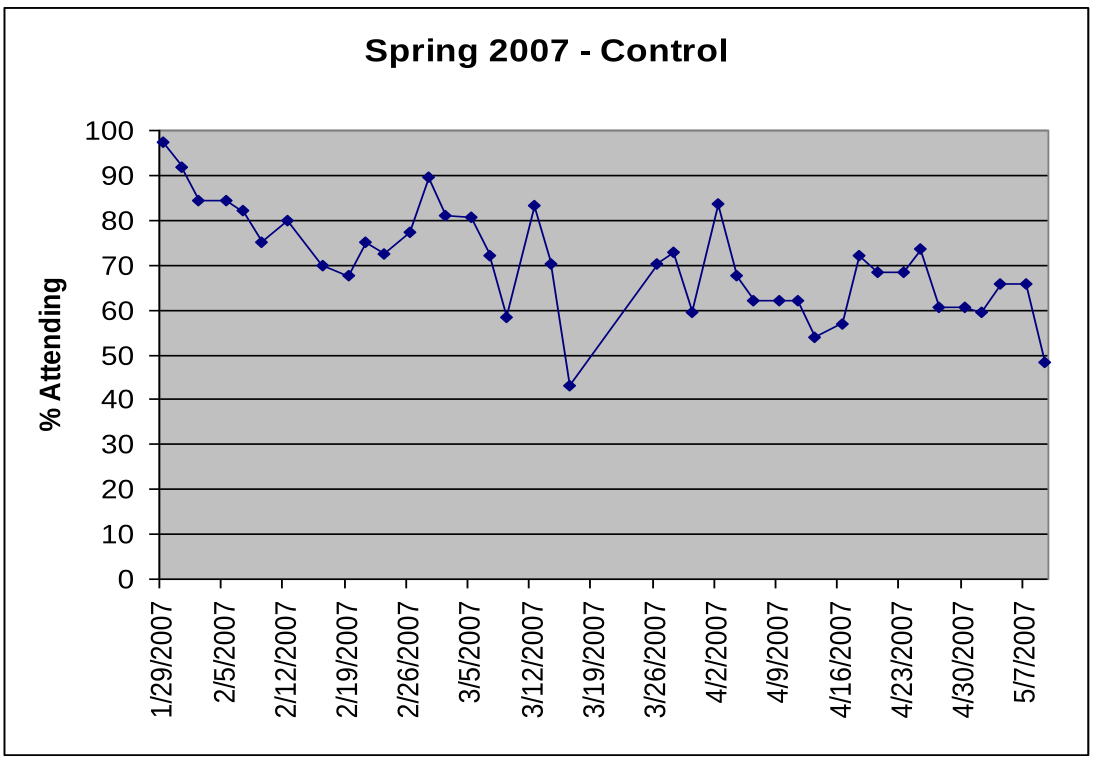

Figure B-4: *Spring 2007 Pilot Study Attendance Pattern (Control)*
Average Attendance = 70.76%
9 students stopped attending = 23.68%

APPENDIX C: INTERVIEW QUESTIONS

1. What was the highest math class you took in high school?

2. Did you take math in your senior year of high school?

3. How long has it been since you have been in a math class?

4. What kind-of grades did you earn in your math classes?

5. Did you have any memorable, positive or negative experiences in your math classes?

6. Do you have any weaknesses, anxieties, or concerns pertaining to math that you would like me to know about?

7. Why do you think you were placed into this math class?

8. What are your goals for this semester?

APPENDIX D: OBSERVER CHECKLIST

	Date	Class Time/Location:
Personal Contact/Interest ex: Are you feeling better today? How are you doing? Did you win your game?		
Responding to a question Math (content) related		
Non-Content Related ex: When is my HW due?		
Follow-up (Content Related) ex: Did you work on ______? Do you understand it better now?		
(Non-Content related) ex: Did you turn in your homework? Would you like to look at your exam?		
Teacher Initiating content questions (to struggling students) Are you okay with word problems? Do you understand the procedure for completing the square?		

APPENDIX E: BACKGROUND INFORMATION AND CAREER ASPIRATIONS FORM

1. Please indicate your gender.	Male ◯ Female ◯
2. Please indicate your racial/ethnic background. (Mark all that apply)	African American/Black ◯ American Indian/Alaska Native ◯ Asian American/Asian ◯ Mexican American/Chicano ◯ Native Hawaiian/Pacific Islander ◯ Puerto Rican ◯ Other Latino ◯ White/Caucasian ◯ Other (please specify) ____________ ◯
3. What year did you graduate high school? (Mark one)	2004 or earlier ◯ 2005 ◯ 2006 ◯ 2007 ◯

4. Please identify the current program you are enrolled. (Mark one)	
AGNR: Agriculture & Natural Resources	◯
ARCH: Architecture	◯
ARHU: Arts & Humanities	◯
BSOS: Behavioral & Social Sciences	◯
BMGT: Business & Management	◯
CLFS: Chemical & Life Sciences	◯
CMPS: Computer Science, Physics, & Mathematics	◯
EDUC: Education	◯
ENGR: Engineering	◯
HLHP: Heath & Human Performance	◯
CLIS: Information Studies	◯
JOUR: Journalism	◯
LFSC: Life Sciences	◯
LTSC: Letters & Sciences	◯
PUAF: Public Affairs	◯
UGST: Undergraduate Studies	◯

5. What is your official class standing here at UMD? (check one)

______freshman ______sophomore _______junior
_____senior

6. How long has it been since you were enrolled in a math class? ________year(s)

7. What was the last math you took? ____________________

Where did you take this class? ______________________

8. Did you take math in your senior year of high school? __________

9. Did you transfer any AP credits from high school ______yes_____no

If yes, how many credits_______

10. Is this your first time in MATH 003? __________________

If no, when (semester & year) was the last time you took this class?
____

11. Are you a transfer student? _______________

If yes, how many credits are you transferring in? _____________

12. How many credits are you taking this semester? __________

APPENDIX F: FENNEMA-SHERMAN MATHEMATICS ATTITUDE SURVEY

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. I like mathematics.					
2. Math is very interesting to me.					
3. It would make me happy to be told I was an excellent math student					
4. I think I can handle more difficult mathematics.					
5. I know I can do well in math.					
6. I like to work on math problems I can't understand immediately.					
7. It would make people like me less if I were a really good math student					
8. I don't like people to think I am smart in math.					
9. Doing well in math is not important for my future.					
10. If I had good grades in math, I would try to hide it.					
11. The challenge of math problems does not appeal to me.					
12. If I can't solve a math problem right away, I stick with it until I do.					
13. I am sure that I can learn math.					
14. I have had a hard time getting teachers to talk seriously with me about math.					
15. It would be really great to win a prize in math.					
16. If I got the highest grade in math I wouldn't want anyone to know.					
17. I'll need a good understanding of math for my future work.					
18. It's hard to get math teachers to respect me.					
19. I don't expect to use much math when I get out of school.					
20. I will use mathematics in many ways as an adult.					

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
21. I feel that math teachers ignore me when I talk about something serious.					
22. Math teachers have made me feel that I have the ability to go on in mathematics.					
23. I think about unanswered questions after math class is over.					
24. I am sure of myself when I do math.					
25. Math is not important for my life.					
26. I do as little work in math as possible.					
27. I don't understand how people can enjoy spending a lot of time on math.					
28. It would be great if other people thought I was smart in math.					
29. Winning a math prize would make me feel uncomfortable.					
30. Figuring out math problems does not appeal to me.					
31. My teachers have been interested in my progress in math.					
32. Most subjects I handle o.k., but I just can't do a good job with math.					
33. Math has been my worst subject.					
34. I see mathematics as something I won't use very often when I get out of college.					
35. Once I start trying to work on a math puzzle, I find it hard to stop.					
36. I can get good grades in math.					
37. Math puzzles are boring.					
38. Math is hard for me.					
39. My teachers have wanted me to take all the math I can.					
40. I study math because I know how useful it is.					

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
41. My teachers have thought that I am the kind of person who could do well in math.					
42. I'm not the type to do well in math.					
43. I don't think I could do advanced math.					
44. Math is fun and exciting.					
45. I'll need mathematics for my future work.					
46. People would think that I was a student who worked too hard if I got high grades in math.					
47. I would be proud to be first in a math contest.					
48. My teachers think that advanced math will be a waste of time for me.					
49. My teachers have encouraged me to study more math.					
50. I am sure I can do advanced work in math.					
51. I would talk to my math teachers about a career which uses math.					
52. Taking math is a waste of time.					
53. Knowing mathematics will help me earn a living.					
54. I'd be happy to get top grades in math.					
55. Math is a worthwhile and necessary subject.					
56. I would rather have someone give me the solution to a hard math problem than to work it out for myself.					
57. Math will not be important to me in my life's work.					
58. I like math puzzles.					
59. My teachers would not take me seriously if I told them I was interested in a career in science and mathematics.					

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
60. I'm no good in math.					
61. I'd be proud to be the outstanding student in math.					
62. Getting a teacher to take me seriously in math is a problem.					
*63. Learning from a computer improved my overall algebraic understanding.					
*64. The ability to move at my own pace made me feel comfortable in this class.					
*65. The amount of interaction with the teacher was critical to my success.					
*66. I feel I am prepared for my credited math class.					
*67. I felt comfortable asking my teacher questions.					
*68. This math class has been a good experience.					

*Overall, what did you find the most helpful in this course?

*Additional questions were only asked in the end-of-the-semester survey

APPENDIX G: ATTENDANCE PATTERNS OF STUDY POPULATION

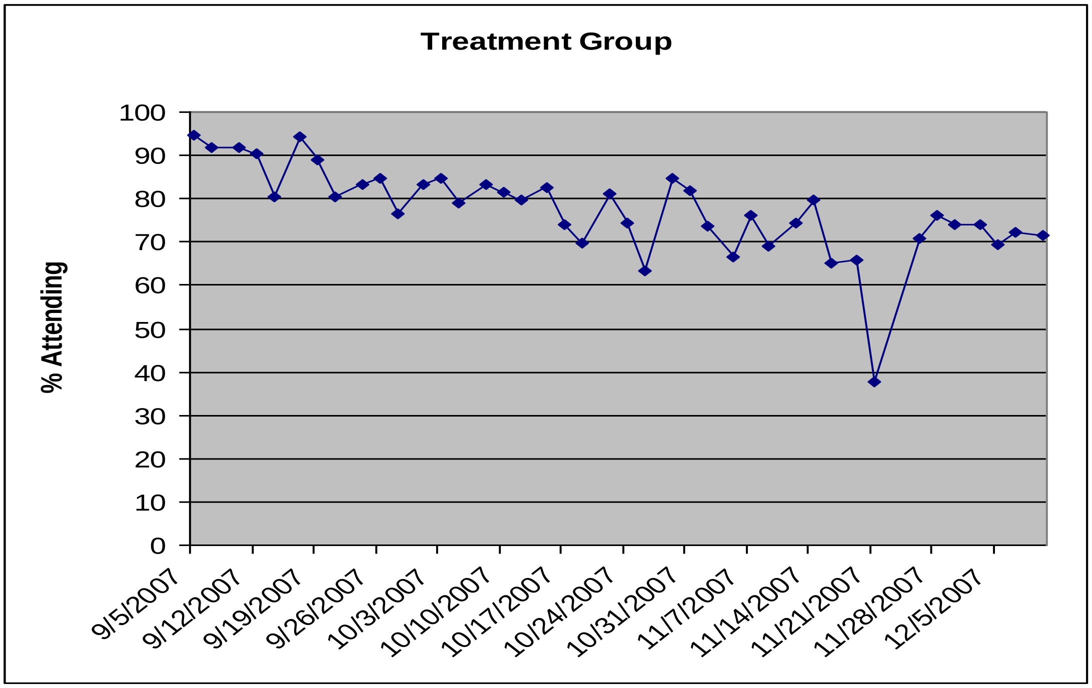

Figure G-1: *Attendance Pattern (Treatment)*
Average Attendance = 77.5%
7 students stopped attending = 9.72%

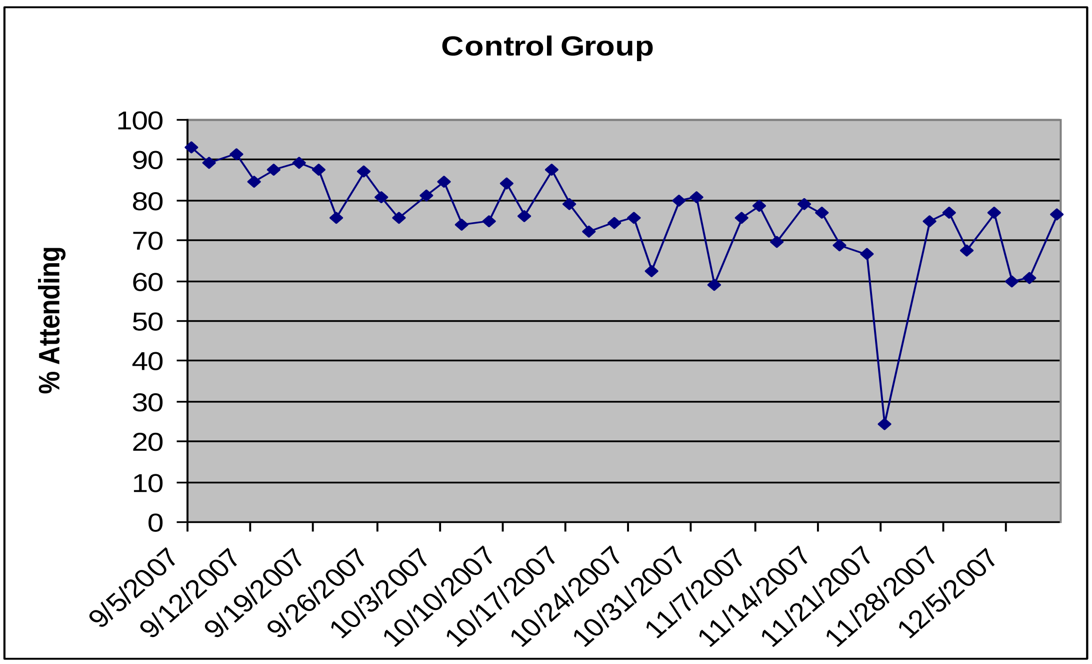

Figure G-2: *Attendance Pattern (Control)*
Average Attendance = 76.1%
4 students stopped attending = 7.02%

APPENDIX H: MODULE RESULTS FOR PART III OF ACHIEVEMENT TEST

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-P3 vs. Post-P3	995.033	1	955.033	99.094	.000
Pre/Post-P3 * Class	1.076	1	1.076	.107	.744
Pre/Post-P3 * Module	47.750	3	15.917	1.585	.198
Pre/Post-P3 * Class * Module	16.315	3	5.438	.542	.655
Error	1004.131	100	10.041		

APPENDIX I: STATISTICAL ANALYSIS FOR THE FIVE DIMENSIONS

TableI-1: *Attitude Toward Success*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre- vs. Post-	2.625	1	2.625	.383	.538
Pre/Post * Class	3.799	1	3.799	.554	.459
Error	617.304	90	6.859		

Table I-2: *Effectance Motivation*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre- vs. Post-	11.658	1	11.658	.576	.450
Pre/Post * Class	53.658	1	53.658	2.652	.107
Error	1780.792	88	20.236		

Table I-3: *Confidence in Learning Mathematics*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre- vs. Post-	288.045	1	288.045	14.700	.000
Pre/Post * Class	.914	1	.914	.047	.829
Error	1763.580	90	19.595		

Table I-4: *Mathematics Usefulness*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre- vs. Post-	2.242	1	2.242	.118	.732
Pre/Post * Class	.029	1	.029	.002	.969
Error	1742.125	92	18.936		

Table I-5: *Teacher Scale*

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre- vs. Post	86.515	1	86.515	7.628	.007
Pre/Post * Class	16.902	1	16.902	1.490	.225
Error	1032.076	91	11.341		

APPENDIX J: IRB APPROVAL AND CONSENT FORM

UNIVERSITY OF MARYLAND
INSTITUTIONAL REVIEW BOARD

2100 Blair Lee Building
College Park, Maryland 20742-5121
301.405.4212 TEL 301.314.1475 FAX
irb@deans.umd.edu
www.umresearch.umd.edu/IRB

June 21, 2007

MEMORANDUM

Renewal Application Approval Notification

To:	Dr. Anna O. Graeber Kristy Vernille Blocklin Department of Curriculum and Instruction
From:	Roslyn Edson, M.S., CIP, IRB Manager University of Maryland, College Park
Re:	**IRB Application Number:** 06-0391 **Project Title:** "Assessing Developmental Students' Attributions and Teacher Interaction in a Computer-Based Mathematics Class"
Approval Date:	June 18, 2007
Expiration Date:	June 18, 2008
Type of Application:	Renewal
Type of Research:	Non-exempt
Type of Review For Application:	Expedited

The University of Maryland, College Park Institutional Review Board (IRB) approved your IRB application. The research was approved in accordance with 45 CFR 46, the Federal Policy for the Protection of Human Subjects, and the University's IRB policies and procedures. Please reference the above-cited IRB application number in any future communications with our office regarding this research.

Recruitment/Consent: For research requiring written informed consent, the IRB-approved and stamped informed consent document is enclosed. The IRB approval expiration date has been stamped on the informed consent document. Please keep copies of the consent forms used for this research for three years after the completion of the research.

Continuing Review: If you want to continue to collect data from human subjects or to analyze private, identifiable data collected from human subjects after the approval expiration date indicated above, you must submit a renewal application to the IRB Office at least 30 days before the approval expiration date.

Modifications: Any changes to the approved protocol must be approved by the IRB before the change is implemented, except when a change is necessary to eliminate apparent immediate hazards to the subjects. If you would like to modify the approved protocol, please submit an addendum request to the IRB Office. The instructions for submitting an addendum request are posted on the IRB website at: **http://www.umresearch.umd.edu/IRB/irb_Addendum%20Protocol.htm.**

(Continued)

Informed Consent Form

Project Title: *Assessing Developmental Students' Attributions, Achievement, and Teacher Interaction in a Computer-Based Mathematics Class.*

Purpose: This is a research project conducted by Kristy Vernille Blocklin under the direction of Dr. Anna Graeber at the University of Maryland, College Park. We are inviting you to participate in this research project because you are enrolled in [redacted]. The purpose of this research project is to examine the feelings students have towards mathematics and their beliefs about their ability to succeed. The results of this study could potentially provide valuable information about the learning experiences, achievement, and faculty interaction with undergraduate students in developmental mathematics courses. Your participation is important to us; but it is voluntary and you do not have to answer questions that make you feel uncomfortable. Thank you in advance for your assistance in this important work.

Procedures: The procedures of this study involve completing a modified version of the Fennema-Sherman Mathematics Attitude survey both in the beginning of the semester and at the end, providing the investigator with background information, and also allowing the investigator to conduct individual interviews where necessary. The survey includes questions about your confidence in mathematics, the usefulness of mathematics, your attitude about success in mathematics, and your previous experiences with mathematics classes and teachers. It should take you approximately five minutes to complete this survey and interviews will last no longer than 20 minutes. The unique identifier that you provide, University ID (UID), will be used only for the purpose of linking your responses to other academic data kept in institutional databases. Academic data that will be collected includes your score on the mathematics placement test taken prior to the first day of class. The data you provide will be grouped with data others provide for reporting and presentation and neither your name nor other personally identifiable information will be included.

Confidentiality: We will do our best to keep your personal information confidential. To help protect your confidentiality, your responses, test scores, and interviews will only be available to the researcher. Also, after all data has been merged, your name and unique identifier will be removed from the data set and only the investigator will be able to link the survey to your identity. All data will be kept in locked storage and only the researcher will have access to the data. All reports will discuss only group trends and achievement. After five years, the data will be destroyed by shredding.

Project Title:	*Assessing Developmental Students' Attributions, Achievement, and Teacher Interaction in a Computer-Based Mathematics Class.*
Confidentiality (cont.)	This research project involves making audiotapes of your interview responses. The interviews are being recorded so that the investigator is able to make comparisons between participants. The investigator will be the only person who has access to them and they will be stored in a locked filing cabinet. The audiotapes will be destroyed by shredding after five years. ___ I agree to be audiotaped during my participation in this study. ___ I do not agree to be audiotaped during my participation in this study. If we write a report or article about this research project, your identity will be protected to the maximum extent possible. Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law.
Risks:	There are no known risks associated with participating in this research project. Whether or not you choose to participate in this study, there will be no impact on your grade.
Benefits:	This research study is not designed to help you personally, but the results could potentially be used to improve students' undergraduate experiences in computerized mathematics courses.
Freedom to Withdrawal:	Your participation in this study is completely voluntary. You may choose not to take part at all. If you decide to participate in this research study, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.
Contact Information of Investigators:	If you have any questions or concerns regarding your participation in this study, please contact Kristy Vernille Blocklin, Math Lecturer & PhD Student, 2201 Shoemaker Building, University of Maryland, College Park, MD 20742 (e-mail) vernille@umd.edu; (telephone) 301-314-7696 or Professor Anna Graeber, 2226F Benjamin Building, University of Maryland, College Park, MD, 20742; (e-mail) annagrae@umd.edu; (telephone) 301-405-7060.

Project Title: *Assessing Developmental Students' Attributions, Achievement, and Teacher Interaction in a Computer-Based Mathematics Class.*

Contact Information of Institutional Review Board:	If you have questions about your rights as a research subject or wish to report a research-related injury, please contact: **Institutional Review Board Office, University of Maryland, College Park, MD, 20742; (e-mail) irb@deans.umd.edu; (telephone) 301-405-421**

I understand that by participating in this research study I agree with the above statements and give my informed consent.

Statement of Age of Subject and Consent:	Your signature indicates that: you are at least 18 years of age; the research has been explained to you; your questions have been fully answered; and you freely and voluntarily choose to participate in this research project.

___ I agree to be involved in this research study.

___ I do not agree to be involved in this research study.

____________________________ Name of Subject (printed)

____________________________ Signature of Subject

__________________ Date

__________________ Student ID Number

REFERENCES

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148.

Bandura, A. (1997). Self-efficacy: The exercise of self-control. New York: W. H. Freeman.

Boylan, H. (1999). Demographics, outcomes, and activities. *Journal of Developmental Education, 23*(2), 2-7.

Boylan, H. R., & Bonham, B. S. (2007). 30 years of developmental education: A retrospective. *Journal of Developmental Education, 30*(3), 2-4.

Brophy, J. (1999). Toward a model of the value aspects of motivation in education: Developing appreciation for particular learning domains and activities. *Educational Psychologist, 34*(2), 75-85.

Casazza, M. E. (1999). Who are we and where did we come from? *Journal of Developmental Education, 23*(1), 2-7.

Cooper, S., & Robinson, D. (1991). The relationship of mathematics self-efficacy beliefs to mathematics anxiety and performance. *Measurement and Evaluation in Counseling and Development, 24*(1), 4-11.

Dweck, C., & Reppucci, N. D. (1973). Learned helplessness and reinforcement responsibility in children. *Journal of Personality and Social Psychology, 25*(1), 109-116.

Dweck, C., & Leggett, E. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256-273.

Elliott, E., & Dweck, C. (1988). Goals: An approach to motivation and achievement. *Journal of personality and social psychology*, *54*(1), 5-12.

Fennema, E., & Carpenter, T. P. (1998). New perspectives on gender differences in mathematics: An introduction and a reprise. *Educational Researcher*, *27*(5), 4-11, 19-22.

Fennema, E., & Sherman, J. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, *7*(5), 324-326.

Garcia, T., & Pintrich, P. R. (1994). Self-regulation of learning and performance: Issues and educational applications. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 127-153). Hillsdale, NJ: Erlbaum.

Hagedorn, L. S., Siadat, M. V., Fogel, S., Nora, A., & Pascarella, E. (1999). Success in college mathematics: Comparisons between remedial and non-remedial first-year college students. *Research in Higher Education*, *40*(3), 261-284.

Hall, J. M., & Ponton, M. (2005). Mathematics self-efficacy of college freshman. *Journal of Developmental Education*, *28*(3), 26-33.

Hanlon, E., & Schneider, Y. (1999). Improving math proficiency through self efficacy training. Paper presented at the annual meeting of AERA, Montreal, Canada. (ERIC Document Reproduction Service No. ED433236).

Hardin, C. (1988). Access to higher education: Who belongs? *Journal of Developmental Education*, *12*(1), 2-6.

Hardin, C. (1998). Who belongs in college: A second look. In J. L. Higbee & P. L. Dwinell (Eds.), *Developmental education: Preparing successful college students* (pp. 15-24). Columbia, SC: National Resource Center for The First-Year Experience and Students in Transition, University of South Carolina.

Hasselbring, T. (1986). Research on the effectiveness of computer-based instruction: A review. *International Review of Education*, *32*(3), 313-324.

Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley.

Higbee, J. L., & Thomas, P. V. (1999). Affective and cognitive factors related to mathematics achievement. *Journal of Developmental Education, 23*(1), 8-10, 12, 14, 16, 32.

Ironsmith, M., Marva, J., Harju, B., & Eppler, M. (2003). Motivation and performance in college students enrolled in self-paced versus lecture-format remedial mathematics courses. *Journal of Instructional Psychology, 30*(4), 276-284.

Isaac, S., & Michael, W. B. (1981). *Handbook in research and evaluation: A collection of principles, methods, and strategies useful in planning, design, and evaluation of studies in education and the behavioral sciences* (2nd ed.). San Diego, CA: EdITS.

Jacobson, E. (2005). Increasing attendance using email: Effect on developmental math performance. *Journal of Developmental Education*, *29*(1), 18-26.

Johnson, M. L. (1984.) Minority differences in mathematics. In M. M. Lindquist (Ed.), *Results from the fourth mathematics assessment of the National Assessment of Educational Progress* (pp. 135-148). Reston, VA: National Council of Teachers of Mathematics.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

Kinney, D. P. (2001). Developmental theory: Application in a developmental mathematics program. *Journal of Developmental Education, 25*(2), 10-18.

Kinney, D. P., & Robertson, D. (2003). Technology makes possible new models for delivering developmental mathematics instruction. *Mathematics and Computer Education, 37*(3), 315-328.

Kinney, D. P., Stottlemyer, J., Hatfield, J., & Robertson, D. F. (2004). A comparison of the characteristics of computer-mediated and lecture students in developmental mathematics, *Research and Teaching in Developmental Mathematics, 21*(1), 14-28.

Kloosterman, P. (1984). Attribution theory and mathematics education. Paper presented at the annual meeting of AERA, New Orleans, LA. (ERIC Document Reproduction Service No. ED244830).

Kloosterman, P. (1997). Assessing student motivational beliefs in high school mathematics. Unpublished manuscript. University of Indiana. Retrieved, May 18, 2008, from http://www.indiana.edu/~pwkwww/AERA97.pdf.

Lesh, R., Lovits, B., & Kelly, A. (2000). Purposes and assumptions of this book. In A. Kelly & R. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 17-33). Mahwah, NJ: Lawrence Erlbaum Associates.

Lifetime Library. (2006). [Computer software]. Minneapolis, MN: Liafail, Inc

Lumpkin, A. (2007). Caring teachers: The key to student learning. *Kappa Delta Pi Record, 43*(4), 158-160.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education, 28*(1), 26-47.

Maxwell, M. (1979). *Improving student learning skills*. San Francisco, CA: Jossey-Bass.

Mayeroff, M. (1971). *On caring*. New York: Harper & Row.

McCoy, L. P. (1996). Computer-based mathematics learning. *Journal of Research on Computing in Education, 28(*4), 438-461.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-591). New York: MacMillian.

Mercer, C. (1991). *Students with learning disabilities* (4th ed.). New York: Merrill.

Merisotis, J. P., & Phipps, R. A. (2000). Remedial education in colleges and universities: What's really going on? *The Review of Higher Education*, *24*(1), 67-85.

Meyer, D. K., Turner, J., & Spencer, C. (1997). Challenge in a mathematics classroom: Students' motivation and strategies in project-based learning. *Elementary School Journal, 97*(5), 501-521.

Middleton, J., & Spanias, P. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education, 30*(1), 65-88.

Miller, R. B., Greene, B. A., Montalvo, G. P., Ravindran, B., & Nichols, J. D. (1996). Engagement in academic work: The role of learning goals, future consequences, pleasing others, and perceived ability. *Contemporary Educational Psychology, 21*(4), 388-422.

Moore, R. (2007). Course performance, locus of control, and academic motivation among developmental education students. *Research and Teaching in Developmental Education.* Retrieved, May 2, 2008, from http://www.highbeam.com/doc/1P3-1396747481.html

National Association for Developmental Education (NADE). (2008). Goals of developmental education. Retrieved May 20, 2008, from http://www.nade.net/aboutDevEd/goals.html

National Center for Education Statistics (NCES). (2001). Participation in remedial education. Retrieved August, 19, 2007, from http://nces.ed.gov/surveys/peqis/publications/2004010/index.asp?sectionID=5

National Center for Educational Statistics (NCES). (2004). Out-of-field teaching by poverty concentration and minority enrollment. Retrieved May 31, 2008, from http://nces.ed.gov/programs/coe/2004/section4/indicator24.asp#info

National Research Council. (2003). *Evaluating and improving undergraduate teaching in science, technology, engineering, and mathematics*. Committee on Recognizing, Evaluating, Rewarding, and Developing Excellence in Teaching of Undergraduate Science, Mathematics, Engineering, and Technology, M.A. Fox and N. Hackerman, Editors. Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Noddings, N. (2001). The caring teacher. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 99-105). Washington, DC: American Educational Research Association.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543-578.

Pape, S. J. (2002). Theory into practice: Self-regulating mathematics skills. [Online]. Retrieved June 4, 2005, from http://www.findarticles.com/p/articles/mi_m0NQM/is_2_41/ai_90190496

Pascarella, E., Edison, M., Hagedorn, L., Nora, A., & Terenzini, P. (1996). Influences on students' internal locus of attribution for academic success in the first year of college. *Research in Higher Education, 37*(6), 731-757.

Penny, M., & White, W. G., Jr. (1998). Developmental mathematics students' performance: Impact of faculty and student characteristics. *Journal of Developmental Education, 22*(2), 2-8.

Pintrich, P. R. (1994). Student motivation in the college classroom. In K. W. Princhard & R. McLaren Sawyer (Eds.), *Handbook of college teaching: Theory and applications* (p. 23-44). Westport, CT: Greenwood.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (p. 452-502). San Diego, CA: Academic Press.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 28(*1), 33-40.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*(2), 167-199.

Pintrich, P. R., & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom tasks. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 149-183). Hillsdale, NJ: Erlbaum.

Ray, M., Garavalia, L., & Murdock, T. (2003). Aptitude, motivation, and self-regulation as predictors of achievement among developmental college students. *Research and Teaching in Developmental Education, 20*(1), 5-21.

Ross, D. (1970). Remedial or developmental? Confusion over terms. *The Two-Year College Mathematics Journal, 1*(2), 27-31.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement, *Psychological Monographs*, *80*(1), 1-28.

Sagher, Y., Siadat, M. V., & Hagedorn, L. S. (2000). Building study skills in a college mathematics classroom. *The Journal of General Education, 49*(2), 132-155.

Schoenfeld, A. H. (1987). What's all the fuss about metacognition? In A. H. Schoenfeld (Ed.), *Cognitive Science and Mathematics Education* (p. 189-215). Hillsdale, NJ: Erlbaum.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*, 111-139.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26*(3), 207-231.

Schunk, D. H. (1996). Self-evaluation and self-regulated learning. Paper presented at the The City University of New York, New York, NY. (ERIC Document Reproduction Service No. ED403233).

Smith, J. O., & Price, R. (1996). Attribution theory and developmental students as passive learners. *Journal of Developmental Education, 19*(3), 2-6.

Smittle, P. (2003). Principles for effective teaching in developmental education. *Journal of Developmental Education*, *26*(3), 10-16.

Snow, R. E., Como, L., & Jackson, D. (1996). Individual differences in affective and connative functions. In D.C. Berliner & R.C. Calfee (Eds.), *Handbook of educational psychology* (pp. 243-310). New York: Simon & Schuster Macmillan.

Sowder, J. T. (Ed.). (1989). *Research agenda in mathematics education: Setting a research agenda*. Reston, VA: National Council of Teachers of Mathematics.

Spann, G., & McCrimmon, S. (1998). Remedial/developmental education: Past, present and future. In J. L. Higbee & P. L. Dwinell (Eds.), *Developmental education: Preparing successful college students* (pp. 37-47). Columbia, SC: National Resource Center for The First-Year Experience and Students in Transition, University of South Carolina.

Tapia, M., & Marsh, G. E., II (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly, 8*(2), 16-21.

Treisman, U. (1985). A study of the mathematics performance of black students at the University of California, Berkeley. (Doctoral dissertation, University of California, Berkeley, 1985). *Dissertation Abstracts International*, *47*, 1641.

Volkwein, J. F., & Cabrera, A. (1998). Student measures associated with favorable classroom experiences. Paper presented at the Annual Forum of the Association for Institutional Research, Minneapolis, MN. (ERIC Document Reproduction Service No. ED422809).

Wadsworth, L. M., Husman, J., Duggan, M. A., & Pennington, M. N. (2007). Online mathematics achievement: Effects of learning strategies and self-efficacy. *Journal of Developmental Education, 30*(3), 6-15.

Wambach, C., & Brothen, T. (2000). Toward a developmental theory for developmental educators. *Journal of Developmental Education, 24*(1), 2-10.

Wang, J., Wildman, L., & Calhoun, G. (1996). The relationships between parental influence and student achievement in seventh grade mathematics. *School Science and Mathematics, 96*(8), 395-400.

Weiner, B. (1974). *Achievement motivation and attribution theory.* Morristown, N.J.: General Learning Press.

Weiner, B. (1980). *Human motivation*. United States of America: Holt, Rinehart and Winston.

Wheland, E., Konet, R. M., & Butler, K. (2003). Perceived inhibitors to mathematics success. *Journal of Developmental Education, 26*(3), 18-27.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12*(3), 265-310.

Wright, G. L., Wright, R. R., & Lamb, C. E. (2002). Developmental mathematics education and supplemental instruction: Pondering the potential. *Journal of Developmental Education, 26*(1), 30-35.

Yaworski, J., Weber, R., & Ibrahim, N. (2000). What makes students succeed or fail?: The voices of developmental college students. *Journal of College Reading and Learning, 30*(2), 195-221.

Young, D. B., & Ley, K. (2001). Mathematics self-efficacy performance discrepancies of underprepared (developmental) and regular admission college students. *Academic Exchange Quarterly,5*(2), 167- 175.

Young, D. B., & Ley, K. (2003). Self-regulation support offered by developmental educators. *Journal of Developmental Education, 27*(2), 2-10.

Zimmerman, B. (1986). Development of self-regulated learning: Which are the key sub-processes? *Contemporary Educational Psychology, 16,* 307-313.

Zimmerman, B. (1990). Self-regulating academic learning and achievement: The emergence of a social cognitive perspective. *Educational Psychology Review*, *2*(2), 173-201.

Zimmerman, B. (2001). Theories of self-regulated learning and academic achievement: An overview and analysis. In B. Zimmerman, & D. Schunk (Eds.), *Self-regulated learning and academic achievement: Theoretical perspectives* (p. 1-38). Mawah, NJ: Erlbaum.

Zimmerman, B., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, *29*(3), 663-676.