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DEVELOPMENTAL MATHEMATICS IN TWO-YEAR COMMUNITY

COLLEGES AND STUDENT SUCCESS

By

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Dissertation

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Developmental Mathematics In Two-Year Community Colleges And Student Success

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Poor success rates of developmental mathematics courses at community colleges have currently received nationwide attention. Efforts to remedy the situation include complete course redesigns and intervention strategies. A recent intervention strategy in use is the implementation of success courses that are aimed at changing the learning perspectives of developmental students. The purpose of this mixed-method comparative study was to closely examine this strategy as it relates specifically to students studying developmental mathematics at the lowest level at one community college. Students taking the lowest level developmental mathematics course at the participating community college were designated into one of two groups: those taking mathematics with the success course and those taking mathematics without a success course. The study explored students' perceptions and belief structures regarding the study of developmental mathematics and focused on identifying any changes in student belief structures over the course of one semester. Descriptive statistics regarding grade achievement of the population with the student success course provide insight into the possible benefits of the success course for developmental mathematics students. Participants in the study, starting out in the lowest mathematics course offered at the community college, need more mathematics in order to obtain a degree or certificate from the college. Rate of registration for the subsequent mathematics courses were also analyzed in the study.

Findings showed that the offering of a success course to students who are at-risk in developmental mathematics has made some improvements in the percentage of students who were able to satisfactorily complete the first level developmental mathematics course at one community college. It also showed that for students who did not pass the success course, there was a nearly one-to-one relationship with unsuccessful completion of a low-level mathematics course. Qualitative data helps explain how the two groups were quite different and also helps to explain findings.

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Finally, I wish to thank my children and husband. Their faith in me provided a foundation which sustained my efforts and work.

DEDICATION

My focus and attention on this research was balanced with the joy and awe of watching my grandchildren learn and grow. They have reminded me of the creative and curious nature of our minds. Their love for learning, I hope, will continue to grow and will be strengthened through the years, knowing that life-long learning is available to anyone who chooses it. I dedicate this work to my current and future grandchildren.

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CHAPTER I

THE PROBLEM

Professional interest on the part of the researcher guided the creation of this study on developmental mathematics. While teaching a variety of mathematics courses at a community college over the past 15 years, the researcher noticed a prevailing phenomenon particularly apparent with students entering the lowest level mathematics course. The observation is of no surprise to any educator or active community member. The phenomenon is that regardless of age nearly every student taking a beginning mathematics course at a community college will, given the chance, profess either a complete disdain for mathematics, an anxiety for mathematics or the fact that they are “just not good at mathematics”. These observations resonate from students who are responding to the course in terms of their prior experience with the subject (Cherkas, 1992). Qualitative researchers (Caniglia & Duranczyk, 1999; Cherkas, 1992; Khazanov, 2007; Stage & Kloosterman, 1995; Weinstein, 2004) in particular have identified similar characteristics of developmental mathematics students including negative mathematic learning histories, unusual time gaps between courses, low self-confidence, math anxiety, negative self-talk, and math avoidance or deep rooted aversion to mathematics.

Upon further observation of the phenomenon one begins to see that some of these students, even those with some of the strongest negative belief structures, are able to successfully complete a developmental mathematics course and subsequently continue through multiple mathematics courses ending with satisfactory completion of

college level mathematics courses. Most students, however, allow negative beliefs to regulate the outcome, and are unsuccessful. It would seem that regardless of pedagogy, curriculum and support efforts, some students are able to adopt a learning model that allows them to overcome negative belief structures and form new ones. Unlocking the mystery of how these students are able to overcome these hurdles and succeed is currently a focus for interested educators, researchers, and nationwide movements in education.

The purpose of this study was to explore the relationship of a student success course that focuses on changing student learner belief structures and success in developmental mathematics at one particular community college in Minnesota. This comparative study investigated changes in belief structures using qualitative data collection and analysis. Descriptive statistics reporting grade achievement and subsequent semester registration provide further insight into the phenomenon. The study provides a glimpse of how a student success course might be helpful in facilitating change in belief structures that inhibit students from reaching post-secondary mathematical goals. Qualitative data provide insight into how these developmental mathematics students see themselves as learners.

Background of the Problem

Community colleges came into existing in America around 1901 in an answer to social calls to broaden access to higher education and training opportunities (Boggs, 2010). The movement to respond to local economic and industrial needs soon took off, by 1915 there were 15 Junior Colleges in the nation, including one in Minnesota.

The movement continued such that, during the 1960s an additional 457 public community colleges were opened. As noted by Ratcliff (1986), “the early colleges were philosophically committed to equal-access, equal-opportunity education, offering both vocational and transfer curricula” (p. 15). This was in a response to local communities’ concern that universities were inaccessible to general public due to distance from students’ homes and lack of financing.

Although community colleges have been fulfilling their missions for around 100 years, during much of this time they were invisible players in higher education. Currently, new attention is being focused on this uniquely American model of higher education as our nation begins to focus on ways to move a generation forward economically. With the number of community colleges today being 1,166 (American Association of Community Colleges, 2012), many are identifying community colleges as unique and powerful channels in bringing workforce skills to more people (Hagedorn, Siadat, Fogel, Pascarella, & Nora, 1999). National success in mathematics is in the forefront of these economically driven movements. In October, 2010, *The Huffington Post* reported on a recent White House Summit on community colleges at which President Obama addressed the issue:

Calling community colleges the "unsung heroes of America's education system," Obama said community colleges "may not get the credit they deserve, they may not get the same resources as other schools, but they provide a gateway to millions of Americans to good jobs and a better life". Obama's goal of adding 5 million more community college graduates over the next decade would represent a 50 percent increase in the number of students graduating, according to the American Association of Community Colleges. It's a crucial piece of Obama's goal for the U.S. to produce the highest proportion of college graduates in the world by 2020 (Gorski, Turner, & Superville, 2010).

Community colleges offer open door policies and affordability so that students of all backgrounds can begin or refresh their education. Many minority, low-income, and first-generation students find community colleges to be a gateway to higher education (American Association of Community Colleges(AACC), 2009).

Community colleges have a unique population mix of traditional and non-traditional students; the average age of a community college student is 29 (AACC, 2009).

Currently, “community colleges provide access to higher education to the most diverse student body in history. It is diversity in every respect: age, ethnicity, nationality, socioeconomic status and degree of disability. Forty-seven percent of the first-generation college students, 53% of Hispanic students, 45% of Black students, 52% of Native American students and 45% of Asian/Pacific Islander students attend community colleges” (Boggs, 2010, p. 3). Furthermore, half of all students who receive a baccalaureate degree attend community college during their undergraduate studies (AACC, 2009; Boggs, 2010).

These characteristics make for a unique higher-education experience for students at community colleges, but also present challenges for community colleges to address the needs of students from a wide variety of backgrounds and future plans.

This is particularly reflected for many schools in regards to developmental mathematics instruction at community colleges. The ability of community colleges to teach to multiple level students is a complex system of placement testing, developmental mathematics course offerings and instructor sensitivity. Currently the number of students entering these institutions who are placing into developmental

mathematics courses is increasing, while completion and retention rates remain low. For example, all community colleges in the United States and the majority of all universities offer at least one developmental course (Kozeracki, 2002). Moreover, Kozeracki (2002) found that 55% of community colleges reported increased enrollment in developmental courses over the last five years. In Minnesota, enrollment in developmental education courses rose about five percent between 1999 and 2005 (Russell, 2008). Furthermore, McCabe (2003) contends that half of community college students enroll in at least one developmental course and of that only half complete the courses satisfactorily. Although these numbers include both developmental English courses as well as mathematics courses, it is clear that developmental education at community colleges is a thriving trend.

Contemporary schooling is impressively large, and held in high regard by governments and citizens for its perceived ability to enhance the quality of life (Brint, 1998). The sociological schooling of children in our society therefore structures curriculum with focus and sequencing (Brint, 1998). This is especially true in the study of mathematics. Some claim that this forced sequencing of mathematical topics that exists in our schools today is the root of the problem of underprepared adults in mathematics (Lockhart, 2002; Neill, 1977). Lockhart (2002) and Neill (1977) contend that when students are forced to learn topics that are unrelated to their own lives and interests, boredom and rejection will inevitably result leaving the student with an incomplete understanding of the subject and a hodgepodge of random facts, in

addition to leaving students with negative mathematical experiences that shape learner belief structures.

Other reports suggest that students should be encouraged to take more structured mathematics courses and to study mathematics past Algebra II topics in high school. Adelman (2006) studied post-secondary remedial education and found that less than half of high school graduates are prepared for college level mathematics. A disconnect between high school curriculum and college expectations is a possible result. Adelman (2006) addresses mathematics learning:

There is a quantitative theme to the curriculum story that illustrates how students cross the bridge onto and through the postsecondary landscape successfully. The highest level of mathematics reached in high school continues to be a key marker in pre-collegiate momentum, with the tipping point of momentum toward a bachelor's degree now firmly above Algebra 2. But in order for that momentum to pay off, earning credits in truly college-level mathematics on the postsecondary side is *de rigueur*. The world has gone quantitative: business, geography, criminal justice, history, allied health fields—a full range of disciplines and job tasks tells students why math requirements are not just some abstract school exercise. By the end of the second calendar year of enrollment, the gap in credit generation in college-level mathematics between those who eventually earned bachelor's degrees and those who didn't is 71 to 38 percent. The same magnitude of disparity among community college students in relation to earning a terminal associate degree exists. The math gap is something we definitely have to fix. (p. xix)

From a sociological perspective, the functionalistic theories relate to the historical perspective of the problem. Among the purposes for schooling within this theory are an acquisition of cognitive knowledge and skills, preparation for later work force, and the selection and training of the work force (deMarrais & LeCompte, 1999). Mathematics coursework at all levels has historically followed these ideals. Our nation's K-12 system was never designed to prepare all students for college; a

traditional view held that only the top 15% of all graduating seniors would proceed to college, and often it was perceived that the mathematical ability of the student was an indicator of whether or not postsecondary education was appropriate (McCabe, 2003). From a structural functionalism approach, we might note how the higher education of these underprepared students disturbs the equilibrium of the system. As youth now recognize that a high school education alone will not sustain them for the future economic climate, more individuals seek post-secondary degrees while the system still operates under traditional foundations. Addressing these issues at the secondary level, the Common Core State Standards Initiative (National Governors Association for Best Practices & Council of Chief State School Officers, 2010), posits mathematical practice and content standards for each grade level, K-12, with a focus on preparing youth for college and the workforce. These efforts bring focus to the problem as we look toward the future; however, currently many mathematically underprepared traditional and non-traditional students find access at community colleges in the hopes of acquiring career and college skills. We now know from research that people's intellectual growth is much more than an IQ test and has more to do with having a the proper mindset (Dweck, 2006). Therefore, the challenge before us is to begin to understand the phenomenon from multiple perspectives so that a greater percent of the population can be successful in college level mathematics.

Statement of the Problem

Many community colleges begin their developmental course offerings with a basic mathematics course often called pre-algebra. It is roughly equivalent to an

eighth grade mathematics course and usually contains topics such as working with decimals, percents, fractions, proportions, expressions, and simple equations.

Although data of success rates vary from community college to community college, organizations such as the National Council of Academic Transformation have reported that most community colleges have a success rate of about 30% in these developmental courses (Twigg, 2003). Students who test into and register for pre-algebra have the odds against them for reaching and completing a college level mathematics course. While colleges search for solutions to increase the retention and success rates of this population of students through mathematical curriculum and pedagogies, many are simultaneously looking for campus-wide solutions that might increase student retention and success. Some colleges are beginning to require first year students to complete a freshmen orientation course that focuses on student awareness, emotional maturity, self-responsibility, self-esteem and the creation of a learning mindset. Many colleges call these courses First Year Experience, Orientation or Student Success. For the purpose of this study they will be referred to as student success courses. Although many colleges have implemented these course additions, and some even mandate all freshmen to register for them, little is known of their effects on developmental mathematics students. Many community colleges, in an effort to create data-informed policy, have tracked these initiatives and report positive results in retention and success in developmental education in general by these efforts. However, few colleges have tracked the effects for developmental mathematics

students as a group, and even fewer seek to explain how or why these courses aid student improvement.

Purpose of the Study

The purpose of this study was to closely examine the intervention strategy of a student success course, called First Year Experience (FYEX), as it related specifically to students studying developmental mathematics at the lowest level at a Minnesota community college. This concurrent mixed-method comparative research study explored students' perceptions and belief structures regarding the study of mathematics. In particular, the study focused on identifying any changes in these beliefs in the course of the fall semester 2011. Two groups of students were identified: those enrolled in both a low-level developmental mathematics course and a FYEX, and those enrolled in developmental mathematics course, but not FYEX. Course completion grades were analyzed using descriptive statistics between the two groups. In addition, students in both groups were tracked to the subsequent semester registration noting intent to continue the study of mathematics. The following research question guided the inquiry.

Research Questions

Quantitative Research Questions

What is the difference, if any, between success and persistence of studying mathematics of students taking the lowest developmental mathematics course at a community college concurrently with a student success course and those who take the lowest developmental mathematics course without a student success course?

Descriptive questions:

1. What are the students' achievement levels (or grades) in the lowest level mathematics course while taking a student success course?

2. What are the students' achievement levels (or grades) in the lowest level mathematics course without taking a student success course?
3. At what rate do students taking a low-level developmental mathematics course with a student success course register for subsequent mathematics courses?
4. At what rate do students taking a low-level developmental mathematics course without a student success course register for subsequent mathematics courses?

Qualitative Research Questions

How are student perceptions similar or different between the two groups throughout the semester?

1. What obstacles interfere with student studies in mathematics and what skills do they have to counter these obstacles?
2. How do they feel about mathematics?
3. What do they do to gain mathematical skills and understanding?
4. How do they see themselves as learners in a mathematics class at a community college? Does this change over time? If so, how and why?

Importance of the Study

The current national challenge of bringing a greater percent of the population into college level mathematics affects many degree programs and contributes to the training of a nation's workforce. The study does not solve the problem, but does provide a glimpse into the possible benefits of such a course for underprepared mathematics students as well as contributing to the research on how these students see themselves as learners of mathematics. Educators may find it helpful in understanding how to better serve the population of students who begin college mathematics at the pre-algebra level. Administrators might find it helpful to determine which population of students can best be served by using the student success course intervention strategy.

Definition of Terms

The following terms will be used extensively throughout the study.

Developmental mathematics: The term “developmental” is synonymous with remedial. The term developmental mathematics will refer to any college level mathematics education considered to be below the level of college algebra (Howard, 2008).

Remedial mathematics course: mathematics course offered at a postsecondary institution to prepare a student for a college-level entry mathematics course (Howard, 2008).

Developmental mathematics student: one who has tested into a developmental mathematics course, either through the ACT score or the college placement exam (Howard, 2008).

Learning experiences: students’ experiences in an educational setting in which mathematics’ understanding takes place (Howard, 2008).

Students’ attitudes: students’ beliefs and emotions regarding their knowledge of mathematics and their capability of learning mathematics (Howard, 2008).

Math anxiety: an intense feeling that one cannot perform efficiently in situations that involve the use of mathematics.

Intervention strategy: programs or initiatives designed to make significant progress on improving outcomes for students who arrive at community colleges with weak academic skills (Bailey & Cho, 2010).

Redesign Efforts: course-redesign projects that focus on large-enrollment, introductory courses that reach significant student numbers. The redesign methodology addresses higher education's primary challenges of enhancing quality, improving retention, expanding access, and increasing institutional capacity (Twigg, 2005).

Student success course: a course designed to facilitate self-development through a variety of exercises and activities that relate to their personal and educational development (Derby & Smith, 2004). Sometimes referred to as first year experience courses or orientation courses.

Pre-algebra course: a course for students whose placement test score indicates the need for a review of fractions, decimals, ratios, proportions, percents, signed numbers, polynomials/like terms, and solving basic linear equations in one variable before beginning elementary algebra.

Community College: community college has become used generically in higher-education literature to refer to all colleges awarding no higher than a two-year degree

Two-year college: "all institutions where the highest degree awarded is a two-year degree (i.e., associate of arts, associate of science, associate of general studies, associate of applied arts, associate of applied science). Generally, community colleges are comprehensive institutions that provide: (a) general and liberal education, (b) career and vocational education, and (c) adult and continuing education. Yet many two-year colleges do not offer the comprehensive curriculum just outlined, and

therefore are not truly community colleges in this comprehensive use of the term”

(<http://education.stateuniversity.com/pages/1873/Community-Colleges.html#ixzz1qd80hQB4>).

Technical college and technical institute: those institutions awarding no higher than a two-year degree or diploma in a vocational, technical, or career field. Technical colleges often offer degrees in applied sciences and in adult and continuing education. Also, there are technical institutes with curricula that extend to the baccalaureate, master's, and doctorate (i.e., Massachusetts Institute of Technology, Rensselaer Polytechnic Institute), but these are not community colleges”

(<http://education.stateuniversity.com/pages/1873/Community-Colleges.html#ixzz1qd8bR1my>).

Junior college: “an institution whose primary mission is to provide a general and liberal education leading to transfer and completion of the baccalaureate degree. Junior colleges often also provide applied science, adult and continuing education programs as well” (<http://education.stateuniversity.com/pages/1873/Community-Colleges.html#ixzz1qd7sDnnp>).

Epistemological beliefs: Learners’ general understanding about the nature of knowledge and learning (Cole, Geotz & Willson, 2000).

Students who are at-risk: The participating college intervention strategy targeted students who are at risk and defined these students as those who are first generation college students, Pell-grant students, students of color and students testing

into developmental English by completing the Accuplacer placement exam (personal correspondence from participating college FYEX coordinator, April 4, 2012).

Summary

Developmental mathematics curriculum at community colleges usually refers to course offerings which are below college level. They are usually offered in a variety of delivery options and often as self-paced. They can range anywhere from one to five semester credits. Students usually pay per credit for the courses and although the courses are reflected on transcripts and calculated into GPA's, students do not receive any college credit for them. They exist as pre-requisites for college level mathematics courses that are required for degree programs. In an effort to increase student success, many community colleges require college entrance placement exams to determine which course incoming students should begin with. Mandatory placement efforts at many campuses prohibit students from by-passing these pre-requisite courses if they have tested into them. With the increase of students testing into developmental mathematics at community colleges coupled with the reported low success rates of passing, efforts have begun to analyze and rectify the problem.

In the following, Chapter II, a literature review highlights the recent research regarding the problem of low success in developmental mathematics. Research addressing effective educational settings for developmental mathematics are discussed along with current ideas of course redesign and intervention strategies. Current research suggests a connection between belief structures and academic success.

Chapter II contains a thorough examination of the research exploring developmental mathematics students' beliefs. A brief review of the history of community college development is also included.

CHAPTER II

LITERATURE REVIEW

Chapter I presented the research study which examined the intervention strategy of student success course, called First Year Experience, FYEX, as it related specifically to students studying developmental mathematics at the lowest level at a community college in Minnesota. Along with quantitative descriptive analysis of student grade achievement, this mixed-method comparative study also explored students' perceptions and belief structures regarding the study of developmental mathematics. Chapter II addresses the literature pertaining to the research study and includes a brief history of community colleges followed by categories of educational settings for effective learning in developmental education, current intervention and redesign efforts aimed at increasing student success in developmental mathematics, and developmental mathematics students' beliefs.

The literature review engaged the use of the Mansfield Library of The University of Montana on-line databases including ERIC (Education Resources Information Center) and JSTOR, where searches of scholarly journal articles and publications were executed using keywords including community colleges, developmental mathematics, student perceptions, student beliefs, remedial college mathematics instruction, student success, interventions, redesign, and college success courses. In addition, professional industry Web sites including the American Mathematical Association of Two-Year Colleges, American Association of

Community Colleges, National Council of Teacher of Mathematics, U. S. Department of Education, Community College Research Center, National Association of Developmental Education, ProQuest Dissertations and Theses, Problems and Issues in Mathematics Undergraduate Studies, National Center for Postsecondary Research, and National Council of Academic Transformation were searched for information relative to the research questions. Reference lists of relevant articles were closely examined and aided in the acquisition of further literature pertaining to the problem. Published books also aided in the collection of pertinent literature.

History of Community Colleges

Community colleges came into existence in America around 1901 in an answer to social calls to broaden access to higher education and training opportunities (Boggs, 2010). Most historians agree that the founding of Joliet Junior College, near Chicago, Illinois, in 1901 spearheaded the social movement which intended to remove economic, mobility and social barriers for students seeking post-secondary education. William Rainey Harper, the president of the University of Chicago, and J. Stanley Brown, the principal of Joliet High School, collaborated to found Joliet Junior College, a institution that is still in operation today (Boggs, 2010). Ratcliff (1986) provided insight into the struggles on the evolution of community colleges during this reformist period. He contends that,

Education is basically reformist in orientation. Educators' interest in how people and institutions change is based on their desire to improve the content, processes, and organization of education. The evolution of community and junior colleges is a case in point. These institutions evolved as part of an effort to improve upon the structure and efficiency of higher education. Along with the advent of the state university, the two-year college represents an

American innovation in the reform of the structure of higher education.
(Ratcliff, 1986, p. 151)

These efforts in most states, Ratcliff (1987) professes, were layered with obstacles such as: support of various interest groups needed development, passage of state legislation had to be garnered and relationships with neighboring four-year institutions needed to be fostered to allow transfer of credits. Despite these challenges, the early founding community colleges thrived and more and more came into existence. By 1915, there were fifteen junior colleges including one in Minnesota. Community colleges continued to be established around the nation. For example, during the 1960s, 457 more community colleges were opened; this was more than the total existence before that decade (American Association of Community Colleges, 2012). As noted by Ratcliff (1986), the early community colleges were philosophically committed to equal access and equal-opportunity education, offering both vocational and transfer curricula.

The 1,166 community colleges of today educate more than half of the nation's undergraduates (AACC, 2012). "Each community college is a distinct educational institution, loosely linked to other community colleges by the shared goals of access and service. Open admissions and the tradition of charging low tuition are among the practices they have in common. But each community college has its own mission" (AACC, 2012, p.1). These missions typically align with local partnerships to build a sense of community, making facilities available to civic groups and providing remedial services for underprepared local students. All of the United States

community colleges now offer courses in developmental general studies (Kozeracki, 2002).

Educational Settings for Effective Learning

At the heart of effective learning in the developmental mathematics is the examination of the current classroom environment and teaching efforts. Research efforts to bring these stories to the forefront of developmental education have focused both on educators' philosophies and pedagogy along with identification of institutional obstacles to improvement. Studies have shown that developmental mathematics instructors at community colleges typically show concern and respect for students. However, this field is often times saturated with part-time or adjunct faculty members that come and go quickly (McCabe, 2003). Institutions spend little time or effort in identifying and executing effective teaching strategies for developmental mathematics (Grubb, 2010; McCabe, 2003). Of educators that consistently teach in developmental mathematics, inconsistencies exist between faculty philosophy and classroom environment. For example, many educators verbalize philosophies of teaching consistent with constructivist theories while their teaching aligns more with behaviorism (Grubb, 2010). Grubb views these pedagogical approaches as polar ends; "on the one hand are those pedagogical approaches called constructivist, student-centered, conceptual, active, teaching for meaning, or innovative, while others are called behaviorist, teacher-centered, traditional, conventional, informational transfer, or passive" (Grubb, 2010, p. 3). Balanced teaching is pedagogy that draws from both schools of thought. His study regarding developmental programs in thirteen

community colleges in California found that “the vast majority of instruction follows the practices of remedial pedagogy, which involves drill and practice on small sub-skills that most students have been taught many times before, in de-contextualized ways that fail to clarify to students reasons for or the importance of these sub-skills” (Grubb, 2010, p. 9). Grubb (2010) outlines several reasons that support more constructivist or balanced approaches of instruction.

In particular, the review of engagement and motivation outlines several recommendations for engaging instruction. Students are more likely to be motivated in programs with close adult-student relationships; where they have some autonomy in selecting tasks and methods; where they can construct meaning, engage in sense-making on their own, and play an active role in learning; in well-structured education environments, with clear purposes, a challenging curriculum, high expectations, and a strong emphasis on achievement; when students have multiple paths to competence; and when students can enhance their understanding of school and its relation to future goals. But most teaching in basic skills, especially the remedial pedagogy, does not look like this (Grubb, 2010, p. 5).

Although Grubb (2010) found that most instructors at community colleges believe in balanced approaches to instruction, the community college environment for remedial instruction often interferes with improvements or innovations in teaching. He identified part-time faculty, popular viewing of developmental courses as basic skills and the complexity of developmental student population as some of the components that stand in the way of making improvements in developmental instruction.

In addition to Grubb (2010), Baker and Epper (2009) found that “the content/coverage issue is the single most common reason mathematics instructors give for not transforming their practice. [Instructors] claim that they do not have time to be innovative; they have to cover ten chapters” (p. 9). However, their study found that

when pre-algebra concepts were reduced by one-third and practical applications for essential concepts were provided to students, retention and success rates increased (Baker & Epper, 2009).

Other studies have examined the heart of the matter more thoroughly, questioning the cultural structure of mathematics education in the college classroom. For example, Stage (2001) examined the symbolic interaction in college mathematics in both remedial and college level mathematics. Stage contends that the instructor holds the only real meaning of mathematics in the college classroom; students' meanings are of little value and may or may not develop in complete isolation of the classroom. Even the most successful students in Stage's study lacked vocabulary and fluency of understanding exactly what they were symbolically manipulating. Weinstein (2004) concurred with the balanced instructional approach in developmental mathematics and focused on how negotiation over conflicting meanings for mathematical language and symbols is relevant for educators in developmental mathematics. His work looked at both cognitive and sociocultural factors.

While most research on developmental mathematics in community colleges mentions the importance of quality instruction in the classroom, few place a major focus on it; instead a great amount of literature focuses on college intervention strategies and course redesigns.

Intervention and Redesign Efforts

Recently, the problem of increased numbers of adult students needing remedial or developmental mathematics programs nationwide has caught the attention of many administrators and organizations. There is a national movement to explore best practices specifically relating to developmental education. Large scale initiatives such as the Lumina Foundation's Achieving the Dream and Getting Past Go, and MDRC's (formerly known as the Manpower Demonstration Research Corporation) Opening Doors provide reports highlighting the poor success rates of developmental education, but also provide hope that some interventions may be having a positive effect. Many of these reports include data which support inclusion of learning communities, accelerated learning programs, success courses, intrusive advising, supplemental instruction and summer bridge programs for developmental students (Bailey & Cho, 2010).

In addition, redesign efforts involving restructuring course contents and delivery methods are rapidly spreading across the country. For example, The National Center for Academic Transformation promotes transition from sequential developmental course offerings to emporium, modular instruction. Case studies of community colleges that have engaged in complete re-designs of developmental course offerings have been highlighted by this organization (Twiggs, 2003, Baker & Epper, 2009). These redesign efforts focus on new technologies that allow students to skip mastered topics and focus on remediating only weaknesses. This moves away from the cultural sequencing of mathematical topics and considers the point that while

mathematics exposure in formative years may be culturally fairly consistent, retention and understanding of mathematical topics exists at many different levels for adult students.

Strategies to accelerate the movement through the developmental mathematics sequence is also gaining attention as research identifies the negative correlation between time spent in remediation and certificate and degree completion (Baker & Epper, 2009).

Within the research, no articles could be located that addressed or explored the relationship of student success courses on developmental mathematics students. Two research studies however did find that students taking success or orientation courses gained advantages as far as the completion of degree or credential programs. Zeidenberg, Jenkins and Calcagno (2007) found that among students who needed a least one remedial course, those who passed a success course were more likely than non-completers to achieve the earning of a community college credential, transferring to the state university or remaining enrolled in college after five years. Derby and Smith (2004) also found that a greater proportion of students who took the orientation course obtained their degrees than did those students who did not take the orientation course.

One study was found that examined the effects of formal mathematics study skills instruction on remedial mathematics achievement. This quasi-experimental, retrospective study found that study skills instruction did not increase remedial mathematics student achievement (Bogardus, 2007). Her study examined 90 students

who were enrolled in four Math Fundamental classes. The 90 students were divided into two groups. One group included 46 students who received only mathematics instruction while the other group of 44 students received mathematics instruction and formal study skills instruction. Using pre and post tests Bogardus (2007) found that the control group scored significantly higher on the post test than the experimental group did. Thus the study concluded that instruction in formal mathematics study skills does not improve remedial mathematics student achievement. Even though Bogardus' study did not use randomized assignment that greatly limits the generalizability of the study, the contribution of the project to the greater body of work is interesting and begs the question of whether there is something a bit deeper than study skills that have a great impact on students in developmental mathematics. Perhaps careful identification of how these students see themselves as learners and clearer identification of which groups of students could benefit from such interventions would be appropriate for future research efforts. Moreover, an experimental design including a greater population using random samples and control groups may lead to a better understanding of whether or not formal mathematics study skill instruction can lead to more success for students.

Much of the research professes not only the complexities of the issue of developmental education, but also the poor state of achievements across the nation. There is a wealth of quantitative data available which supports the need for changes. Moreover, many initiatives and studies focus on developmental education as a

program; few examine closely how efforts are affecting developmental mathematics specifically.

Student Attitudes and Beliefs

A recurring theme in the literature on developmental mathematics is the identification of the characteristics of developmental mathematics students and how they view themselves as learners of mathematics. Khazanov (2007) noted, for example, that “many [remedial math] students lack motivation and bring to the classroom the adolescent attitudes characterized by vesting all the responsibility for their learning in the hands of the instructor” (p. 158). Stage and Kloosterman (1995) profess that of remedial mathematics students, “beliefs about learning and doing mathematics seem to be key to many students’ inability to focus themselves enough to survive mathematics courses that they see as both emotionally and cognitively difficult” (p. 295). “Perception of one’s ability in mathematics, which is a belief about oneself as a learner of mathematics, was a significant predictor of the value of mathematics and a strong predictor of expectation of success” (p. 296). Moreover, Cobb (1986) contends that “beliefs are an essential aspect of meaning making in general and of mathematical meaning making in particular” (p. 2).

Cherkas (1992) examined essays from remedial mathematics students and found them to be “replete with ingrained misperceptions about mathematics, such as: it is all just so much memorization; there is only one right way to do a problem; or it shouldn’t be expected to make sense” (p. 84).

Caniglia and Duranczyk (1999) collected autobiographies from developmental mathematics students over a two year time period exploring the conditions that affect students' attitudes toward mathematics and trends that emerge from students' writing that may indicate ways of altering perceptions of mathematics. "The characteristics of developmental math students as revealed through their math autobiographies were similar to the findings of Stage and Kloosterman (1995). Many students possessed negative math and learning histories with unusual time gaps between courses. "Their writings included failure identifiers, math anxiety, negative self-talk, and math avoidance" (Caniglia & Duranczyk, 1999, p. 52). The literature clearly articulates an overwhelmingly negative or naïve epistemological belief structure that is common for developmental mathematic students.

These epistemological beliefs influence self-regulated learning (Cole, Goetz, & Willson, 2000) and fall into two major categories; beliefs about the nature of learning, such as control and speed of acquisition and beliefs about the structure, certainty, and source of knowledge. Within these parameters Schommer and Walker (1997) identified four epistemological continua: (1) *fixed ability*, ranging from the ability to learn is fixed at birth to the ability to learn can be improved; (2) *simple knowledge*, ranging from knowledge is a collection of isolated bits and pieces to knowledge is a complex interrelated network; (3) *quick learning*, ranging from learning is quick or not at all to learning is gradual; (4) *certain knowledge*, ranging from knowledge is unchanging to knowledge is evolving. Cole, Goetz and Willson (2000) explored epistemological beliefs of underprepared entering students at a four-year institution.

Their study examined 101 underprepared undergraduates who participated in a summer program that was designed for remediation. Students in the study were classified as provisional by the university and were enrolled in two 5-week summer sessions. During the first 5-week session the students took two courses, a study skills course and an introductory course in history, sociology, psychology, English, political science, or algebra. Two more introductory courses were completed during the second 5-week session. The questions that this study hoped to answer included the following: What are the epistemological beliefs of entering students, and, do epistemological beliefs change after initial college exposure? The Beliefs About Learning Questionnaire (Jehng, Johnson, & Anderson, 1993) was used to collect pre and post epistemological beliefs of underprepared students. Expanding the work of Schommer and Walker (1997), Jehng et al. found five dimensions of beliefs: certain knowledge, rigid learning, innate ability, omniscient authority and quick process. Students were characterized along a continuum ranging from naïve (less facilitative of learning) to sophisticated (more facilitative of learning) in the five dimensions. The study found that Quick Process was the only one that had a significant shift towards sophistication. Their study confirmed, however, that these dimensions are independent of one another and that the epistemological beliefs of underprepared students were generally naïve (Cole et al., 2000). Their conclusion is pertinent to understanding underprepared students:

The concept of epistemological beliefs suggests that in order to be academically successful, the student must have appropriate beliefs about learning and knowledge. We challenge that tooling students with reading and learning strategies may not be enough to facilitate academic success. Rather,

we must find ways to help students believe that knowledge is not always certain, that abilities can be fostered and developed, that faculty and textbooks don't contain the "answers" and that learning is often a long and complicated process. It is only with these understandings that students may transition from underprepared to academically successful, lifelong learners. (Cole et al., 2000, p. 66)

Palmer and Marra (2004) found that individual learners rarely have consistent epistemological beliefs across domains. Moreover, they contend that shifts of epistemological beliefs toward sophistication could be domain specific. In their qualitative grounded theory study they observed that a shift "from singular truth to multiple perspectives appears to happen more naturally in humanities and social sciences" (Palmer & Marra, 2004, p. 333) and less likely to occur in the sciences.

These studies regarding epistemological beliefs are crucial indicators of learning success for underprepared learners. While colleges continue to address poor success rates in developmental courses with external components, such research theories indicate a need for educators to focus more attention on how to move students toward more sophisticated belief structures. Placement tests for incoming freshmen currently focus on academic knowledge and skills, but rarely identify these crucial indicators of successful learning. Schommer and Walker (1997) indicate for example that epistemological beliefs should be considered in the college admissions process. Identification and instruction of students, who are in need of epistemological guidance in their early years of post-secondary education, perhaps could increase retention and learning success.

Students who place into developmental mathematics courses at community colleges not only have a more naïve epistemological belief structure (Khazanov, 2007; Cole et al., 2000; Stage & Kloosterman, 1995) but are also at a greater risk to suffer from math anxiety (American Mathematical Association of Two-year Colleges, 2007). Similar to the fixed ability belief continuum of Schommer and Walker (1997), Dweck (2006) found that many students believe the assumption that some people are just not good at mathematics. Extensive research into the mindsets of successful people begins to explain why some students will succeed and others fail. Dweck (2006) describes two types of mindsets; a fixed mindset, a belief that intelligence is a talent or attribute that one is born with or without, and a growth mindset, a belief that intelligence is malleable and that every experience provides a learning opportunity. Dweck found that individuals who display a growth mindset do not believe in failures, but rather view unreached goals as challenges that may need to be attacked from a new angle. Although the work of Dweck included students of mathematics, among other disciplines, extension of her theories with developmental mathematics students at community colleges could shed light on the current phenomenon.

Taking a closer look at specifically developmental mathematics students, Howard (2008) described experiences, attitudes, and learning strategies students believed contributed to their previous failures and current successes in learning of basic mathematics skills. Her phenomenological study focused on 14 developmental mathematics students who were identified by their current success in developmental mathematics, but had previous history of failures. She found that as students

experienced failure, they began to view themselves as incapable of learning mathematics; they viewed their ability as unchangeable, and they were in a state of learned helplessness. All of the students in her study were adults when they experienced success in learning mathematics. A turning point was noted where students made a conscious choice to learn mathematics. She noted how each student in the study had changed their belief structures; “they [now] believed that their ability was malleable and that if they put forth the effort, they could learn” (Howard, 2008, p. 160).

Success courses that focus on student awareness, emotional maturity, self-responsibility, self-esteem, and the creation of a learning mindset may help students’ move epistemological belief structures toward sophistication and thereby increase the likelihood of successful learning in developmental mathematics. Research clearly indicates a potential likelihood that these efforts could make a powerful impact in the lives of developmental mathematics students.

Conclusion

As research supports the need for attention to developmental mathematics, community colleges around the nation continue to seek solutions to the problem of low retention and success rates of developmental mathematics students. “Perhaps the most important implication for students is helping them recognize attitudes and behaviors that they can change to impact future math learning experiences” (Caniglia & Duranczyk, 1999, p. 52).

The purpose of this study is to contribute to the research by looking at how exposure to success courses that are designed to help guide students through these transformations might impact success for developmental mathematics students.

CHAPTER III

METHODOLOGY

Pragmatic position claims on knowledge derived from the work of Peirce, James, Mead, and Dewey (as cited in Creswell, 2003) focus on the problem and “what works” and is not committed to any one system of philosophy. Because mixed-method research draws liberally from both quantitative and qualitative data, pragmatic researchers can look at both the “what” and the “how” of a research problem providing the best understanding (Creswell, 2003). Mixed-method research is designed to clarify and explain relationships between variables (Fraenkel & Wallen, 2008). This mixed-method comparative study employed both qualitative and quantitative research methodologies for the purpose of gaining the best possible understanding of what is actually occurring for students in low level developmental mathematics courses who are also taking success courses. The design compared students taking pre-algebra along with a student success course with students who are taking pre-algebra without a student success course. Quantitative data provide a visual representation of whether these courses might contribute to increased grade achievement and persistence in the study of mathematics. Qualitative data collection focused on student attitudes and beliefs regarding how they view themselves as learners of mathematics and provides the reader with a rich description of student perceptions while attempting to capture the true voice of students. Both qualitative and quantitative research questions are posed.

Selection of Participants

Both qualitative and aggregated quantitative data were collected from students taking pre-algebra at a community college in Minnesota during the fall semester, 2011. In addition, aggregated quantitative data were obtained from the same community college for the spring 2010, fall 2010 and spring 2011 semesters. The participating community college was founded in 1915 and has the distinction of being the oldest public community college in Minnesota. Originally founded as a community college it became both community and technical college by state legislation requirement in 1996. Today this community and technical college upholds the mission to “provide accessible, affordable, quality learning opportunities to serve a diverse and growing community” (Supalla, 2005). It serves approximately 7,500 students in credit based programs and offers 70 credit-based programs and more than 130 credential options. The colleges’ largest programs include liberal arts, nursing, business, digital arts, and law enforcement. Unique programs include: Dental hygiene, equine science, horticulture technology, radiography, surgical technology, and veterinary technology. Demographic categories of age, gender, and ethnicity of the college are displayed in Table 1.

Table 1

Participating Community and Technical College Demographics (Supalla, 2005)

Ethnicity	69.9% Caucasian	19.9% Not reported	4.8% African American	3.5% Asian	1.9% Other
Age	60.9 % Over 21			39.1% 17- 21 years old	
Gender	61.9% Female			38.1% Male	

The Mathematics department at this community college comprises 16 unlimited full-time instructors as well as several adjuncts. Developmental mathematics courses are offered at a much higher rate than college level courses due to the population demand of the student body. For example a typical fall semester offers approximately 50-58 developmental sections while offering approximately 30 college level sections of a variety of courses. Developmental courses at this community college include Math 0093-Pre-Algebra (3 credits), Math 0098-Elementary Algebra (4 credits), Math 0099-Intermediate Algebra (4 credits), and Math 0100-Combined Elementary and Intermediate Algebra (5 credits). Students are required to take the Accuplacer placement test upon enrolling at the college. Students are electronically blocked from registering for courses that they have not tested into. Pre-Algebra, one of the largest populated courses on the campus, running approximately 28 sections with nearly 500 students each fall, is the gateway to students' ultimate success in college level mathematics. Even with a variety of teaching delivery methods including on-line, hybrid, individualized computer assisted, and traditional lecture, approximately 40% of students attempting this class do not complete it successfully. With all degree programs requiring a college level mathematics course and several credential programs as well, students testing into Pre-Algebra who are unsuccessful have serious consequences in reaching their ultimate goals toward graduation.

Like many other community colleges, the participating community college is beginning to focus on the implementation of success initiatives. It has recently explored initiatives of summer bridge program, intrusive advising, learning communities, supplemental instruction and the offering of a student success course. The student success course implementation process began with faculty work during the fall of 2010. The offering of a one-credit course called First Year Experience, FYEX, targeted students who tested into developmental English courses began in the spring of 2011. Fifteen sections each with a maximum of 20 students were delivered during that first semester. During the fall of 2011 the number of sections was increased to 30. Nearly all sections were set up to meet twice per week for the first eight weeks of the semester. Roughly 75% of the fall sections were paired with a developmental English class for registration purposes. In this way administration felt that the targeted population, Pell eligible, first generation, students of color and underprepared students, for the initiative would be realized. The remaining quarter of the courses was available for any student to register for. Advisors were encouraged to promote the success course to students who are at-risk. Table 2 provides diversity and gender demographics of the two semesters of FYEX students.

As we can see from Table 2, even though standalone courses of FYEX were offered and theoretically could have been taken by any student, over 90% of the FYEX students were students who tested into and registered for developmental English. It is important to note that the groups of students in FYEX in both semesters appear to have high academic need and may be disadvantaged learners.

Table 2

FYEX Demographics Spring and Fall 2011
(Administrative report meeting Thursday, April 12, 2012)

	Total FYEX enrollment	Registered for developmental English	Pell eligible	Students of color	First generation	Male/female
Spring 2011	194	190	60% (116)	33% (63)	36% (70)	49% Male 51% Female
Fall 2011	367	323	56% (205)	31% (113)	28% (103)	57% Male 43% Female

In addition to being a course that was designed to target underprepared students, FYEX was much more than a study skill course or college orientation course (See Appendix A for sample syllabi from FYEX 1000). Objectives that were covered included, in addition to student preparation issues and college resource exposure, topics that challenged students' epistemological beliefs. The course was taught using the text, *On Course* by Skip Downing and included a focus on aligning choices with the characteristics of successful learning including: accepting personal responsibility, discovering self-motivation, mastering self-management, employing interdependence, gaining self-awareness about beliefs and attitudes, adopting lifelong learning, developing emotional intelligence, and believing in themselves (Downing, 2011). A pre and post self-assessment enabled students to explore their own belief structures, while journal entries and class discussion allowed for a deeper connection with the material. The course is taught with a focus on active learning which often engages students in case studies or analogous situational exploration. Reflective writing is a

major component of assessment. The course foundation was established on three basic beliefs:

Belief 1: The most successful people (and learners) are empowered people. Empowered people are self-responsible, self-motivated, self-managing, interdependent, self-aware, emotionally intelligent, self-esteeming lifelong learners. They make choices that lead them toward their desired outcomes and experiences.

Belief 2: In formal education, the deepest learning is provided by well designed learner-centered experiences. All learning is ultimately created by what the learner does, not by what the educator says. Effective educators provide students with well-designed learner-centered experiences and the opportunity to reflect meaningfully on them.

Belief 3: At the intersection of an empowered person and a well-designed learner-centered experience lies the opportunity for deep, perhaps even transformational learning. (Downing, 2011)

Students taking pre-algebra during the fall semester of 2011 were separated into two groups. One group included students who were taking both a pre-algebra course and FYEX, and the second group included those who took pre-algebra, but not FYEX. Two research sites were populated on RCTC's D2L web browser site using the criteria above. The group of students who were enrolled in Pre-algebra along with FYEX was enrolled in a D2L course entitled Dissertation study: Math 0093 and totaled 163. The other group who were enrolled in Pre-Algebra, but not FYEX were in a D2L site entitled Dissertation study: Pre-algebra and totaled 340. Access to the sites was limited to the researcher alone. Using the D2L sites students were invited to participate in on-line, pre- post, qualitative surveys (see Appendix B) which focused on students' perceptions regarding the learning of mathematics. Access to on-line

surveys was restricted to those students who had read and electronically accepted the terms in the consent release form (see Appendix C).

In addition, representatives from each classified group were invited to participate at a deeper level by attending a focus group interview, writing journal entries, and allowing class observation. These participants were selected by instructor nomination. Diversity of populations, ability, and willingness of student to share feelings about mathematics learning, and strength of feelings were considered as participants were selected, however, some faculty felt strongly about including students based on observation and contributions in class. All faculty nominations were invited to participate in the qualitative data collection. All participants in this phase of data collection were informed of the study's intentions and were asked to sign consent release forms (see Appendix D).

The researcher is a mathematics faculty member at the participating community college. The decision to focus the study at this particular college was twofold. One is the advantage of familiarity with the success course components and teaching pedagogy. The researcher participated on a campus wide committee and helped organize the pilot FYEX course offering in the spring of 2011. Prior to spring 2011 this campus offered no student success course or orientation course. The second reason for including this community college is its ability to generate the two groups for the study. Many other colleges that have initiated this intervention have required all developmental students or all freshmen to take a success course. Although the

researcher taught one section of FYEX in the fall 2011, her students were excluded from the study.

Collection of Data

Qualitative Data

The collection of qualitative data began in the fall 2011 with on-line surveys during the second week of classes. The *Preliminary Survey of Students' Perceptions* (Howard, 2008) laid the foundation for the construction of the on-line survey. Questions regarding how students see themselves as learners of mathematics were added, as well as a small number of rated questions that were designed to provide insight to the existing belief structures of the students. The fall semester started on Monday, August 22. The first on-line surveys were completed on Tuesday, August 30th. Ninety percent of pre-surveys were completed by Monday, September 12, the third Monday of the semester. Students are allowed to drop and add classes freely during the first week. Freedom to move between sections and courses continues with instructor permission until the 10th day of classes. The on-line survey was made available to students during the second week of classes in the hope to ensure an accurate pre-existing belief structure from the students. Any student who dropped the class during this time was simply removed from the D2L site automatically and therefore, was not a participant in the study. All Pre-algebra students were invited to participate in the on-line surveys and were contacted through e-mail, (see Appendix E) by instructor and researcher announcements in classes, handing out flyers, welcome day booth, and D2L announcements. Most instructors who met their classes in

computer labs asked students to complete them during class time. The researcher visited 10 traditionally taught sections and provided information regarding the study and encouragement to participate. The researcher spent five days in the college entrance lobby handing out information as well. Instructors were asked to provide small classroom incentives for completion of the survey in the form of bonus points or homework at their discretion and were asked to report these (see Appendix F, communication with RCTC Pre-algebra instructors). No instructors provided information to the researcher that they had utilized classroom incentives. Three instructors verbally indicated to the researcher that they simply told their students “it is required, do it during class”. The post survey was executed in the same manner and was available to students November 28 through December 16. In addition to the recruitment efforts for participation in the on-line pre survey, the researcher added a lottery chance for all Post survey completers. Two students were drawn from the participants in the Post survey on Dec 16th and these two students each received \$20 RCTC bookstore gift cards. The pre/post surveys contained the same questions. The pre/post survey completion numbers in each group are displayed in Table 3. While the

Table 3

Pre/Post Survey Completions Fall 2011

	Students who completed Pre surveys	Students who completed Post surveys	Students who completed both Pre/Post surveys
Pre-algebra with FYEX	29% (47/163)	18% (29/163)	10% (17/163)
Pre-algebra without FYEX	40% (135/340)	20% (69/340)	14% (46/340)

breakdown of survey completers by gender, age, and ethnicity is described in Table 4, Table 5, and Table 6.

Table 4

Pre/Post Survey Completions Fall 2011 Gender

	Pre-algebra with FYEX –all individuals	Pre-algebra with FYEX – Pre/Post completers	Pre-algebra without FYEX	Pre-algebra without FYEX— Pre/Post completers
Female	54% (32/59)	76% (13/17)	69% (107/158)	82% (38/46)
Male	46% (27/59)	24% (4/17)	31% (51/158)	18% (8/46)

Table 5

Pre/Post Survey Completions Fall 2011 Age

	Pre-algebra with FYEX –all individuals	Pre-algebra with FYEX – Pre/Post completers	Pre-algebra without FYEX	Pre-algebra without FYEX— Pre/Post completers
18-20 yrs old	58% (34/59)	76% (6/17)	39% (61/158)	30% (14/46)
21-24 yrs old	20.3% (12/59)	24% (6/17)	15% (23/158)	9% (4/46)
25-30 yrs old	9% (5/59)	6% (1/17)	24% (38/158)	39% (18/46)
31-40 yrs old	10% (6/59)	12% (2/17)	15% (24/158)	11% (5/46)
41 or older	3% (2/59)	12% (2/17)	8% (12/158)	11% (5/46)

To gain further information regarding student perceptions, and to triangulate data, a sample of twelve students from each group was identified by instructor nomination to contribute more deeply to the collection of qualitative data. These students were identified and invited to participate by the fifth week of the semester

Table 6

Pre/Post Survey Completions Fall 2011 Ethnicity

	Pre-algebra with FYEX –all individuals	Pre-algebra with FYEX – Pre/Post completers	Pre-algebra without FYEX	Pre-algebra without FYEX— Pre/Post completers
Caucasian	76% (45/59)	94% (16/17)	78% (123/158)	89% (41/46)
African American	14% (8/59)	0% (0/17)	11% (18/158)	4% (2/46)
Asian	3% (2/59)	0% (0/17)	3% (5/158)	0% (0/46)
Native American	0% (0/59)	0% (0/17)	1% (1/158)	2% (1/46)
Hispanic	7% (4/59)	6% (1/17)	6% (9/158)	4% (2/46)
Non- reported	0% (0/59)	0% (0/17)	1% (2/158)	0% (0/46)

and were contacted by the researcher via e-mail. All faculty nominations were contacted and invited to participate, of 35 students nominated 24 (12 in each research group) agreed to participate and confirmed with the researcher to participate, of these 10 were able to follow through. Participation in this phase of data collection included attendance at one focus group interview session (see Appendix G, focus group protocol), to allow the researcher to engage in participant observation (see Appendix H, classroom observation protocol) in courses if deemed necessary, and to complete 4 personal journal entries (see Appendix I, journal entry prompts). Participation in phase two of the qualitative data analysis is displayed in Table 7.

The focus group interviews were conducted on Monday, October 24th and Thursday, October 27th and were facilitated by a professional educator. Focus group interviews were scheduled during the semester such that the FYEX course was

Table 7

Number of Students Participating in Research Activities

	Focus group interview # of student attendees	Journal entries completed by	Classroom observation	Follow up interviews
Pre-algebra with FYEX	4	4	2	2
Pre-algebra without FYEX	6	6	4	0

completed. The researcher met with the moderator three times prior to the focus group interviews to discuss protocol, answer questions, and to ensure a good understanding of the goals of the study. The researcher was a participant observer during the focus group interviews and recorded field notes of the events. The interviews were videotaped and transcribed and student brainstorming notes during the interview were retained.

Journal entries were submitted on-line using the research D2L sites. Journal entry drop box entries were spread out during the semester. Classroom observations were scheduled during the last third of the semester and included five total classrooms and six research participants. The researcher assumed the role of participant observer and had a research relationship with the students prior to the classroom observation. This relationship was nurtured by informal conversations following focus group interviews, and on-line communication regarding journal entries and scheduling activities. The classroom observations focused on student learning. The researcher asked questions of the students when clarity was needed. In this way many of the

observations, depending on the classroom environment, were at times conversational. Field notes were recorded for all classroom observations.

Because qualitative research involves an interchange of data collection and analysis (Strauss & Corbin, 1990) follow up interviews were in the research design as probable inclusions. Two informal student interviews were conducted in the spring semester 2012 as indicated in the chart above.

Quantitative Data

Pre-algebra final grades aggregated data were obtained from the participated community college for the following semesters; spring 2010, fall 2010, spring 2011, and fall 2011. Data indicating subsequent registration for mathematics course (the next mathematics course in the sequence) were collected for fall 2010, spring 2011, and fall 2011. Spring 2011 and fall 2011 data were separated into two groups, those Pre-algebra students also in FYEX and those Pre-algebra students not in FYEX. Table 8 identifies the population size for all pre-algebra students in a semester as well as population size of each group for the given semesters.

Table 8

Population Size of Aggregated Quantitative Data by Semester

Semester:	All pre-algebra students by 10th day of registration	Students in pre-algebra and FYEX	Students only in pre-algebra
Spring 2010	269	None	269
Fall 2010	507	None	507
Spring 2011	296	75	221
Fall 2011	503	163	340

The subsequent registration query identified Pre-algebra students who were registered for Elementary algebra after the 10th day of classes in the subsequent semester. Spring 2011 included both summer and fall semester enrollment as registration in subsequent semester. Fall 2010 data were used as comparison only as no FYEX course was offered during that semester.

For comparison of similar disadvantaged groups Spring 2010 and Fall 2010 data collection included identification of Pre-algebra students who were also in developmental English.

The quantitative data were aggregated; the researcher did not have direct access to numerical code identification of specific students.

Analysis of Data

Data analysis and validation procedures in mixed method designs occur both within the quantitative and qualitative approaches, and, also between the two approaches (Creswell, 2003). Two analysis techniques identified by Creswell (2003) for between the approaches were utilized in the study. The first, data transformation, creating codes and themes qualitatively, and then counting the number of times they occur in the text, (Creswell, 2003) was used to compare the two groups of the study while at the same time identifying changes in student belief structures. The second, exploration of outliers, was used to follow up on outliers in two areas of interest. One example of exploration of outliers occurred in a follow up with a student who had polar answers on a rated question in the pre-post survey. Another occurred with a student who failed FYEX, but, completed Pre-algebra with a C.

Quantitative analysis involved a comparison component where groups were selected without random assignment. Frequency tables for grade and subsequent registration were constructed and compared between groups. Significance tests were performed as necessary to explain relationships.

Qualitative comments by students were categorized by similar meanings and coded by category. These categories were cross examined using all data collection strategies including on-line survey question answers, journal entries, interviews and classroom observations between the two research study groups. Online survey answers were coded and enumerated. Pre and post surveys were analyzed at three different levels. The first level is that of all individuals who completed at least one survey, second level compared pre/post surveys as groups and the final level compared pre and post surveys of only individuals who completed both.

Rich text descriptions for qualitative data protect the identity of individual participants by using alternate names.

Validity

Historically, positivist views held that methods can guarantee validity. This position has since been abandoned by philosophers (Maxwell, 2005). Maxwell (2005) contends that validity is a goal rather than a product. Moreover, validity threats are made implausible by evidence, not methods; methods are only a way of getting evidence that can help you rule out threats. Nevertheless, the goal toward internal and external validity is a key issue in research designs.

Researcher Bias

The researcher is a mathematics faculty member at the participating community college and has a strong interest in learning about how developmental mathematics students can be successful, especially regarding the change of mindset. To this end, the researcher may have *seen* things from an *insider's* point of view. There is a greater risk of researcher bias in qualitative studies. Creswell (2003) indicated that at least two of his eight verification procedures should be utilized to verify the findings of a qualitative data. Triangulation, rich thick description to convey findings, clarification of researcher bias, and presentation of negative and discrepant information were utilized in the analysis of the qualitative data (Creswell, 2003). The researcher used comparative groups in both the quantitative and qualitative data collection and analysis. This is another way to minimize this threat (Maxwell, 2005)

Reactivity

The influence of the researcher on the setting or participants studied is generally known as reactivity. Individual interviews have a higher threat to reactivity than participant observation; to this end the design included individual interviews only if necessary to clarify emerging ideas. To minimize reactivity the researcher included focus group interviews, classroom observation, and journal writing. The triangulation of these collection strategies minimizes the possibility of this validity threat. Journal writing in particular provides a nonintrusive form of collecting data. It allows the individual participants time for personal reflections and can lead to clearly articulated

thoughts. Understanding possible reactivity between the researcher and participants is crucial to the research. Students of the researcher were not included in the study.

Generalizability

In qualitative studies “researchers usually study a single setting or a small number of individuals or sites, and they rarely make explicit claims about the generalizability of their accounts” (Maxwell, 2005, p. 115). Internal generalizability, however, is protected to some degree in the research plan. The *grouping* of these students is in theory random, but may be affected by student election in courses or advisor placement in courses, these transactions however are normal occurrences in every academic cycle at the community college. For this particular study events that unfolded during the study did have an effect on the randomization of the groups. In fact, since many of the stand alone FYEX courses were cancelled due to low enrollment, the two groups identified in the study were quite different from each other. Administration’s intent to focus the intervention strategy on students who are at-risk was defined by them to include students who were first generation college students, Pell-grant students, students of color and students testing into developmental courses, specifically developmental English. One can argue that such a group has quite a different makeup from the general population of students at RCTC and begins their college career disadvantaged. Within the group of students then who were taking Pre-algebra along with FYEX it was highly likely that these individual students had at least one “at-risk” identifier and that this identifier was the main contributor to the their placement into FYEX.

The comparison between these two groups were carried out and discussed, however, in order to remove the bias threat of unequal groups additional information was collected from grade distributions from Spring 2010 and Fall 2010 semesters. These semesters reflected grade distributions prior to offering FYEX. By identifying which students in these semesters were also taking developmental English an equivalent comparison group was created to better understand the affects of FYEX on the developmental group.

External generalizability for this study would pertain to whether or not the findings would hold true at other community colleges. The intent of the design is not to make these claims, but, rather to allow a rich description of the population, characteristics of the setting and validity of findings such that audiences can determine extensions of findings or theories.

CHAPTER IV

RESULTS

In Chapter I the problem of low success rates for developmental mathematics courses at community colleges was discussed and the purpose of this study, to closely examine the intervention strategy of a student success course, called First Year Experience (FYEX), as it related specifically to students studying developmental mathematics at the lowest level at one Minnesota community college, was identified. Chapter II discussed the current literature and gaps in the literature, while Chapter III identified the mixed-method methodology. In this chapter the results of the data analysis will be shared. The following research questions guided the study.

Quantitative Research Questions

What is the difference if any between success and persistence of studying mathematics of students taking the lowest developmental mathematics course at a community college concurrently with a student success course and those who take the lowest developmental mathematics course without a student success course?

Descriptive questions:

1. What are the students' achievement level (or grades) in the lowest level mathematics course while taking a student success course?
2. What are the students' achievement levels (or grades) in the lowest level mathematics course without taking a student success course?
3. At what rate do students taking a low level developmental mathematics course with a student success course register for subsequent mathematics courses?
4. At what rate do students taking a low level developmental mathematics course without a student success course register for subsequent mathematics courses?

Qualitative Research Questions

How are student perceptions similar or different between the two groups throughout the semester?

5. What obstacles interfere with student studies in mathematics and what skills do they have to counter these obstacles?
6. How do they feel about mathematics?
7. What do they do to gain mathematical skills and understanding?
8. How do they see themselves as learners in a mathematics class at a community college? Does this change over time? If so, how and why?

Pre-algebra Grade Distributions

Analysis of grade distributions identifies any difference that may or may not exist between students taking Pre-algebra alone, or students taking it with a FYEX course with regard to success in pre-algebra and answers research questions one and two. Successful completion of Pre-algebra was defined as grade achievement of A, B, or C. Students must achieve these levels in order to meet the pre-requisites to advance to the next mathematics course in the developmental math sequence. Table 9 indicates the successful completion rate of the two groups of students by semesters. All registered students in pre-algebra are included in the calculation including students who received grades of W, FN, or FW. Pre-algebra students who were registered in FYEX by the 10th day of classes were identified in the FYEX group regardless of their final FYEX grade.

Table 9

Percent of Students Successfully Completing Pre-algebra in 2011

	Spring 2011	Fall 2011
Pre-algebra students in FYEX	39% (29/75)	48% (79/163)
Pre-algebra student not in FYEX	54% (120/221)	67% (229/340)

Pre-algebra students in FYEX have a lower passing percentage than the Pre-algebra students not in FYEX. Using $P_1 =$ Pre-algebra students also in FYEX and $P_2 =$ Pre-algebra students who are not in FYEX; let $H_0: P_1 = P_2$ and $H_1: P_1 < P_2$. The p-value = $0.00965 < .05$, and therefore the null case is rejected. Hence, the FYEX group's successful completion percentage was significantly less than that of the non-FYEX group during the spring semester of 2011.

Using the same two proportions z-test for the fall semester provides a p-value = $.0000236 < .05$, hence, again the FYEX group of students in the fall of 2011 had a statistically significant lower successful completion rate compared to the non-FYEX group.

Why might this difference exist? The FYEX course is designed to help students identify and mimic characteristics of successful students. It would appear from the data that these efforts did not transfer to increased academic success in mathematics. However, because random samples were not generated, the two groups were actually academically quite different from each other from the start. Although, the participating college offered open FYEX sections, designed for any student to register, in reality, most of the students that registered for the course were those who were told to do so by an advisor or those who tested into developmental English at the college. In fact, the college cancelled many sections that were open to all students due to low enrollment. The remaining open sections of FYEX were paired with a developmental English course, such that any student registering for developmental English would automatically be registered for FYEX. Therefore, 90% of all FYEX

students were in developmental English as we have seen in the data report in Chapter II (see Table 2). Moreover, the college targeted students who were Pell Grant eligible, first generation college student, or minority students. Many students who registered for FYEX were told that it was required or were strongly encouraged by advisors to take the course. Qualitative data from on-line surveys support this. Of the 20 FYEX/mathematics students who responded to an open-ended question: “Explain your reason for enrolling in the [FYEX] course?” 17 (85%) indicated that they were told to take it, or were not given a choice. See data clips below:

“I was not given a choice on enrollment” (data code: 2APre10).
 “I enrolled because it was not voluntary” (data code: 2APre35).
 “I was told to enroll in it by my advisor” (data code: 2APost8).
 “I was told to take the course” (data code: 2APre31).
 “It was a required class” (data code: 2APre34).
 “I was not given a choice” (data code: 2APre4).
 “I was put in it by the guy who set up my classes; it wasn’t really my choice” (data code: 2APre48).
 “It was a mandatory course” (data code: 2APre24).

Only two students identified personal choice as reason for the decision to enroll in the course:

“I enrolled in this class to get a better idea of how to be a successful college student.” (data code: 2APre47).
 “I thought it would be a good class to take.” (data code: 2A Pre33)

Comparison of the average mathematics grade in the groups shows a similar story and again supports the notion that the two groups were significantly different from each other in terms of academic need (see Table 10). The average Pre-algebra grades of the FYEX groups are well below the average of non-FYEX groups from all of the four semesters studied.

Table 10

Average Pre-algebra Grade by Semester (4.0 scale with FN grades omitted)

	Spring 2011		Fall 2011		Spring 2010		Fall 2010	
	μ	σ	μ	σ	μ	σ	μ	σ
In FYEX	1.469	1.59	1.500	1.52	n/a		n/a	
Not in FYEX	1.861	1.69	2.319	1.63	1.779	1.71	1.836	1.67
FYEX < NonFYEX	p = .0502		p = .00000009					

Noting that the comparative groups were not random, a discussion is warranted on the overall performance of all Pre-algebra students by year. Table 11 provides a visual of the successful completion of all students and compares the year prior to the offering of FYEX with the year when FYEX was offered to the at-risk population.

Table 11

Percent of Students Successfully Completing Pre-algebra by Year

Spring & Fall 2010 (FYEX was not offered)	53% (412/776)
Spring & Fall 2011 (FYEX was offered to at-risk population)	57% (457/799)

There appears to be a slight increase of student achievement during the year that FYEX was offered, $p = 0.0568$. During the spring 2011, when FYEX was first implemented, only 25% of the Pre-algebra population enrolled in the course, but, during the fall 2011 this percentage increased to nearly a third of the population, 32%.

Comparison of the two fall semesters (Table 12) provides a better glimpse of what might be occurring. The fall 2011 group performed significantly higher, 61%

Table 12

Percent of Students Successfully Completing Pre-algebra Fall Semesters 2010 and

Fall 2010 (FYEX was not offered)	54% (274/507)
Fall 2011 (FYEX was offered to at-risk population)	61% (308/503)

compared to 54%, $p = 0.011$, $< .05$, than the previous fall 2010 Pre-algebra students. Is this due to the intervention efforts of the FYEX course targeting students who are at-risk? To be sure, more data collection would be necessary, but, we do see a possible trend in a positive direction. Having several non-FYEX semesters to compare with several FYEX semesters would be ideal. The current data do suggest, however, that the FYEX course may be providing some benefit toward successful completion in Pre-algebra. A more thorough look at the population that was targeted with this intervention is worth examination.

To this end, the researcher identified a need to compare a similarly disadvantaged group of Pre-algebra students during the year 2010, prior to offering FYEX. This was accomplished by identifying which Pre-algebra students in 2010 were also in developmental English. Because the FYEX students were identified and registered based on placement testing into developmental English, nearly all Pre-algebra/FYEX students were in developmental English (over 90%). Comparison between these two more equivalent groups, 2010 Pre-algebra students in Developmental English and 2011 Pre-algebra students in developmental English and

in FYEX, then provides a clearer understanding of whether or not FYEX is helpful to developmental mathematic students. Examination of these comparative groups (see Table 13 and Table 14) does show an increase in mathematical success for students taking FYEX.

Table 13

Pre-algebra Grade Distribution for Students in Developmental English Prior to FYEX

	A	B	C	D	F	FW	W	FN	Total	C or >	B or >	A
Spring 2010	9	10	5	4	17	9	14	3	71	34% (24/71)	27%	13%
Fall 2010	24	35	22	11	41	19	52	3	207	39% (81/207)	29%	12%
Total 2010	33	45	27	15	58	28	66	6	278	38% (105/278)	28%	12%

Table 14

Pre-algebra Grade Distribution for Students in Developmental English and FYEX

	A	B	C	D	F	FW	W	FN	Total	C or >	B or >	A
Spring 2011	11	8	9	5	5	12	16	8	74	38% (28/74)	26%	15%
Fall 2011	19	28	26	5	16	19	28	6	147	50% (73/147)	32%	13%
Total 2011	30	36	35	10	21	31	44	14	221	46% (101/221)	30%	14%

A spring semester comparison between the two years indicates an increase in the percentage of successful mathematics students, 34% compared to 38%, albeit, it is not statistically significant, (see p value in Table 15). However both fall semester and total year percentage comparisons indicate significant increase in student success in Pre-algebra for FYEX students who were also in developmental English.

Table 15

Two Proportion z-test Results

Total 2011 > Total 2010	p = .037 (significant)
Fall 2011 > Fall 2010	p = .024 (significant)
Spring 2011 > Spring 2010	p = .306

It is interesting to note that the percentage of students who received a B or better in the two groups is similar to each other, i.e., there is no statistical difference between the two. However, examination of C or better percentages yields a significant increase in student success rates for 2011. This may suggest that FYEX could be positively affecting the middle population of students; perhaps the ones that would have *fallen through the cracks* in previous semesters are now finding skills that help them persevere in their mathematics course.

This finding of increased mathematics success for this at-risk population exposed to FYEX not only supports the continuation of offering, but, in addition raises some hypothetical questions. Specifically, we see an increase from spring to fall semesters. This might be due to the fact that the course offering expanded. Perhaps further expansion of offering could make even greater impacts. Moreover, the course is in its infancy at the participating community college, what could happen to student success if the course was offered to many more students at a deeper level, for example, would increasing the amount of exposure to the material increase student success? The course is currently offered as a one-credit course meeting twice per week for the

first half of the semester. What might happen for example if the course was offered as 2 semester credits?

FYEX Grade Compared to Pre-algebra Grade

In addition to an overall look at success rates, it is also interesting to examine the FYEX group of students more closely. For example, by looking at the mathematics success in relationship to the grade in FYEX a new angle for interpretation is unveiled. Table 16 shows the grade distribution of FYEX student performance and pre-algebra performance for the spring semester 2011.

Table 16

FYEX Grade Related to Pre-algebra Grade Spring 2011

Grades Math FYEX	A	B	C	D	F	I	FW	W	FN	Total	C or better
A	9	6	4	4	0	0	1	6	0	30	63%
B	1	2	4	1	2	0	1	0	0	11	64%
C	1	0	1	0	0	0	1	1	0	4	50%
D	0	1	0	0	1	0	1	1	0	4	25%
F	0	0	0	0	0	0	0	2	1	3	0%
W	0	0	0	0	0	0	0	4	0	4	0%
FW	0	0	0	0	1	0	6	2	5	14	0%
FN	0	0	0	0	1	0	2	0	2	5	0%
Totals	11	9	9	5	5	0	12	16	8	75	39%
Not in FYEX	58	36	26	10	19	1	32	34	5	221	54%

During the spring semester, for example, of the 41 students who were able to complete the FYEX one-credit course with an A or B, 26 (63%) were also successful in Pre-algebra. Non-FYEX pre-algebra success rate during the same semester was only 54%.

Of interest also from the data is that there were virtually no successful mathematics completers from students who were not successful in FYEX.

The data from the fall 2011 semester tell a similar story. Out of 77 students receiving an A or B in FYEX, 57 (74%) successfully completed Pre-algebra. In addition it is also interesting to note, that of the successful completers of FYEX, (ABC or D in FYEX) 67% were also successful in Pre-algebra. The non-FYEX group during the same semester had the same successful completion rate of 67%. It would appear that the intervention for the disadvantaged group during this semester somewhat leveled the likelihood of success in mathematics. The trend in the data regarding FYEX non-performers is also confirmed here, showing that only one student was successful in Pre-algebra after failing FYEX (see Table 17).

It would seem reasonable to assume that out of 238 FYEX students taking Pre-algebra, during its infancy, a few more students might disregard this journal writing course focused on self examination in favor of focus on more academic courses such as Pre-algebra. We can see that this is not the case. A follow-up interview with the outlier, the one student who failed FYEX yet passed Pre-algebra with a C provides a glimpse into the phenomenon. This student shared that he did attend his FYEX course regularly, participated in the class and turned in most journal assignments. However, he did not submit a “large” assignment called, “campus connections.” He felt that this was the reason for his failing grade in FYEX. He indicated that this was, “on him.” His meaning was that he takes full responsibility for “messing up.” This student was an athlete and his coach had suggested the class to him, but, that it was “not what he

expected.” He felt that much of the material was concepts that he already had. “My mother taught me a long time ago that everything is on me. I have been on my own for

Table 17

FYEX Grade Related to Pre-algebra Grade Fall 2011

Grades Math FYEX	A	B	C	D	F	I	FW	W	FN	Total	C or better
A	12	15	8	2	0	1	1	4	0	43	81%
B	3	10	9	1	4	1	2	4	0	34	65%
C	4	4	6	2	2	0	3	6	0	27	52%
D	0	3	2	1	1	0	1	1	0	9	56%
F	0	0	1	0	4	1	9	7	1	23	4%
W	0	0	0	0	1	0	0	5	0	6	0%
FW	0	0	0	0	0	0	3	2	0	5	0%
FN	0	0	0	0	0	0	4	1	6	11	0%
I	0	0	2	0	3	0	0	0	0	5	40%
Totals	19	32	28	6	15	3	23	30	7	163	48%
Not in FYEX	112	85	32	10	15	1	36	44	5	340	67%

a long time” so I already have developed self-awareness and responsibility. Even though he felt that he really did not “need” the course, most of his classmates, he felt, “really needed the course.” Because the student attended nearly all sessions and participated in most reflective journal writing, there is a good chance that these life lessons were re-affirmed for him by the course and contributed to his success in mathematics. He spoke clearly about responsibility and self-awareness issues in a surprising manner.

Is this a unique phenomenon for FYEX students that failure in the course pretty much guarantees failing mathematics? A comparison with the developmental

English students prior to the offering of FYEX does show a pretty strong correlation as well; 15 students out of 138 (11%) successfully completed Pre-algebra while failing to pass developmental English. It would seem reasonable then, however, to expect similar results with the FYEX course, especially since the FYEX course is merely a one-credit course with a focus on self-reflection. It appears that there is a strong message here regarding how powerful the FYEX concepts are to entering students. To confirm this finding however, it is recommended that further semester grades be evaluated.

FYEX Concepts and Student Beliefs

In addition to this finding, it is also possible that there is a trickling effect of the FYEX topics that could help explain why the at-risk group was more successful after being exposed to the course. A mixture of qualitative and quantitative data generated by the study provides areas for discussion regarding how these students see themselves as learners of mathematics and whether or not this changes overtime (research question eight). For example, comparison analysis of the pre and post completers of the on-line survey's rated questions, using mode as the descriptive statistic, shows stunning similarities between the two groups on questions 14, 16, 20, and 21. The answers to other questions provide some substance to the possible trickling effect the course hopes to accomplish. Specifically, in questions 18 and 19 (see Table 18), a slight shift for the FYEX group only is seen in student beliefs

Table 18

Mode of Online Survey Rated Questions -- Pre/Post Completers

1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, 5 = strongly disagree	Pre	Post
Question #14: In mathematics there is always a right answer.		
Mode FYEX	2	2
Mode Non-FYEX	2	2
Question #15: Some people are naturally gifted at mathematics.		
Mode FYEX	3	1
Mode Non-FYEX	1	2
Question #16: If I don't understand something in mathematics, I know how to seek help.		
Mode FYEX	1	1
Mode Non-FYEX	1	1
Question #17: I often feel defeated in math class.		
Mode FYEX	2.5	3
Mode Non-FYEX	3	3
Question #18: Making a mistake in mathematics is a really great learning opportunity.		
Mode FYEX	2	1
Mode Non-FYEX	2	2
Question #19: I am responsible for my own learning.		
Mode FYEX	2	1
Mode Non-FYEX	1	1
Question #20: I am frustrated if the teacher doesn't show me a step-by-step example of math problems.		
Mode FYEX	4	3
Mode Non-FYEX	4	3
Question #21: There is a lot of mathematics that I can do on my own.		
Mode FYEX	2	2
Mode Non-FYEX	2	2

moving toward characteristics of successful thinking. The two questions that we see this slight movement in “Making a mistake in mathematics is a really great learning opportunity” and “I am responsible for my own learning.” Even with a variety of educators teaching the FYEX course, a consistent message that weaves through the course is self-empowerment by accepting responsibility for your own learning while looking at setbacks as opportunities for great learning. These results show improvement in these areas for the FYEX group, while the non-FYEX group stayed relatively constant.

In addition, on-line surveys analyzed using all individuals as participants with no separation for Pre or Post identified some interesting insights into how these students feel about mathematics (research question six) and how they see themselves as a learner (research question eight). The FYEX group had a much higher rate, 51%, of responses that described hope or feelings of competency in mathematics compared to the non-FYEX group where only 32% articulated similar feelings. Twenty-five percent of the non-FYEX group had strong negative or frustrated responses while only 11% of the FYEX group had negative responses. Alternatively, however, the non-FYEX group seemed more likely to specifically describe the best way for learning mathematics for them as an individual, 25% compared to only 10% in the FYEX group. One explanation for this is that although the FYEX group was forming more responsibility and positive thought messages from this exposure, they still were academically more challenged than the other group and did not have as many resources to pull from (see data clips).

FYEX data clips:

I try to make the best of the learning experiences...even though I don't really like doing math. (Q12FYEXpre674)

I feel like its [mathematics] one of my weakest subjects, I hope to get better in it by starting from the beginning. (Q12FYEXpre1070)

I am open to all aspects of learning and am more than willing to ask for help when needed. (Q12FYEXpre268)

I see myself as a person who can do this. I have to tell myself repeatedly, that I can accomplish what I put my mind in. Self-positive talk is how I am able to move forward. (Q12FYEXpost911)

I learn math pretty well once I get the hang of knowing how to do something I can usually fly right through the homework. (Q12FYEXpre212)

Non-FYEX data clips:

I think doing math has a certain logical satisfaction. There is a definite reassurance knowing that 7×7 will always be 49, and no matter how hard you try, you can't divide by 0. There are a lot of uncertainties in day to day life, and sometimes it's nice (dare I say pleasant) to sit down quietly and solve some problems. It's not all a walk in the park, and sometimes when I don't understand something I revert back to my usual "I can't do this" state (which is miserable). The material keeps getting more difficult, so I am slightly anxious that I won't be able to keep a grip on it in the future. Right now I'm just starting to learn about integers, and quite confident in everything that precedes. (Q12nonFYEXpre3347)

I see myself as hesitant. Having a little doubt in myself and my ability as I look for careers, but at the same time try even harder to prove to myself I can do anything I put my mind to. (Q12nonFYEXPost3006)

From these data clips, we see that the non-FYEX responses are more elaborately written than the FYEX responses. At the same time, however, they provide the reader with similar feelings of hope along with an articulation of an artful balance of confidence with uncertainty in abilities.

Examination of what students have to say about how to handle a difficult math question is discouraging for both groups and helps in understanding what skills these

students have for overcoming obstacles while studying mathematics (research question five). In addition classroom observation data provide some insight into what they do to gain mathematical skills (research question seven).

Coded answers to an open-ended question from the on-line survey, for example, (question 13 in Table 19), shows a similar lack of individual resources for students and an over reliance on perceived knowledge givers. Answers that gave more than one idea were coded in multiple categories. Enumeration helps to determine the frequency of a given response. Over 80% of students in Pre-algebra participating in the survey addressed this question by stating that they would “ask someone else” for help.

Table 19

On-line Survey Coded Responses for Question 13

Question #13	FYEX		Non-FYEX	
	Pre	Post	Pre	Post
What do you do if you don't know how to do a math problem?				
Ask, seek help from others	84%	86%	78%	87%
Look for similar problem	14%	14%	14%	16%
Guess	6%	5%	2%	1%
Leave it blank, or move on	6%	14%	9%	10%
Try a different way	0	5%	0	0
Get mad and give up	2%	0	2%	0
Google it	0	0	3%	4%

The FYEX group had a more difficult time articulating a variety of choices; many answers were simply, “I would ask someone” or “I would wait and ask my teacher.” Only one response in all the qualitative data from both groups indicated that perhaps they could “think through” the problem for themselves and find a solution and this response was from the non-FYEX group (see data clip).

When I am faced with a challenge I take a break and go for a walk and think about it. Usually at some point what I am doing wrong will pop into my head. Sometimes even when I am thinking about something else the solution to my problem will come to me. (nonFYEXJ4 John)

This same student was observed in the classroom. This observation involved two non-FYEX research participants John and Carrie. It provides some insight regarding what students do to learn mathematics. The course is part lecture and part computer aided. There is a set schedule for the students to follow. This schedule will have them complete the Pre-algebra topics in the semester by progressing through five modules (chapters). The text that is being used is designed for self-paced completion of all developmental mathematic topics at the community college and contains thirteen modules. The thirteen modules are usually spread over two or three courses/semesters. Although it has been 23 years since his last math class in high school, John has found that he is able to review the topics rather quickly and has made an agreement with the instructor to move ahead. The instructor provides this information to the researcher prior to the observation. Carrie, another research participant, is staying with the class schedule. Both students attend regularly. John sits in near the front of the classroom. Carrie sits near the middle. John will be working on Module 11 and 12 today. The first thing he plans to do is take a computer generated post-test on Module 11. Then he will move on to Module 12. The class begins with a lecture from the instructor with an introduction to algebra; “the first thing we want to talk about is algebraic expressions. Algebraic expressions are composed of numerical values, variables, and operations.” He asks the class, “what is

meant by operations?” A couple of students answer his question. He proceeds to present examples of evaluating expressions and often asks students for input.

Teacher: writes on the board and reads aloud, 3 less than a number. How can we write this in an algebraic expression?

Student answer: $n - 3$

Teacher: Why?

Carrie: Cuz, less than means the number comes first.

Teacher: And does the order matter here?

Student answer: Yes. (classroom observation, November 21, 2011)

After about 20 minutes of lecture the class works independently on computer generated homework. Carrie works through the problems quickly and has not indicated any areas of struggles.

Meanwhile, John is finishing Module 11 post-test. He begins to read through the textbook on Module 12. He reads for about 10 minutes and then begins to work homework problems. He is studying operations with complex numbers. The software provides instant feedback on whether the homework problems are correct or not. The software is generating problems for him like: $6i(4 + 2i)$. There is only one problem on the screen at a time. There are two boxes on the computer screen to input the resulting binomial. John enters $12 + 24i$, the computer responds: incorrect, he changes his answer to $24 + 12i$, wrong, he changes it to $-12 + 24i$, correct. He proceeds through five more problems in a similar fashion. He does not write his work down. Twice he used the “help me solve it” feature of the software which generates a similar problem and walks the student through it step by step. With about 10 minutes left of the class, the researcher asks for clarification.

Researcher: I noticed that you do not write down your work, but, just try different numbers in the problem until you get the correct answer.

John: Yes.

Researcher: What can you tell me about i^2 ?

John: Well, there are only so many possible combinations for the answer, so I just work through and keep trying until I get the correct one.
(Classroom observation, November 21, 2011)

The student does not seem able to address the content question, yet has been able to complete several homework questions and move on to the next. This student seems to be relying on pattern development and possibly will continue to “think through” the problems, finally searching for his missing information. This student displays confidence and pride when he gets a problem correct. Although the student has little interaction with the instructor, his efforts at learning the material are tied to the random generation and immediate feedback that the software is providing for him. Would he have confidence to answer a similar question on paper without being able to check his answer immediately? Neither John nor Carrie make attempts to communicate, share, or collaborate with fellow students.

The following classroom observation is consistent with the survey results which indicated that most students in the study “ask for help” when faced with a mathematical challenge. Kelsi, also a non-FYEX research participant, is in a similar computer lab, however, in this lab all students are working at their own pace. The teacher does not provide any scheduled lectures, but, answers individual questions as they arise.

Kelsi arrives a few minutes late for class, which is usual for her as she has to travel across campus from her previous course. While she waits for the computer

software to “boot up,” she uses her cell phone to text messages. Kelsi explains to the researcher how attendance and homework points are calculated in the class. Today she is working in mod 5, linear inequalities in one variable. Her first problem is $41 < 5 - 6x$ and she is asked to solve for x . She works on her paper for a few seconds. She wants help with the problem. She explains to the researcher that the plastic cups on the computer let the teacher know when you have a question. She said, “I have learned to change cups loudly so the teacher will hear it and know that I have a question.” While she waits for the teacher she clicks on the “help me solve it” link in the software. She turns the cup back after she figures out the problem. The teacher comes by to see how she is doing.

Teacher: Did you get your questions answered?

Kelsi: I used the computer. I wanted to know if I should carry down this sign.

Teacher: But, do you understand it?

Kelsi: Yes. I remembered that you have to insert the symbol. Left is less than. Yes, ok.

Her next problem is: $7 - 5x > 2 - 4x$. Kelsi uses the “view an example” feature on the computer. The example that she gets is: $15 - 9x > 6 - 8x$. She views the steps on the problem and translates each step to her problem. Then she re-checks each step in the example and compares it with hers, she erases some of her problem. She then takes her notebook up to the teacher at the front of the room. The teacher walks her through the problem. She comes back to her chair saying, “yep, I got it.” Then she types her answer in, but, the computer says it is incorrect. She then changes her cup loudly. The teacher comes over.

Kelsi: It is still not letting me put this sign in.

Teacher: Ok, let’s go back. What did you do on this step.....

Teacher: Oh, you did not flip the symbol.

Kelsi: Ok.

Teacher: Do you have it?

Kelsi: I hope so, I don't know if I can remember it. (classroom observation, December 2, 2011)

Kelsi's next problem is $5(2x - 3) < 25$. She immediately clicks on the "view an example" link. The example problem she gets is $7(5x - 8) < 14$. She works through the problem while comparing each step with the example. Her work looks like:

$$\begin{aligned} 5(2x - 3) &< 15 \\ 10x - 15 &< 15 \\ 10x - 15 + 15 &< 15 + 15 \\ 10x &< 30 \\ x &< 3 \end{aligned}$$

She types her answer in, but, the computer indicates that it is incorrect. She is frustrated. After a bit of time, the researcher suggests to check the original problem, and she notes that she copied it down wrong. "My mistakes are always like that," she exclaims. Her next problem is $2(6y - 4) \leq 9(2y + 5)$. "Oh, my gosh!" she exclaims. She begins working on it and uses the calculator in the computer to help with some calculations. Her answer is: $y \leq -53/6$. The directions indicate to express the answer as a mixed number. She exclaims, "I don't remember how to change a decimal to a mixed number." She uses her calculator, then tries long division, finally she gets $-8 \frac{5}{6}$. This is the last problem in the homework set and class time is nearly over. Kelsi shares her frustration with the researcher. She doesn't feel confident with the material, but, has completed all the problems. Researcher asks, "What do you do then, when you still don't feel confident?" She answers that at home she might re-do all the

problems that she just did “without looking.” She is frustrated that there are not more problems, she says, “Now, I just have to ask the teacher.”

These qualitative snapshots perhaps indicate an overreliance on experts as students study mathematics. Conceptual understanding and symbolic meanings also seem remote to these students.

A classroom observation of a participating FYEX student reveals a strong commitment to the learning of mathematics. This student engages in two behaviors that were not witnessed in the non-FYEX observations—previewing the lesson before the class, and helping other students. This student arrives 10 minutes early and has previewed today’s lesson. She indicates to the researcher that today we will be going over multiplication with decimals.

Rae: Today we will be going over multiplication with decimals. Everything in this class is pretty easy. I did a few problems last night.

Researcher: Is that required? Do you always look at the lesson before class?

Rae: I just want to, you know, I did not care in high school and I guess that came back to bite me, but, not really cuz now, I know that I have to care. I just want to really get it down this time and work on pace with the teacher. (classroom observation, November 17, 2011)

Even though the class is set in a computer lab the teacher begins with interactive lecture. She asks all students to turn their computer screens to the front of the classroom as she begins today’s topic.

Rae is engaged in the lesson trying all problems that the instructor presents. She frequently turns to help the student next to her. She is the only student who appears to be “helping” another. Rae does the problems quickly and then rubs her

face while she waits for the rest of the class. This seems to be a reminder to be patient.

The teacher continues lecture with the following question, “is -3.6 a solution to the equation $0.7x = -25.2$?” She shows the work, $0.7(-3.6) = -25.2$, she places a question mark above the equal sign. “We really need to do the multiplication.” Then she writes: $-2.52 = -25.2$ is this true? “So, I would answer, this number is not a solution. Don’t say “no solution,” because there might be a solution.”

The teacher then goes through a perimeter and area rectangle problem using decimals followed by an algebraic expression, $xz - y$, to evaluate given $x = 2.1$, $y = -3.2$ and $z = 1.6$. Then the class is instructed to begin homework on the computer. Rae starts right in working quickly and using scratch paper only for calculations. She completes the assignment with a few minutes left of class without asking any questions.

Rae appears to have some good skills for attaining the success she desires. She habitually previews the lesson prior to class, does not push to move through concepts ahead of the class, and she has a strong desire to do better than she has in the past. She has specific goals to become a police officer and has indicated on surveys, “I only plan to take what I need to take (math courses) in order to obtain my career goals. I have disliked math, but, now I look at it as it has to get done. I look at it as a temporary thing in order to obtain my goals.” She indicated on a survey that although she was told to take the FYEX course she felt that it helped her learn a lot about her learning style.

The individual PRE/POST analysis also reveals that most students have little change in their strategies for dealing with challenging mathematical problems during the semester. Only two revealed change and both of these were from the non-FYEX group. Perhaps experiences in the mathematics classroom were contributors to the change for these students, however, the data do not support or deny this possibility. Indeed, the clip below displays perhaps a change that many mathematics instructors hope to instill in their students. It would seem a bit discouraging then, to note the relatively few responses that indicate such changes.

Non-FYEX data clips:

PRE: Ask the instructor or my son. (Q13nonFYEXpre436)

POST: 1. Did I transfer the problem correctly? 2. What are they asking me to solve. 3. Rework the problem. 4. Evaluate each step; make sure I am using the right processes. 5. Find a tutor or a second tutor if the first one isn't as helpful as I would have liked. 6. Speak with the instructor. (Q13nonFYEXpost437)

PRE: I would ask the Professor to walk me through it. (Q13nonFYEXpre1609)

POST: Read through the books to try to figure out the answer or watch a couple of examples. (Q13nonFYEXpre1610)

Less than 25% of on-line survey participants completed both pre and post surveys, therefore, strength of data regarding the change in perspective for students is limited. The on-line surveys indicated an overall weakness of the FYEX group to articulate specific strategies for success in mathematics; however, focus group interviews (see Table 20) conducted in late October revealed that the FYEX group was much more open and willing to share. They generated more brainstorming ideas regarding success in mathematics. This qualitative sample although, small,

Table 20

Focus Group Brainstorming Student Responses

Question	FYEX (4 participants)	Non-FYEX (6 participants)
What contributes to success in mathematics?	Having a good teacher Practicing problems that aren't assigned Make time to meet with instructor or get help from someone Can go on-line to math web sites to practice areas that you aren't as advanced in. Concentrate and pay attention Time Focus Basic math skills Asking for help Paying attention Understand the steps before moving on. Use the learning center Keep trying Don't give up	Repetition Going at your own pace Memorization Use anagrams – PEMDAS, FOIL Motivation to do well Encouragement from others The ability to work at your own pace Good attitude Open mind
What advice do you have for students studying mathematics?	Concentrate and pay attention Don't be intimidated Always do the homework that is assigned and even the ones that aren't just so you can get practice Go over homework with a classmate Study a few days before the test Stay calm and focused Sit near front Ask for help when needed Don't sit by someone you know, you won't pay attention Think positive Try your hardest Think not only of the present but of the future and how you want to be living Be open minded, don't let it overwhelm you and if you need it ask for help.	Don't be intimidated Use all resources Keep focused on goal Make a commitment to it Stay focused on the long term goal

contributes a bit to the notion that FYEX content ideas could be trickling into Pre-algebra students' ideas regarding the study of mathematics. Specifically, comments such as sitting near the front of the class and "not next to someone that you know" in addition to "doing extra practice" seem to be ideas the FYEX group was quite comfortable with, while these ideas did not occur to the non-FYEX group during the focus group interviews. In addition, the FYEX group seemed more interested in developing an academic support network, i.e., with tutors, instructors, or others, while the non-FYEX group was focused on working at an individual pace, practicing, and using memorization techniques.

In the non-FYEX group, a student speaker received non-verbal confirmation from peer group members while saying, "The mistake many students make is that they try to understand the math concepts. Don't do that. Just practice, practice, practice, practice" (focus group field notes, October 24, 2011). The sentiment for these students in general seems to be centered on viewing mathematics as something that is not necessarily useful, and not necessarily understandable, but, rather something that must be endured as they journey toward a variety of career aspirations (see data clips).

When the teacher does example problems on the board it helps me to write it down so I can refer back to her process when I'm doing my homework and I get stumped. My math abilities are very poor. I would put myself at a 4th or 5th grade math level. My motivation is I just have to get threw [sic] two algebra class's then I will never have to do algebra again because it is not practical in the real world. I am a senior manager at a grocery store and in my four years of working there I have never had to use algebra. I think that algebra is a waste of time I am not going to school to be a rocket scientist or be in a proffesion [sic] that I would use algebra. So WHY!!! Is it a requirement of my Liberal Arts & Sciences degree!!! It is a waste of my time and money to take a course that every person I have ever talked to has told me that I just have

to get threw [sic] the class I will most likely never use algebra in the real world. This is very FRUSTRATING!!! (Q12nonFYEXpre446)

Math has always been a means to an end for me. Like now for instance I need to achieve a certain level in order to be able to proceed with my education. Weirdly enough though now I am not looking at math as a bad thing it has become a challenge to me. (J3FyexBryn)

Mathematics to me means a chance at a better degree. The further I can go with mathematics the better degree I can obtain. The next math class I have is statistics, if I do well, I may take pre-calculus next fall. (J1nonFYEXrk)

I enjoy Mathematics because everything is concrete. You are only required to memorize the processes required to problem solve and as long as you follow the process you will always get the right answer. For me it is a matter of repetition, using the process over and over and over is the best way to remember the next step. I think many students hate math because they spend so much time trying to figure out “why” they should perform the next step when in actuality [in Math] why doesn’t matter---just do it. I think longer class periods are important with Math, with a short time frame many students do not have enough time spent in the repetition phase before they are required to stop. During the next short class period, time is spent reviewing something that you never came to understand in the first place, and suddenly the teacher has moved on to even more difficult problems. (J1nonFYEXbg)

I find it very intimidating to have to have a math class even when it seems your field doesn’t really need an algebra class. I can understand having to take a basic math class but don't know why we need algebra and the extra worry and stress that come with that. I seriously had to think if I could even go for a degree because I needed to take algebra. I wasn’t sure I could do it and still don’t know for sure. It's also frustrating when you are capable of getting good grades in other challenging classes and then the math class is low average or below average or even failing. I find algebra skills hard to retain and the only way for me to pass is to do review right before testing. If I do the material and understand it, if a couple of days go by, most of what I learned is gone from my brain and I need to relearn it before testing. For me, math/algebra is relearning it EVERY DAY. (J1nonFYEXdq)

Subsequent Registration for Mathematics

While there is a good mixture of students with both positive and negative feelings toward mathematics in the study, there seems to be an underlying tone

regarding the necessity of “getting through” the required math courses. Addressing research questions three and four, it is important to note that Pre-algebra is merely a stepping stone to the next developmental math course and that no two-year degree programs require less than Elementary algebra completion. To this end, it would seem reasonable to expect that the majority of students would register for the subsequent math course upon completion of Pre-algebra. However, only approximately 34% of all pre-algebra students during 2010 and 2011 semesters registered for the next developmental mathematics course, Elementary Algebra, by the 10th day of registration. During 2011, the group of Pre-algebra students who were not in FYEX registered for Elementary algebra at a higher rate than those who were in FYEX, 32% compared to 24% during the spring semester, 39% compared to 34% during the fall semester. However, these group comparisons, although interesting, fall short on fairness. Perhaps more pertinent is the comparison between the 2010 developmental English mathematics students and the 2011 FYEX mathematics students, these groups have similar at-risk student populations. The spring comparison shows 2010 registration rate of 21%, and 2011 rate of 24%. Fall comparisons show 29% registration rate in 2010 and 34% in 2011 (see Table 21). These data reveal a slight increase in rate of registration.

Although a strong majority of Pre-algebra study participants indicated a specific academic goal for their studies, perhaps the message of strategic planning to accomplish these goals is amiss. FYEX content includes extensive goal articulation and planning. Although statistically not significant (see Table 22 for p values), this

slight increase of registration for Elementary Algebra for this disadvantaged group, perhaps, correlates with the increase in pre-algebra success, as more students are successful; there is a slight increase in students registering for the next math course. In addition, ideas of strategic planning from FYEX course content could be playing a

Table 21

Pre-algebra Registration for Elementary Algebra (2010 - 2011)

	Registered for elementary algebra	Not Registered for elementary algebra	Total
Spring 2010 pre-algebra students			
Also in Dev. English	21% (15/71)	56	71
Not in Dev. English	32% (64/198)	134	198
total	29% (79/269)	190	269
Spring 2011 pre-algebra students			
Also in FYEX	24% (18/75)	57	75
Not in FYEX	29% (64/221)	157	221
total	28% (82/296)	214	296
Fall 2010 pre-algebra students			
Also in Dev. English	29% (61/207)	146	207
Not in Dev. English	41% (122/300)	178	300
total	36% (183/507)	324	507
Fall 2011 pre-algebra students			
Also in FYEX	34% (56/163)	107	163
Not in FYEX	39% (134/340)	206	340
total	38% (190/503)	313	503

small role, although, there is not enough data to confirm or deny this possibility.

Regardless of specific cause, a movement in the positive direction is visible, however, efforts would hope for greater changes to be sure.

Table 22

Two Proportion z-test Registration (2010 - 2011)

Spring 2011 FYEX > Spring 2010 Dev. English	p = .339
Fall 2011 FYEX > Fall 2010 Dev. English	p = .158
Total 2011 FYEX > Total 2010 Dev. English	p = .175

Conclusion

Quantitative results suggest that the FYEX course could be making a positive impact for students who are identified as at-risk. The original research question: “What is the difference if any between success and persistence of studying mathematics of students taking the lowest developmental mathematics course at a community college concurrently with a student success course and those who take the lowest developmental mathematics course without a student success course?” was answered. The comparison between students taking pre-algebra with FYEX and those taking Pre-algebra without FYEX found significant greater success for the non-FYEX group. Also, the non-FYEX group registered for the next mathematics course at a higher rate. However, this was due primarily to the way the groups were formed at this particular community college. Groups were not randomly generated; it was shown that the FYEX group had a high percentage of students who are at-risk. This greatly effects how this can be analyzed as the two groups were quite different from each other.

The creation of an alternate comparison in the study provided a clearer picture of the possible effects of exposure to the FYEX course for low level developmental

mathematics students. The new grade achievement comparison found that during the year 2011, when FYEX was offered to pre-algebra students who were also in developmental English, these students had a higher rate of successful completion than the same group, pre-algebra students also in developmental English, did in 2010, when FYEX was not offered to them. In addition, there was a slight increase in registration for the next mathematics course, although this increase was not statistically significant. As educators struggle to employ intervention strategies aimed at helping developmental mathematics students at community colleges succeed, this success course could be extremely beneficial. Because the course was new, faculty refinement and expertise in teaching will continue to improve, hence, it is possible that this course could be instrumental to change the tide of math success for students at this community college.

Analysis of FYEX grades compared to pre-algebra grades identified an interesting phenomenon, that is, out of failing FYEX students only one was able to pass pre-algebra. Perhaps this sends a strong message to students and educators regarding the significance of the ability to pass a one-credit course aimed at self-reflection on goal setting and characteristics of successful students. What reactions might students have to this information?

The following qualitative questions guided the study:

1. What obstacles interfere with student studies in mathematics and what skills do they have to counter these obstacles?
2. How do they feel about mathematics?
3. What do they do to gain mathematical skills and understanding?

4. How do they see themselves as learners in a mathematics class at a community college? Does this change over time? If so, how and why?

Data collected indicate that there could be some transfer of FYEX concepts for students in pre-algebra. Negative feelings regarding the study of mathematics were fewer in this group. Later in the semester the FYEX group was able to generate more characteristics of successful students, particularly generating academic support relationships. It appeared that FYEX students in pre-algebra were able to move toward sophisticated beliefs regarding making mistakes and taking responsibility for their learning.

Both groups displayed an underlying concern regarding the need for studying mathematics, and for it possibly standing in the way of completion of degrees. Most students saw mathematics as somewhat useless to them, as something that they should memorize and practice, and as something that made little sense. Students in both groups also relied quite heavily on others or computer help aids. Asking for help was the first and many times only strategy students in this study could identify for learning mathematics or for overcoming struggles.

CHAPTER V

DISCUSSION

Nationwide enrollment in developmental mathematics courses at community colleges has increased, while success rates remain unsatisfactory. Educators, policy makers, and interested parties are taking note and implementing programs and initiatives that hope to increase success for developmental mathematics students at community colleges. A thorough discussion of this is laid out in Chapter I. The purpose of this study was to closely examine an intervention strategy as it related specifically to students studying developmental mathematics at the lowest level at one Minnesota community college. This community college offered a one credit course called First Year Experience (FYEX) to incoming students beginning Spring Semester 2011.

In Chapter II it was noted that little research has examined the effects of such efforts at a micro level. Some studies have examined overall student success indicators such as graduating from programs after exposure to such courses (Derby & Smith, 2004; Zeidenberg, Jenkins & Calcagno, 2007) and many studies have examined the belief structures of developmental students (Caniglia & Duranczyk, 1999; Cherkas, 1992; Cole, Goetz, & Willson, 2000; Howard, 2008; Khazanov, 2007; Stage & Kloosterman, 1995). This study attempts to identify whether exposure to the FYEX course provided low-level mathematics students with new skills that aid in

learning mathematics. In addition possible changes in belief structures for students were explored.

This concurrent mixed method comparison study examined pre-algebra students in the Fall Semester 2011 by identifying two groups of students, those in pre-algebra and FYEX and those in pre-algebra but not in FYEX. Quantitative comparisons were extended to include four semesters of grade achievement data. The community college participating in the study offered this course to “at-risk” students, defined as: students who were first generation college students, Pell-grant students, students of color, and students testing into developmental courses—specifically developmental English during the year of 2011. A comparison was extended to students who are at-risk during the preceding year, 2010, when FYEX was not offered. Qualitative data during the fall 2011 included on-line surveys, focus group interviews, journal entries, and classroom observations. A full discussion of methods used in the study is found in Chapter III.

Discussion of Major Findings

Increase in Mathematics Success for At-risk Population Exposed to FYEX

Quantitative results described in Chapter IV suggest that the FYEX course could be making a positive impact for students who are identified as at-risk. The original design of the study included comparisons between students taking pre-algebra with FYEX and those taking Pre-algebra without FYEX during the same semester with the hopes to answer the following research question:

What is the difference, if any, between success and persistence of studying mathematics of students taking the lowest developmental mathematics course at a community college concurrently with a student success course and those who take the lowest developmental mathematics course without a student success course?

This comparison was completed and it was found that there were significantly greater success and persistence rates for the non-FYEX group; however, this is due primarily to the way the groups were formed at this particular community college. The community college that participated in the study had intended to offer the FYEX course to a mixed population, but, actually offered the course only to the defined at-risk population due to low-enrollment and cancelation of courses. This greatly affected the comparison capabilities of the study. To overcome this, however, pre-existing data on a similar at-risk group from 2010, before the FYEX group was offered were compared to the year 2011, when FYEX was offered. This analysis showed significant increase in success for the pre-algebra students who are at-risk. Thirty-eight percent of the at-risk, pre-algebra students were successful in 2010, while 46% were successful in 2011 while taking the FYEX course. Two proportion significance test results indicate a p value of 0.024 which supports significant increase in success in 2011.

Non-successful FYEX Students Lack Success in Pre-algebra

Analysis of FYEX grades compared to pre-algebra grades identified an interesting phenomenon, that is, of the unsuccessful FYEX students only one was able to pass pre-algebra. Is this a characteristic of non-successful students in general? A look at unsuccessful developmental English students during 2010 has shown that 11%

of them were successful in their pre-algebra course. This suggests that perhaps the FYEX result is significant. Although, more data and research are required to confirm this phenomenon, educators and students can benefit from this knowledge. Perhaps it is somewhat of a descriptor on what it might mean to fail the FYEX course. While there are many reasons for student failure, including attrition, family interference, medical, transportation, and financial reasons, one literal interpretation could be not meeting the course objectives. Course objectives include developing self-awareness that leads to taking responsibility for one's own learning. In addition to discovering self-motivation, course content includes mastering self-management, employing interdependence, gaining self-awareness about beliefs and attitudes, adopting lifelong learning, developing emotional intelligence, and believing in themselves. Educators may ask themselves if these skills are consistently represented in their developmental mathematics students, and if not, how crucial are they for their success. Can developmental mathematics educators contribute to students' attainment of these skills, and if so, in what ways? With the quantitative results showing increased developmental mathematics success for students exposed to learning opportunities that address these areas, perhaps this message enables mathematics educators to, at a minimum, encourage the offering of the FYEX course or even incorporate the concepts into an existing mathematics course.

Qualitative data seem to indicate that there could be some transfer of FYEX concepts for students in pre-algebra. Qualitative research questions that guided the study included:

How are student perceptions similar or different between the two groups throughout the semester?

1. What obstacles interfere with student studies in mathematics and what skills do they have to counter these obstacles?
2. How do they feel about mathematics?
3. What do they do to gain mathematical skills and understanding?
4. How do they see themselves as learners in a mathematics class at a community college? Does this change over time? If so, how and why?

Qualitative research focuses on building answers by discovering reasons behind a phenomenon (Strauss & Corbin, 1990) and as such the qualitative research questions were a guide that allowed for discovery of student thoughts, beliefs, and feelings. While the study provided some insights into the answers to some of the research questions, these insights were often intertwined between how they felt about mathematics, what they do to gain skills, what their struggles were, and how they see themselves as learners of mathematics. The following discussion presents findings that relate to these questions and seem to suggest that there could be some positive effects for students taking FYEX.

FYEX Concepts May Transfer

Comparative analysis of on-line surveys found that negative feelings regarding the study of mathematics were fewer in the FYEX group. This could be due to the exposure to the content of the FYEX course because students were anywhere from one to two weeks into the eight week course when they first completed on-line surveys. Later in the semester the FYEX group was able to generate more ideas characteristic of successful students, particularly generating academic support relationships, while the non-FYEX group tended to regard success strategies as memorization and

individual practice. It appeared that FYEX students in pre-algebra were able to move toward sophisticated beliefs regarding making mistakes and taking responsibility for their learning. People who view mistakes as learning opportunities display characteristics of a growth mindset (Dweck, 2006). Having a growth mindset has been shown as a characteristic of a successful person. If indeed exposure to the FYEX course aids in the acquisition of a growth mindset, this could be quite beneficial to developmental mathematics students.

As Khazanov (2007) has noted, this population (developmental mathematics students) has a tendency to “vest all responsibility for their learning in the hands of teachers” (p. 158). Developmental mathematics educators have struggled in the past balancing mathematical pedagogy (Grubb, 2010) designed to entice students to learn mathematics, but, perhaps a more direct route could be employed. This study provides a glimpse into the possible benefits of exposing students to lessons designed for self-reflection, awareness, and discovery regarding how they view themselves as learners regarding self-responsibility. When students make the connection that they alone are responsible for what they learn they become empowered. Empowered people make choices that lead them toward, rather than away from, their desired outcomes and success (Downing, 2011).

Although a single case, this study does present qualitative data, (the classroom observation of Rae, a FYEX student), which provide educators a glimpse of a developmental mathematics student who displayed self-responsibility and willingness to accept that learning mathematics would be gradual for her. She had a plan that

included self-management and interdependence. She was determined to move toward her goal in a positive manner. It is not clear whether or not her exposure to the FYEX course contributed to her belief structures; however, it does provide hope that this course has some effect.

Pre-algebra Students May Rely on Others When Struggling in Mathematics

While students begin to develop a sense of responsibility for learning, struggles in mathematics became problematic. Many students in the study displayed the need to balance conflicting self messages such as the data clip presented in Chapter IV suggests: “I see myself as hesitant. Having a little doubt in myself and my ability as I look for careers, but at the same time [to] try even harder to prove to myself I can do anything I put my mind to.” While epistemological belief structures may be content specific, they may be less likely to occur in the sciences (Palmer & Marra, 2004). Cole, Goetz and Willson (2000) found that Quick process (ranging from learning is quick or not at all to learning is gradual) was the only epistemological belief structure to change during a summer program for underprepared students. While this study did not measure these processes formally, many students in this study seemed to be frustrated if they perceived that learning was not immediate. This seemed to intensify the doubt that students had in themselves as learners of mathematics. A standard response from participants struggling with a mathematics problem was “I will wait and ask for help.” Indeed, asking for help was often the first, and many times the only, strategy students in this study could identify for learning mathematics or for overcoming struggles. This sentiment was revealed in on-line

survey responses, journal entries, and also in some classroom observations. In some cases, students seemed extremely dependent on computer aids or instructors. These are insights which can aid educators in understanding developmental mathematics students. Moving lessons away from step-by-step demonstrations of algorithms and toward student exploration and discovery seems pertinent, while students in this population might have a tendency to resist such practices.

Pre-algebra Students See Mathematics as Memorizations Disconnected to Their Lives

Both groups displayed an underlying concern regarding the need for studying mathematics, and for it possibly standing in the way of completion of degrees. Most students saw mathematics as somewhat useless to them, as something that they should memorize and practice, and as something that made little sense. This emulates the findings of Cherkas (1992) who noted that developmental mathematics students' journals were replete with notions that "it (mathematics) is all memorization" and "it shouldn't be expected to make sense" (p. 84).

Indeed, focus group interviews confirmed this notion with group confirmation to the following student statement; "The mistake many students make is that they try to understand the math concepts. Don't do that. Just practice, practice, practice, practice" (focus group field notes, October 24, 2011). This sentiment has possible connections to the concepts studied in the FYEX course; moreover, it seems pertinent for understanding the struggles of developmental mathematic students.

Limitations

A major limitation of the study was low participation rate for on-line surveys. Although the surveys were qualitative in nature, and qualitative studies examine small groups, the pre and post surveys helped to develop a sense of whether or not there were changes in belief structures for students taking FYEX. Only 17 of 163 students completed both pre and post surveys of the FYEX group and only 59 of 340 of the non-FYEX group. Hence, being able to ascertain changes was limited.

Attendance at the focus group was less than desirable as well with only four students participating in the FYEX group and six in the non-FYEX group. This is not an uncommon characteristic of this population. Classroom observations conducted in November 2011 reported attendance in all observed classes to be less than 1/2 of the actual class size. Although, this study did not examine the effects of attrition, future studies could include examination in this area to fully understand this population of developmental mathematics students.

While grades are not an accepted measure of student success, nor does the researcher intend to imply such, the study did use final grades of A, B, or C in Pre-algebra courses to indicate successful completion of the course. Students taking Pre-algebra at the participating community college are required to earn an A, B, or C in order to meet the pre-requisites for the next developmental mathematics course.

Another limitation in the study is that the researcher is an educator at the research site. The researcher limited possible bias by employing multiple data collection techniques, eliminating any past or current students from the study, and

using a moderator at the focus group interviews. The researcher engaged in peer collaboration of quantitative data analysis.

Finally, the comparative nature of the study was changed from its original plan. Pre-existing data regarding success of students in pre-algebra that are also in developmental English were employed to allow fair comparison for the quantitative analysis. Qualitative data collection, however, occurred during the fall 2011 only. Comparisons of qualitative data were informative and descriptive but, did indeed compare two very different groups that were not formed with random assignment.

Practical Implications

The results of the study have implications for educators who have concerns regarding success for developmental mathematics students. The non-mathematics intervention course seemed to have some benefit to enrolled students. At this level at least, it would seem that success in mathematics might have much to do with having the proper mindset (Dweck, 2006). Being able to move students from naive to sophistication in the areas of how they view knowledge appears to be critical for this population. As this study has shown, many students are convinced that they have no capacity to figure out mathematical problems without the aid of another person. Developmental mathematics educators can benefit from learning the nature of these students as it can aid in the development of lessons and choices for interactive computer software.

Identification of students who would benefit most from FYEX concepts also appears pertinent. While the study has shown that for the at-risk student population

the FYEX course increased success in pre-algebra, the question remains, what benefit might it have for all students? In particular, as there were non-successful pre-algebra students in both groups, could the FYEX course reach both populations in a positive manner? And if so, how do we identify these students?

Perhaps one of the most important results of the study mirror the sentiment of Cole, Goetz, and Willson (2000):

The concept of epistemological beliefs suggests that in order to be academically successful, the student must have appropriate beliefs about learning and knowledge. We challenge that tooling students with reading and learning strategies may not be enough to facilitate academic success. Rather, we must find ways to help students believe that knowledge is not always certain, that abilities can be fostered and developed, that faculty and textbooks don't contain the "answers" and that learning is often a long and complicated process. It is only with these understandings that students may transition from underprepared to academically successful, lifelong learners. (Cole et al., 2000, p. 66)

It is common practice for community colleges to use academic placement tests for incoming freshmen. These tests provide guidance to students for course selection, usually in mathematics and English, however, as Schommer and Walker (1997) contend perhaps examinations that access epistemological beliefs should be considered in college admissions as well. Students who are identified in college admissions as needing epistemological guidance can then be directed to register for a course similar to the FYEX course that was a component of this study.

In addition to college implications, this study contributes to the support of state adoptions of the Common Core State Standards (CCSS) for mathematics (National Governors Association for Best Practices & Council of Chief State School Officers,

2010). The focus of CCSS on the blending of procedural skills with conceptual learning is appropriate as this study has been able to bring to light how problematic the viewing of mathematics as “tools to be memorized” can be for students as they continue learning mathematics. In addition, the study might suggest a balance of instruction that employs not only creative lessons designed to allow conceptual understanding of mathematical ideas, but, also exposes students to the notions of self-responsibility, self-esteem and the creation of a learning mindset. Courses designed similar to the FYEX course, for example, might be made available for high school students where appropriate. This would perhaps enable more students to enter college as empowered, self-responsible learners. Having a belief that learning is gradual rather than immediate will help students become life-long learners. In addition, having a more sophisticated belief about mathematics is crucial. If students can move away from viewing mathematics as a course that must be endured and memorized toward a view of mathematics as a collection of conceptual understandings and skills connected to their career lives, they will be better prepared for a future where learning will be constant.

Directions for Future Research

Although this study adds to the current research, especially in regard to how developmental mathematics students might benefit from exposure to a student success course, an experimental design would allow for generalization of results. Randomly generated treatment and control groups would be ideal. Unfortunately many community colleges are either offering these courses as mandates to all incoming

freshmen or targeting special populations of students as was the case with the participating community college in this study.

Longitudinal studies that are able to track students' progression through developmental mathematics on into college level mathematics would also be beneficial. Pertinent to our nation's concern regarding mathematics achievement is whether developmental students are able to complete the full sequence of mathematics courses necessary to support career goals.

Another area for future research includes comparisons with a variety of community colleges. Community colleges are implementing similar interventions, while adapting them specifically to meet their needs. However, an exploration of best practices could be helpful to decision makers. As this study has shown that there is a benefit to developmental mathematics students who take a one-credit success course, comparisons could be made with other community colleges, some of whom are offering two- and three-credit student success courses, to determine what is the ideal length and exposure of the course for maximum student success particularly for developmental mathematics students.

Conclusions

Increasing the success for developmental mathematics students particularly at community colleges is on the minds of many. This study has shown that one intervention, the offering of a non-mathematics success course to students who are at-risk has made some improvements in the percentage of students who were able to satisfactorily complete the first level developmental mathematics course at one

community college. Moreover, the results provide an opportunity to witness a phenomenon where students who were unsuccessful in FYEX were also unsuccessful in a low-level mathematics course.

These insights should encourage next steps that could include expansion of offering of the course, both in content as well as in population exposure. Continual tracking of how these courses affect developmental mathematics students is crucial. In addition, developing a system that could help identify incoming freshmen who are in need of epistemological belief instruction seems logical.

Qualitative data generated in the study confirm the need for students in this population to have access to instruction on characteristics of successful students, many of which align with more sophisticated epistemological beliefs. The qualitative data also contribute to the body of knowledge regarding belief structures of developmental mathematics and provides an understanding of how many students view mathematics as something to be memorized and practiced, rather than something to think about or figure out. Students displayed an underlying concern regarding the need for studying mathematics, and for it possibly standing in the way of completion of degrees. Most students saw mathematics as somewhat useless to them and as something that made little sense. Students in both groups also relied quite heavily on others or computer help aids. Asking for help was the first and many times only strategy students in this study could identify for learning mathematics or for overcoming struggles.

Efforts that focus on success for low-level mathematics students, it appears, should address these characteristics in the form of non-mathematical instruction, like

the student success course in this study. Whether that instruction is delivered in a success course, or interwoven with mathematical course deliveries, results of this study seem to suggest that such efforts could increase mathematical achievement for low-level developmental mathematics students.

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APPENDIX A
FYEX SAMPLE SYLLABUS

FYEX SAMPLE SYLLABUS

FYEX 1000 College Success Strategies Spring 2011

Description

This course introduces proven strategies and applications to help students create greater success in college and life. Provides an active environment for students to identify and engage choices that promote responsibility, motivation, interdependence, self-awareness, and persistence for academic and career decision-making. Students will also explore and use campus resources and services. (Credits: 1)

Learning Outcomes

- Demonstrate an understanding of expressions of self-responsibility.
- Design a life plan.
- Create a self-management plan.
- Understand methods for creating a support network for student success.
- Demonstrate knowledge of intrapersonal communication.
- Demonstrate strategies for lifelong learning.
- Demonstrate knowledge about emotional intelligence with a self-care plan.

Required Texts

- *On Course: Strategies for Creating Success in College and in Life*, 6th Edition by Skip Downing, Wadsworth CENGAGE Learning: ISBN 978-1-4390-8217-1

Expectations

Professionalism: To succeed, I choose to perform my best work, turn in my assignments on time, and respect the learning in the classroom

Turn in work on time and before the assigned due date

Assignments turned in late will have a grade reduction of 10% of the possible points for each class session it is late

Have an official RCTC student email account that you check often

Be at class on time and prepared (pencil/pen, paper, notebook, caffeine if required)

FYEX 1000 will meet for 16 sessions

Silence your phones and do not text during class

Listen to the person who is talking and reflect silently

Actively participate during each class session

Actively participate in Portfolio activities

Academic Integrity: To succeed, I choose to be ethical, honest, and true to myself and others

Academic honesty is expected of every individual

Academic dishonesty includes cheating, plagiarism, and collusion

Plagiarism is using others' ideas, words, images, or music without credit

Acts of academic dishonesty will result in failure of the assignment, test, or the class; reference the RCTC Student Conduct and Academic Dishonesty Policy ([RCTC Policy 3.6, Section 2](#))

Attendance: To succeed, I choose to be present for every class and stay for the whole session

Attendance is required

Participation and Attendance – 20% of final grade

Your participation and attendance is **vital to your success**. There will be a variety of ways that you will show your participation in class activities. Some of these ways include:

- Quick-Writes
- Quick-Quizzes
- Classroom Participation
- Idea Cards

Journal Entries – 50% of final grade

Your journal is an opportunity to explore your thoughts and feelings as you experiment with the success strategies presented in this class. **Write your journal for yourself**, not for me. Your journal entries may occasionally be read by your classmates.

Portfolio – 30% of final grade

Your success at RCTC is supported by the different services that the campus offers. Your portfolio is a collection of activities that allow you to **dive deep** through participation. To receive credit for your participation, you will write a short response to your participation in an activity.

FYEX Student Success Activities (do **ONE** of the following):

- Reading FYEX Workshop
- Test Taking FYEX Workshop
- Note Taking FYEX Workshop

Academic Activities (do a minimum of **THREE** of the following):

- Attend a session during Student Success Day
- Attend the keynote speech during Student Success Day
- Schedule a meeting and meet with your academic advisor
- Attend a Drop-in Library Orientation Session
- Schedule a meeting and meet with one of your instructors to talk about your progress in a course
- Form a study group to succeed in one of your courses
- Visit the Comprehensive Learning Center
- Write a *Personal Philosophy of Success* Essay
- Write a *One Student's Story* Essay for submission to the [On Course Essay Content](#)

Student Life Activities (do **ONE** of the following):

- Attend an RCTC athletic event
- Attend a campus cultural event (play, art opening, musical production, etc.)
- Attend a lecture or seminar on campus
- Join an RCTC student club

Final Grade

Your final grade will be determined according to the following percentages:

A = 100–90

B = 89–80

C = 79–70

D = 69–60

F = 59 and below

Timeline (Our schedule is subject to change)

Session	Reading Due	In Class	Assignment Due
1		Syllabus <i>Opening Activity</i>	
2	Chapter 1 2–23	The Power of Choice How the Human Brain Learns <i>The Learning Game</i> Self-Acceptance	Journal 1
3	Chapter 2 31–42	<i>The Late Paper Case Study</i> Creator Language	Journal 2
4	Chapter 2 43–49	Wise Choice Process <i>The Road Not Taken</i>	Journal 5
5	Chapter 2 50–54 Chapter 3 65–75	Inner Conversations Stinkin' Thinkin' <i>Inner Dialogue Role-Play</i> Creating Inner Motivation	Journal 6
6	Chapter 3 76–90	Designing a Compelling Life Plan <i>Guess my Dream</i>	Journal 9
7	Chapter 4 103–116	Creating a Self-Management System <i>The Procrastinators Case Study</i>	Journal 12
8	Chapter 4 117–128	<i>The Graduation Game</i> Develop Self-Confidence	Journal 13
9	Chapter 5 141–151	<i>Professor Rogers' Trial Case Study</i> <i>The Scavenger Hunt</i> Creating a Support Network	Journal 17
10	Chapter 5 151–162	Be Assertive <i>The Party</i>	Journal 19
11	Chapter 6 173–183	<i>Strange Choices Trial Case Study</i> Identifying Your Scripts <i>Author, Author</i>	Journal 21
12	Chapter 6 184–195	Write Your Own Rules <i>Changing Habits</i> <i>The Paper Pull</i>	Journal 23
13	Chapter 7 207–216	<i>A Fish Story Case Study</i> Preferred Learning Styles <i>My Favorite Teacher</i>	Journal 24
14	Chapter 7 216–234	Learning to Make Course Corrections <i>The Failure Toss</i>	Journal 26
15	Chapter 8 243–258	<i>After Math Case Study</i> <i>I'm Willing to Feel</i> <i>Right Now I Feel</i>	Journal 28
16	Chapter 8 259–270 Chapter 9 280–285	<i>Clump</i> <i>Work Becomes Play</i>	Journal 32

APPENDIX B
D2L ON-LINE SURVEY

D2L ON-LINE SURVEY

1. Math course presently enrolled in:
2. Are you currently enrolled in a First Year Experience Course at RCTC? If so, explain your reason for enrolling in the course and what you hope to gain from it.
3. Gender: ___Female ___Male
4. Age: ___ years
5. Race/ethnicity: _____
6. What are your college and career goals? _____
7. Before this course, when was your last math course? _____
8. What was your last math course? _____
9. What mathematics courses do you plan to take in the future?

10. How would you describe your attitude towards mathematics in the past?
11. How would you describe your attitude towards mathematics now?
12. How do you see yourself as a learner of mathematics? Provide as much detail as possible describing your abilities, motivations, and emotions regarding learning mathematics.
13. What do you do if you don't know how to do a math problem?

Rate the following from 1 – 5:**1 being strongly agree, 2 agree, 3 neutral, 4 disagree, 5 strongly disagree**

14. In mathematics there is always a right or wrong answer.
15. Some people are naturally gifted at mathematics.
16. If I don't understand something in mathematics, I know how to seek help.
17. I often feel defeated in math class.
18. Making a mistake in mathematics is a really a great learning opportunity.
19. I am responsible for my own learning.
20. I am frustrated if the teacher doesn't show me a step-by-step example of math problems.
21. There is a lot of mathematics that I can do on my own.

APPENDIX C
INFORMED CONSENT FOR ON-LINE SURVEY

INFORMED CONSENT FOR ON-LINE SURVEY

Title: Developmental Mathematics in Community Colleges and Student Success

Project Director: Brenda Frame, a doctoral candidate at The University of Montana and a faculty member in the Mathematics Department at Rochester Community and Technical College. 507-280-2814 or Brenda.frame@roch.edu

Faculty Advisors: James Hirstein, Professor, Mathematics, The University of Montana, 406-243-2661, HirsteinJ@mso.umt.edu
David Erickson, Associate Professor, Curriculum and Instruction, The University of Montana, 406-243-5318, david.erickson@mso.umt.edu

Purpose: The purpose of this study is to explore student success in developmental mathematics courses.

Procedure: If you agree to take this online survey, you will answer 21 questions. This will take approximately 15 minutes to complete. Completion of this on-line survey is restricted to those at least 18 years of age.

Risks/Discomforts: There are minimal risks involved in this study. You may have mild discomfort from uncomfortable feelings you've had about mathematics while answering some of these questions. At the end of the survey, a list of resources is provided that may help you cope with your reactions.

Benefits: There may or may not be any direct benefit to you from this study. The study may provide information that can assist educators and administrators to develop strategies to aid students having learning difficulties in mathematics. You will also assist in advancing educational research in student-learning strategies developed to learn mathematics.

Confidentiality: Written materials will be kept private and your online survey, administered through the secure campus D2L, site will be assigned a number code for data analysis. Your consent form will be kept separate from your survey and stored in a locked file cabinet. Written records will be shredded within 12 months of completing the study.

Voluntary participation & right to withdraw: Participation in this study is entirely voluntary. You are not required to answer any questions in this study. You may choose to take part or withdraw at any time without penalty or loss of benefits to which you are normally entitled.

Reporting of Results: The results of this study will be reported in a doctoral dissertation at The University of Montana, Missoula, MT. Other articles may be published in educational journals. It is anticipated that the dissertation will be available by Fall 2012.

Questions: If you have any questions about this research now or in the future, please contact Brenda Frame 507-280-2814 / Brenda.frame@roch.edu or James Hirstein 406-243-2661 / HirsteinJ@mso.umt.edu or David Erickson 406-243-5318 / david.erickson@mso.umt.edu

If you have any questions regarding your rights as a participant in this research, you may contact the chair of the IRB at The University of Montana-Missoula, 406-243-6670.

Please select one of the options below:

- I have read the above description of this research study. I have been informed of the risks and benefits involved. I understand that if I have questions, I may contact the project director at 507-280-2814. I affirm that I am at least 18 years of age. I voluntarily agree to take part in this study. I understand that this survey is confidential.
- I did not read or understand the above and do not wish to take part in this study or am not at least 18 years of age and not eligible for this study.

APPENDIX D
INFORMED CONSENT FOR PHASE II PARTICIPANTS

INFORMED CONSENT FOR PHASE II PARTICIPANTS

Title: Developmental Mathematics in Community Colleges and Student Success

Project Director: Brenda Frame, a doctoral candidate at The University of Montana and a faculty member in the Mathematics Department at Rochester Community and Technical College. 507-280-2814 or Brenda.frame@roch.edu

Faculty Advisors: James Hirstein, Professor, Mathematics, The University of Montana, 406-243-2661, HirsteinJ@mso.umt.edu
 David Erickson, Associate Professor, Curriculum and Instruction, The University of Montana, 406-243-5318, david.erickson@mso.umt.edu

Purpose: The purpose of this study is to explore student success in developmental mathematics courses.

Procedure: If you agree to participate in this case study, you will be asked to attend a one hour focus group interview that will be scheduled on campus during the weeks of September 26 – November 4, 2011. This interview will be videotaped. In addition you will be asked to complete 4 journal entries throughout the semester. You will be able to complete these entries on-line using the research D2L site. E-mail's will be sent to remind you when each journal entry is due. You will have a span of approximately 10-14 days to submit each entry. Two entries will be completed by October 30, 2011 and the remaining two entries will be completed by December 7, 2011. In addition the researcher will observe your mathematics course at least once during the semester.

Risks/Discomforts: There are minimal risks involved in this study. You may have mild discomfort from uncomfortable feelings you've had about mathematics while answering some questions. At the end of the research study, a list of resources will be provided to you that may help you cope with your reactions.

Benefits: There may or may not be any direct benefit to you from this study. The study may provide information that can assist educators and administrators to develop strategies to aid students having learning difficulties in mathematics. You will also assist in advancing educational research in student-learning strategies developed to learn mathematics. In addition you will receive a gift card at a local mall or bookstore as a thank you for your participation.

Confidentiality: There is a very remote chance of a loss of confidentiality. Attempts to maintain confidentiality include: (a) names of students will remain confidential to everyone except the principal investigator, (b) all coding documents will be stored in double-locked filing cabinets, (c) names of persons identified in the research will be given pseudonyms as it is anticipated that some statements will be quoted, (d) information collected

will not be released to any person, (e) written records will be shredded within 12 months of completing the study and video records will be destroyed within 6 months of completion of the study.

Voluntary participation & right to withdraw: Participation in this study is entirely voluntary. You are not required to answer any questions in this study. You may choose to take part or withdraw at any time without penalty or loss of benefits to which you are normally entitled.

Reporting of Results: The results of this study will be reported in a doctoral dissertation at The University of Montana, Missoula, MT. Other articles may be published in educational journals. It is anticipated that the dissertation will be available by Fall 2012.

Questions: If you have any questions about this research now or in the future, please contact Brenda Frame 507-280-2814 / Brenda.frame@roch.edu or James Hirstein 406-243-2661 / HirsteinJ@mso.umt.edu or David Erickson 406-243-5318 / david.erickson@mso.umt.edu

If you have any questions regarding your rights as a participant in this research, you may contact the chair of the IRB at The University of Montana-Missoula, 406-243-6670.

Statement of Consent: I have read the above description of this research study. I have been informed of the risks and benefits involved, and all my questions have been answered to my satisfaction. Furthermore, I have been assured that any future questions I may have will also be answered by a member of the research team. I voluntarily agree to take part in this study. I understand I will receive a copy of this consent form.

Printed Name of Subject

Subject's Signature

Date

APPENDIX E
STUDENT E-MAIL COMMUNICATION

STUDENT E-MAIL COMMUNICATION

Dear RCTC student,

I am Brenda Frame, a doctoral candidate at The University of Montana and a faculty member in the Mathematics Department at Rochester Community and Technical College. I am conducting a comparative mixed-method research study to explore student success in developmental mathematics.

You have been identified to share your insights and feelings regarding the study of mathematics. By doing this you may contribute to growing field of mathematics education and particularly in the area of developmental mathematics at community colleges.

Your participation is strictly voluntary and you may discontinue at any time.

In order to participate please do the following steps:

- Log into your D2L site,

- Click on the course whose title begins with: Dissertation Study

- Click on the survey link on the top of the page.

- Complete the student consent page.

- Your consent will automatically route you to the survey.

The survey will take about 15 minutes to complete.

I sincerely thank you for your participation.

Brenda Frame

Doctoral Candidate, The University of Montana-Missoula

Rochester Community and Technical College Mathematics Department

Rochester, MN 55963

APPENDIX F
FACULTY E-MAIL COMMUNICATION

FACULTY E-MAIL COMMUNICATION

Dear Faculty member,

I am Brenda Frame, a doctoral candidate at The University of Montana and a faculty member in the Mathematics Department at Rochester Community and Technical College. I am conducting a comparative mixed-method research study to explore student success in low-level developmental mathematics. There are two comparison groups in the study. One group is comprised of students who are taking both Math 0093 and FYEX 1000 and the other group is made up of students who are taking only Math 0093.

Students in your course have been identified as possible participants in the study. I am asking all participants to complete on-line surveys twice during the semester. The first on-line survey will be available _____. The second will be available _____. The survey will be administered on D2L site and students will be sent e-mail invitations and reminders to complete the survey. Your encouragement is welcomed and you may entice students with minimal bonus points for completing the surveys. Students can prove completion of the survey by printing the time and dated thank you page after completing the survey. All surveys are confidential and students will not be asked the name of course instructors or sections.

A qualitative component of the study will include focus group interviews, journal entries and classroom observations of five to eight students per comparison group. Your recommendations are encouraged and welcomed for student participants in this portion of the study. I am particularly exploring the changes in belief structures regarding how students see themselves as learners of mathematics. Individuals that have demonstrated strong feelings and seem willing to share their insights and stories would be candidates for the study. Students participating in this level of the study will be asked to attend one focus group interview during late October or early November, to write four journal entries (these can be submitted on-line), and to allow the researcher to observe classes periodically during the semester (maximum of three times).

Please respond to this e-mail with the following:

1. Confirm receipt of e-mail and acknowledge your intentions concerning participation in the study.
2. Indicate student encouragement strategies if applicable (I will maintain records of strategies and survey completion rates during the study. Instructor names will not be attached to these records).

In a couple of weeks I will send you student recommendation invitations for participation in the second level of the research study. I look forward to your communication and am hopeful for your acceptance of the research study. The research study is designed such that your participation involves minimal extra time or energy. I sincerely thank you for your consideration of the research.

Brenda Frame
Doctoral Candidate, The University of Montana-Missoula
Rochester Community and Technical College Mathematics Department
Rochester, MN 55963

APPENDIX G
FOCUS GROUP INTERVIEW PROTOCOL

FOCUS GROUP INTERVIEW PROTOCOL

Focus group interviews will be scheduled on campus. A trained moderator will be present and will moderate student discussion. A flip chart will be used by the moderator to record student ideas, clarify student meaning, and generate discussion. The researcher will observe and may ask for clarification. The interview will be videotaped.

Before the interview begins, the students will be informed that:

- The interview will be digitally recorded.
- Their identity will remain confidential during the whole course of the study and in the written report of the study.
- They can discontinue their participation at any time.
- If they have not already done so, they will be asked to sign an informed consent form.

The following core questions will be asked:

As a group discuss the following questions.

1. What is mathematics to you? Why study it?
2. What kinds of feelings have you had about learning mathematics? Would you say that certain feelings occur more than others, if so, which ones? Why?
3. How do you see yourself as a learner of mathematics? Has this changed this semester? If so, how, and why?

The following questions will be optional:

4. What does a successful math student look like to you? What would they do?
5. What difficulties have you had with mathematics? What did you do to cope with these difficulties?
6. What attitudes do you recall having toward math in the past?
7. What do you attribute success in mathematics to?
8. What advice do you have for learners of mathematics?

APPENDIX H
CLASSROOM OBERVATION PROTOCOL

CLASSROOM OBERVATION PROTOCOL

Date _____

Name _____

Course _____

Concept Taught: _____

1. Describe student's interaction with the teacher.
2. Describe student's interaction with other students.
3. Describe how the student participates in class.
4. What behavior(s) does the student demonstrate when a concept is not understood?
5. What behavior(s) does the student demonstrate when a concept is understood?
6. What attitude towards mathematics does the student exhibit?

APPENDIX I
JOURNAL ENTRY PROMPTS

JOURNAL ENTRY PROMPTS

Journal Entry: 1 – Respond to the following question using a free write technique. Write openly without concern of correcting spelling or grammar. While writing continue to reflect on the question, and try to take your thoughts to a deep level.

Student Name: _____ Date: _____

How do you feel about mathematics? Provide examples that might explain these feelings or experiences that you remember.

Journal Entry: 2– Respond to the following question using a free write technique. Write openly without concern of correcting spelling or grammar. While writing continue to reflect on the question, and try to take your thoughts to a deep level.

Student Name: _____ Date: _____

How do you see yourself as a learner of mathematics?

Journal Entry: 3– Respond to the following question using a free write technique. Write openly without concern of correcting spelling or grammar. While writing continue to reflect on the question, and try to take your thoughts to a deep level.

Student Name: _____ Date: _____

What does mathematics mean to you? Provide many examples and explain background where necessary.

Journal Entry: 4– Respond to the following question using a free write technique. Write openly without concern of correcting spelling or grammar. While writing continue to reflect on the question, and try to take your thoughts to a deep level.

Student Name: _____ Date: _____

What do you do when you are faced with a challenge in mathematics? What advice would you give to other learners of mathematics?

APPENDIX J
CURRICULUM VITAE

CURRICULUM VITAE

Brenda C. Frame

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brenda.frame@roch.edu

Education

Master of Education in Mathematics Education

University of Minnesota, Minneapolis, MN 1999

Bachelor of Arts in Mathematics

St. Olaf College, Northfield, MN 1990

Professional Experience.....*Post-Secondary Experience***Mathematics Instructor**, Rochester Community and Technical College, RCTC, Rochester, MN
1992 to present

- Teach the following courses: Elementary Algebra, Intermediate Algebra, College Algebra, Finite Mathematics, Pre-Calculus, Applied Calculus and Contemporary Concepts in a variety of delivery methods
- Have experience teaching technical mathematics courses that have been offered in the past including: Applied Technical Math, Principles of Technical Math I and II, Math for Technology, and College Math
- Member of MinnMATYC and AMATYC; Attend annual conferences
- Teach on-line and hybrid courses using MyMathLab software
- Served on the Academic Standards college committee for three years
- Have served on various search committees for the college
- Faculty leadership on developmental mathematics reform committee for two years
- Faculty member of steering committee for the development of First Year Experience course; a campus wide initiative
- RCTC faculty representative for Promising practices grant proposal participation
- Worked with Summer Bridge program for six years. Summer Bridge provides a transition for at-risk high school seniors who plan to attend RCTC in the following fall. This includes meeting with secondary educators and collaborating with them regarding curriculum.
- Presenter at designated Student Success Days
- Continuing education in curriculum and instruction through graduate program at The University of Montana-Missoula

Student Support Services Math Specialist, RCTC

1994 - 2000

- Provided academic advising and support for students who are eligible for SSS services, clientele included first generation, low income, and disabled students enrolled at RCTC
- Provided specific supplemental instruction for SSS students in mathematics
- Monitored and assessed student academic skills and goals
- Assisted students with course selection
- Presented workshops on using the TI-83 graphing calculator
- Received specialized training for accommodating students with disabilities and general student retention strategies

- Encouraged participation in cultural enrichment activities
- Attended MAEOPP, MnAEOPP, NADE, and MnADE annual conferences
- Assisted in writing Student Support Services grant proposals
- Originated and implemented the tutor of the year award and other tutor recognition that continues yearly

Professional Experience continued....***High School Teaching/Coaching Experiences***

High School Girl's Track and Field Coach, Pine Island High School, Pine Island, MN

1985 to Present *Head coach 3 years, Assistant varsity coach 23 years*

- Prepare female athletes for varsity and sub-varsity competition in the sport of track and field by providing meaningful practices and workouts for a variety of competitors and balancing conditioning with event specific training and skill development, Coaching focus: Sprinters, Relays, Hurdlers, & Pole Vault
- Encourage confidence and exploration of events with individual athletes
- Foster an environment that focuses on team as well as individual goals
- Care for equipment, uniforms, and supplies. Assist with preparation of facilities such as: sand pits and jumping boards, hurdle maintenance, high jump and pole vault pits, and shot and disc area markings
- Maintain and update all records for the girl's track program
- Have coached two State Champion titles; Pole Vault 2001, and 4x400 relay team 2006

High School Mathematics Teacher, Pine Island High School

1991-1994

Pine Island, MN

- Taught Algebra I, Algebra II, 7th Grade Math, and 9th Grade Basic Math
- Attended training for implementation of CORD Applied Mathematics curriculum and tech prep initiatives
- Participated in the "Building the World" project through the University of Minnesota

High School Volleyball Coach, Pine Island High School

1986-2000

Pine Island, MN

- Head volleyball coach for 4 years, sub-varsity coach 8 years
- Responsible for all aspects of the program; organizing gym space/time, monitoring and mentoring coaching staff (consisting of 5 coaches) managing budget, equipment, uniforms, supplies, practices, and matches

Honors and Awards

- 2005 Instructor of the Year
Minnesota State College Student Association
- University of Minnesota – 1999 - Recipient of Vincent and Shirley Hagstrom Scholarship for commitment to education
- St. Olaf College – 1990 - Chosen by mathematics faculty as a member of Women in Mathematics Association