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Developmental Students' Perceptions of Unsuccessful and Successful Mathematics Learning

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DEVELOPMENTAL STUDENTS' PERCEPTIONS OF UNSUCCESSFUL AND SUCCESSFUL MATHEMATICS LEARNING

by

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ABSTRACT

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The purpose of this phenomenological study was to describe what experiences, attitudes, and learning strategies developmental mathematics students believed contributed to their failure to gain basic math skill proficiency in the past and what experiences, attitudes, and learning strategies these students now believed were most likely to enhance the successful learning of basic math skills.

To gain an understanding of the lived experiences of successful developmental mathematics students who were previously unsuccessful, structured, open-ended interviews were conducted, classroom observations were made, and formative and summative assessments for the students were collected. Fourteen students from a western 4-year college were selected purposefully based on instructor recommendations and preliminary survey results. The students, who were eight males and six females, ranged in age from 19 to 51. Seven were considered traditional students and seven nontraditional.

Based on the data analysis, five prevalent themes emerged: *turning point, attitude, motivation, learning environment,* and *learning strategies.* Motivation was the most common reason given as the difference between being unsuccessful and successful math skill development. Underlying their motivation were the students' own beliefs. In the unsuccessful period, every student had the fixed mindset of not being capable of learning mathematics. When successful, the students exhibited a growth mindset, believing that if they exerted time and effort, they would be able to learn. This mindset made the difference in their motivation and attitude. Previously they hated mathematics. When successful, students actually enjoyed learning mathematics and expressed confidence that they would be successful in the subsequent course.

When unsuccessful, students were field dependent. Most were children or adolescents. They had no control over their learning environment or selection of learning resources. The predominant coping strategy was one of avoidance. When successful, students were more field independent. They could choose their teachers and actively seek learning resources.

When asked what changes in their K-12 experience would have helped them be more successful, the students paradoxically suggested that a close monitoring of their progress might have made a difference. However, during their unsuccessful period, students did everything they could to avoid being labeled as needing help.

(212 pages)

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Laurel Howard

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CHAPTER I

INTRODUCTION

Today many students come to college having to take at least one remedial course in reading, writing, or mathematics. More than half of all community college students enroll in one or more remedial classes (Hodges & Kennedy, 2004). According to the U.S. Department of Education report of fall, 2000, 71% of all postsecondary institutions and 97% of all public 2-year institutions offer remedial mathematics courses.

As the demand for remedial education increases, the cost to educate an under-prepared college student accordingly rises (Hodges & Kennedy, 2004; Krzemien, 2004). Eduardo J. Martí, President of Queensborough Community College, Bayside, N.Y., part of the City University of New York, cited remediation as a significant part of their budget.

> Remediation is expensive. It is clear that our high schools are graduating students who are not prepared to pass the college-entrance exams. Community colleges spend a large amount of their instructional budgets on remediation: in our case 19.4 percent, or $22-million. ("Challenges of Remedial Education," 2006)

The population of students taking remedial or developmental mathematics courses was surprisingly divided in age. Those who were 22 years old and under comprised 54% of the population and those who were 23 years old and over comprised 46% (Ignash, 1997). Krzemien (2004) separated this population into three groups: (a) those who returned after being away from school for a number of years, which would include those 23 and over; (b) those who were recently out of high school, which would be in the 18 to 22 age category; and (c) those who had been in special education classes during their elementary and secondary education, which could comprise members of both age groups. This third group may have completed the objectives given to them in their own individualized education program, but that is little evidence of what math skills they actually developed or retained.

Those students who had been in special education classes were presumably diagnosed in their earlier stages of education as needing specialized instruction to aid them with their learning disabilities. Therefore, it was understandable that this group needed additional help in learning basic math skills when they entered college.

Compared to students in the younger age group, students in the older group were found to have lower levels of algebra skill, had been away from mathematics longer, had completed less college preparatory classes, and had higher levels of math anxiety (Meeks, 1989). However, the older students were found to have higher motivation than the younger students (Meeks). Therefore, they may have forgotten some of their basic arithmetic skills and need a refresher course in order to be proficient in the math courses required for their particular major. However, there may also be people in this age category who never learned their basic skills at all.

Meeks (1989) found that for the younger group of students, arithmetic skill and years of high school mathematics correlated highly with final course averages. Levels of motivation also correlated highly positively with academic success. The group of students in the younger age category who have not demonstrated proficiency in their basic arithmetic skills may have forgotten them quickly, but there are likely many who never sufficiently learned their skills in the first place.

The academic literature has provided research examining different aspects of why and how students failed to acquire their basic math skills. The literature appears to provide limited information about the students' own perception of what happened to them.

Research Question

This study focused on students who had not been identified as special needs students and who seemed to have never learned basic math skills. The particular question focused on in this study was: What are these students' perceptions about their unsuccessful acquisition of math skills in the past and what different perceptions do these students now have that will enable them to be successful?

The question has been broken down into more specific questions, which were used to guide a qualitative study among a group of developmental mathematics students at a western 4-year college who have not been diagnosed with a learning disability.

1. What experiences, attitudes, and learning strategies have affected students' mastery or lack of mastery of the basic math skills?

2. What do students remember about how the school system helped or did not help them learn math?

3. What current experiences, attitudes, and learning strategies have students developed and what do they now perceive as helpful in developing their math skills?

4. How do the students perceive the school's systems of teaching and learning has changed to influence their success in learning math?

5. What common experiences emerged regarding students' shift from unsuccessful to successful math students?

The academic literature has documented many reasons for why students come to college lacking basic math skills. Researching the students' perspective of their experiences in trying to master basic math concepts provided an added dimension to knowledge about the problem.

Statement of the Problem

Since many developmental math students have been instructed in basic mathematical skills, presumably more than once, the students were attempting once again to acquire these skills. In order to acquire these skills, students' experiences, attitudes, and learning strategies must be different than before; otherwise, students will likely obtain the same results. This research identified, described, and categorized the students' perceptions of their experiences, attitudes, and the learning strategies that they believed hindered their acquisition of skills in the past. It also investigated their perceptions of the experiences, attitudes, and learning strategies that they believe will enable them to be successful now.

Purpose of the Study

The purpose of this phenomenological study was to describe what experiences, attitudes, and learning strategies developmental mathematics students believe were unsuccessful in aiding them in gaining basic math skill proficiency in the past and what experiences, attitudes, and learning strategies these students now believe are most likely to enhance their successful learning of basic math skills.

Definition of Terms

The following terms were used extensively throughout the study.

Basic math skills: the math concepts and skills that students need to prepare them to take college algebra at a postsecondary institution.

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 (Richardson, 1995).

Remedial math course: math course offered at a postsecondary institution to prepare a student for a college-level entry mathematics course.

Developmental mathematics student: one who has tested into a remedial math course, either through the ACT score or the college placement exam.

Learning experiences: students' experiences in an educational setting in which mathematics' understanding takes place.

Learning strategies: plan or activities students and educators initiate to learn mathematics.

Non-traditional Student: students who have been out of school for an extended period of time (3 or more years) and have chosen to come back to college.

Students' attitudes: students' beliefs and emotions regarding their knowledge of mathematics and their capability of learning mathematics.

Traditional student: students who have pursued their education after high school without an extended break (3 or more years).

Literature Review

For the literature review that follows, a systematic search of the literature on developmental mathematics was conducted. Search terms utilized were: developmental mathematics, student success, colleges, learning environment, class size, learning strategies, student perceptions, student attitudes, and student motivation. The following databases were searched electronically: Dissertations Abstracts, ERIC, Education Full Text, and Digest of Education Statistics. In addition, articles found in this initial search were reviewed for additional pertinent references.

In the literature review, studies were found regarding factors influencing student success (Bohrnsted & Stecher, 1999; Carman, 1976; Eggert, 2001; Faro-Schroeder, 1995; Glass & Smith, 1978; Hancock, 1996; Jacobson, 2006a; Klomegah, 2007; Krzemien, 2004; Lizzio, Wilson, & Simons, 2002; Macomber & Siegel, 1960; Molnar, Percy, Smith, & Zahorik, 1998; Mueller, Chase, & Walden, 1988; Pedersen, 2004; Warneke, 2000; Zerr, 2007). In addition, research articles reporting the effects of students' attitudes and motivation on learning were reviewed (Hardre, Crowson, Debacker, & White, 2007; Jones & Smart, 1995; Miller, 2000; Richardson, 1995; Skaalvik & Valas, 1999; Stipek, Givvin, Salmon, & MacGyvers, 1998a; Turner, Thorpe, & Meyer, 1998).

Qualitative studies examining students' perceptions of learning were found in several disciplines: medicine (Evensen, Salisbury-Glennon, & Glenn, 2001), nursing (Ganum, 2004; Starr & Conley, 2006), online learning (Lao & Gonzales, 2005), science education (Spector & Gibson, 1991), foreign language study (Tse, 2000), and nutrition (Vecchiarelli, Takayanagi, & Neumann, 2006). Only one qualitative study in the field of developmental mathematics was found (Weinstein, 2004). Weinstein described students' experiences with tutors as they engaged in the process of learning mathematics and the change in their perceptions of their own success.

CHAPTER II

REVIEW OF THE LITERATURE

Each year, the number of students needing remedial math classes is increasing (Hodges & Kennedy, 2004; Krzemien, 2004). Nationwide, between 60% to 75% of entering community college freshmen need remediation in mathematics in order to succeed in a college environment (Shore & Shore, 2003). Many colleges require developmental students to successfully complete their remedial courses before they are allowed to register for college-level classes. Therefore, some students must take one or more remedial classes, increasing the demand for such courses.

Another reason for increased enrollment in remedial courses is that the standard of remediation has changed. “How much remediation students need changes, too, as the level of knowledge in a field changes or skills required to do a job become more specialized” (Ignash, 1997, p. 9). Therefore, many colleges are reclassifying courses that were once considered college level as developmental. Illinois public universities, for example, have changed intermediate algebra from a college-level course to a remedial course (Ignash). Raising the bar has automatically increased the enrollment in developmental courses.

As students must take more math courses to be prepared to take college-level mathematics courses, choice of major fields of education become limited because of the amount of time it would take to complete those courses and enter into the desired major program. Stage and Kloosterman (1995) called these preparatory developmental courses “gate keepers.”

> Because mathematics is a prerequisite for many professions, these courses serve as "gate keepers" that effectively filter many students out of careers they might otherwise pursue. In brief, many students realize the importance of mathematics for meeting career aspirations. College remedial mathematics courses, however, are one barrier to meeting career aspirations that many find difficult to overcome. (p. 294)

Even with the remedial courses provided for the underpreprepared student, colleges and universities are experiencing high attrition rates (Autrey, Horton, Kher, Molstead, & Juneau, (1999). Academic underpreparation is one of the most predominant factors linked to those attrition rates (Autrey et al.). Students leaving the higher education system "forfeit the occupational, monetary and other societal rewards associated with having a degree" (Autrey et al., p. 1).

Kinney (2001) suggested some reasons that college students are in need of developmental mathematics courses:

> Students arrive at postsecondary institutions with deficits in mathematics for a variety of reasons including: (a) They did not take the relevant courses in high school, (b) they took the relevant courses but did not master the content, and (c) they have forgotten much of the content that they once had mastered. (p. 10)

Graves (1998) compiled a list of common characteristics exhibited by developmental mathematics students.

The remedial mathematics students tend to have one or more of the following characteristics:

1. Lack of academic skills
2. Poor attitude
3. Lack of counseling
4. Lack of college survival skills
5. Low career aspirations
6. Cognitive incompetencies
7. Limited vision
8. Lack of maturity

9. Low income (Austin; Lazdowski; Tinto, 1987b; Zwerling; as cited in Graves, p. 8).

Developmental students participating in this study exhibited one or more of these characteristics in their unsuccessful experiences.

This literature review examines learning experiences and learning strategies that influence mathematics skills acquisition, which include teaching competency, teaching methods, and students' personal circumstances. The review also focuses on student motivation, attitude, and beliefs about learning mathematics.

Learning Experiences

External factors in elementary and secondary education may have contributed to the number of students coming out of high school who are lacking in basic math skills. In order that students can progress with their own age group, students may be passed to the next grade without demonstrating proficiency. Teachers may also not be proficient in teaching some of the skills. Ferrandino (2004) reported that "finding teachers with a solid handle on math can be challenging. Research has found that many elementary and middle grade teachers don't feel as comfortable with their math knowledge as with other subjects" (p. 64). Teachers who do feel inadequate mathematically may not emphasize math skills as much or they may unintentionally pass on their fear or dislike for the subject (Ferrandino).

A comfortable atmosphere where students feel free to ask questions is conducive to learning (Bain, 2004; Kealoha, 2006; Middleton & Spanias, 1999). Schweinle, Meyer, and Turner (2006) suggested that a positive classroom climate promoted engaged learning. “In classrooms that provided a significant positive affective climate, students reported considerable intrinsic motivation, additional help seeking, positive emotions related to content, and significant perceptions of task-specific competencies” (p. 276).

The particular method used to teach mathematical concepts also influences the way students learn. Many theorists suggest that teachers are not aware of the theories and research which reflect best practice in teaching mathematics (Funk, 2003; Kieren, 2000; Lerman, 1996, 2000; Morgan, 2003; Steffe & Thompson, 2000), making the teaching of mathematics less effective than it could be.

A predominant theoretical perspective in the mathematics educational research community today is constructivism (Bain, 2004; Kieren, 2000; Lerman, 1996, 2000; Middleton & Spanias, 1999; Muis, 2004; Pugalee, 2001; Weinstein, 2004). “Constructivist theory rests on the assumption that knowledge is constructed by learners as they attempt to make sense of their experiences. Learners, therefore, are not empty vessels waiting to be filled, but rather active organisms seeking meaning” (Driscoll, 2005, p. 387).

Jean Piaget helped form the constructivist discourse (Driscoll, 2005). Knowledge is acquired in a closed system in which constructs and their interrelationships are changing and evolving. Piaget maintained that the learner continually revises the way he understands the world as he interprets his physical experience (Davis, 2004; Driscoll). Under a constructivist view, the teacher is expected to implement “methodologies that enable students to interact in the learning environment and to construct meanings about mathematics. In such learning situations, individuals construct mathematical knowledge as they interact with peers and teachers" (Pugalee, 2001, p. 171).

Implementation of constructivist principles has proven successful. In a study designed to ascertain the influence of a curriculum redesign on students' math competencies and on math anxiety, Morgan (2003) designed a program encompassing three interventions: (a) a redesign of the curriculum that minimized tracking; (b) a constructivist teaching approach; and (c) an establishment of a community of learners. Students who were part of the targeted group with the curriculum redesign were more successful in their math achievement and in reducing their math anxiety. The constructivist teaching approach assumed that the learners were actively engaged in constructing their knowledge. The active collaboration with other students and teachers aided in students being able to learn faster and in fostering a feeling of community (Morgan).

In teaching mathematics, Funk (2003) suggested that constructivist learning through discovery is "the most powerful form of learning that exists" (p. 214), because it challenges students, gives them the gift of time to think for themselves, and offers the guidance needed to help them draw their own conclusions and discover mathematical relationships. The discovery learning process engages students, gives them the tools to find their own answers, and allows them to construct their own learning (Funk).

After having reviewed research in implementing constructivist methodologies, Muis (2004) stated, "The instructional implications of this research suggest that teachers should engage students in actively learning mathematics using a constructivist-oriented approach to teaching mathematics" (p. 367). Muis noted that in some higher education classes, the emphasis is still on algorithms and how fast they can be performed in timed quizzes rather than stressing critical thinking and the associated concepts.

Learning Environment

Learning environment also affects student learning (Lombardo, 1987; Orzek, 1987; Wozniak & Fischer, 1993). In education, the ecological perspective would emphasize the importance of the environment. “Places ‘do’ things to people” (Orzek, p. 233). Certain places require certain behavior. “The important thing about a behavior setting is that it is the immediate environment of the behavior” (Orzek, p. 234). The behavior setting for art will be different than that for mathematics for example. Teachers not only have to know about each of their individual students, but they need to know which place in the environment would be best suited for the individual student. “School teachers are trained to understand the individual child, but when you have 30 individual children, it is pretty important to know how to organize the setting and have it function” (Orzek, p. 234).

Class size in the public education system has been found to be a factor in student achievement. The issue of class size is not a new education topic; in fact, it has been around for centuries. In the Babylonian Talmud, the maximum size of a *Bible* class was specified as 25 students (Angrist & Lavy, 1997). Some of the first investigators in this last century were Edmondson and Mulder (1924). In a comparison of a 109-student class with a 43-student class of the same course, they found the achievement level to be approximately equal. The students in the smaller class performed better on the essay and the midsemester tests and the students in the larger class had a slight edge on the quizzes and the final examination. However, the majority of students in both classes reported a preference for small classes.

At Miami University, Macomber and Siegel (1960) studied class size impact and, besides the conventional achievement tests, included measures of critical thinking and problem solving and tests of student attitudes toward instruction. There were statistically significant differences favoring the smaller classes. Two years later, the students were tested again for retention of knowledge and again the smaller classes had the edge in eight of the nine courses that were compared.

Elementary and secondary schools have also been concerned with increasing enrollment and expanding class size. Many more studies on class size at this level have been completed (Finn & Achilles, 1999; Glass, Cahen, Smith, & Filby, 1982; Konstantopoulos, 2008; Molnar et al., 1998; Robinson & Wittebols, 1986). Glass and Smith (1978) summarized 77 empirical studies examining the relationship between class size and achievement. They found that “reduced class size can be expected to produce increased academic achievement” (Glass & Smith, p. 4) and that “the major benefits from reduced class size are obtained as the size is reduced below 20 pupils” (Glass & Smith, p. v). Robinson and Wittebols summarized 100 research studies from 1950 to 1985 and concluded that in the primary grades, small classes are important to increased pupil achievement in reading and mathematics. In addition, students of lesser academic ability achieved more in smaller classes. They found that “smaller classes can positively affect the academic achievement of economically disadvantaged and ethnic minority students”

(Robinson & Wittebols, p. 203). Their analysis also concluded that teaching procedures and practices that have been shown to produce greater learning occurred more frequently in smaller classes. In addition, smaller classes had a positive effect on pupil behavior and teacher morale.

In 1985, Project STAR (Student/Teacher Achievement Ratio) was an experiment funded by the Tennessee legislature to determine the impact of class size on the primary grades. STAR was a 4-year longitudinal study that included 79 schools, more than 300 classrooms and 6,000 students. Teachers and students were randomly assigned to three different kinds of classes: a small class with 13-17 students, a regular class with 22-26 students, and a regular class with a teacher's aide also having 22-26 students. There was no intervention other than class size and the teacher's aides. Project STAR results were significant. Students in the smaller classes significantly outperformed the students in the larger classes both on the Stanford Achievement Tests and curriculum-based tests (Finn & Achilles, 1999; Konstantopoulos, 2008). The project also found that a smaller proportion of the smaller class students were retained and students with educational needs were identified earlier. There also was no significant difference in achievement between the larger classes with or without an aide (Finn & Achilles).

Data from Project STAR was collected from 1985 to 1995, and the long-term benefits of the smaller classes in the primary grades were evaluated. In fourth grade, the smaller class students still outperformed the students who had been in the larger classes (Finn & Achilles, 1999). The students from the smaller classes were also better behaved than the larger class students. At the end of fifth grade, students who were in small classes were about half a school year ahead of the larger class students in reading, language arts, math, and science. Through eighth grade, the smaller class students still achieved higher in standardized tests than those in larger classes, though to a smaller degree. Students from the smaller classes were monitored in high school. They were making better grades in high school and taking more advanced courses. Those who were in smaller classes were less likely to be held back a year or be suspended than the students from the larger classes (Finn & Achilles).

Krueger and Whitmore (2000) found that those students who attended small classes from kindergarten through third grade and regular classes thereafter had a somewhat higher performance on standardized tests. They were more likely to take a college-entrance exam. This was especially true for minority students. A significant finding was that the black-white gap in college-test taking appears to have narrowed by 54% for those who were in the smaller classes.

In 1984, Indiana also conducted a class size reduction study called Prime Time, but it was not as rigorously controlled and the results were mixed (Mueller et al., 1988). The average first-grade class size was reduced from 22 to 19 students and the second grade from 21 to 20 students. Test results for the smaller class students found that the reading scores for first-graders showed some improvement and a small improvement in mathematics (Mueller et al.).

In 1990, as a follow up to Project STAR, Tennessee initiated Project Challenge, which phased in smaller classes from kindergarten through third grade in low income districts (Finn, 1998). In addition to having in-grade retention of students reduced, the

Project Challenge districts moved from the bottom in performance on the statewide achievement test to near the middle in both reading and mathematics (Finn).

That same year, Burke County, North Carolina also tested a class size reduction program (Egelson, Harman, & Achilles, 1996). Over 2,000 first and second graders participated in the project. Along with reducing class size to 15 students, professional development on instruction and assessment was included. Students in the smaller classes outperformed the students in the larger classes on both reading and mathematics achievement tests. Teachers in the smaller classes were able to increase their classroom time devoted to instruction from 80% to 86% (Egelson et al.).

In 1996, Wisconsin started a class size reduction program called the Student Achievement Guarantee in Education Program (SAGE; Molnar et al., 1998). A class size reduction was to be implemented in kindergarten through third grade in districts of low-income families. There were 30 schools from 21 districts who participated in SAGE. They were compared to 14 schools in seven districts in regular sized classes. The class size reduction was phased into the SAGE schools each year one grade at a time. Kindergarten and first grade were reduced the first year and second grade the next year with third grade being last. Initial results showed SAGE first-graders performing better in mathematics, reading, language arts and on the Comprehensive Test of Basic Skills. The gap between white and African-American students in SAGE was smaller compared with a widening gap in the districts with larger classes (Molnar et al.). The initial results of the SAGE project seem to be consistent with results reported by the STAR study (Molnar et. al.).

California has also initiated a class size reduction project (Bohrnstedt & Stecher, 1999). Early findings showed some small positive gains in achievement. In trying to reduce class sizes, administrators had to hire more teachers, many of whom were not experienced and had temporary credentials. They also experienced space problems in trying to find classrooms for the extra classes created by the class size reduction. One added benefit for the smaller classes was that poor readers were identified early and given more individual attention. Teachers also spent less time disciplining in the smaller classes (Bohrnstedt & Stecher). A later study of class size reduction and academic achievement in the California Public Schools found that most students benefit from smaller classes and lower-income students were likely to receive larger benefits. Here again teacher experience made a difference in the student achievement. Those smaller classes with experienced teachers scored higher on achievement tests than the larger classes, but those smaller classes with inexperienced teachers did not (Jepsen & Rivkin, 2002, p. 69).

An increasing body of research in elementary and secondary levels of education involving large samples with controlled experiments shows that lowering class size produces significant results and continued benefits to students. Research in class size on the postsecondary level yielded mixed results. At the college or university level, fewer studies with large samples have been done (Hancock, 1996; Toth & Montagna, 2002). Toth and Montagna summarized eight studies conducted between 1990 and 2000. Since these studies were very methodologically diverse with many of them lacking statistical power due to small samples and in some cases quantitative data, no clear conclusions could be made about class size and achievement.

Similar contradictory findings were exhibited in two studies conducted by Fletcher (1999) and Hancock (1996). Hancock studied nine sections of a college statistics class. Six were "normal" size averaging 39 students and three were large averaging 118 students. Hancock concluded that there was no evidence that grade distribution was affected by class size. Besides final grade distribution, no other factors were measured (Hancock). Fletcher's study was conducted over an 8-year period. From 1988 to 1996, the class size in the first year university genetics course rose from 68 to 151 students in 8 years. During that period of time, the final exam average fell by approximately 17%.

Not just the classroom, but the school as well, makes a difference in a student's academic progress (Levitt & Dubner, 2005). Schools that have a higher rate of gang problems, nonstudents loitering in front of the school, and lack of PTA funding foster an environment that is not conducive to learning (Levitt & Dubner).

Some schools may inadvertently teach students to be calculator dependent. Students in this category are well schooled in how to find an answer on the calculator, but cannot "extend their thinking to abstract settings" (Krzemien, 2004, p. 12).

Other external factors during the K-12 years may include the students' personal situation. Illness or frequent moves may remove the students from significant class instruction. Attendance has been found to be a significant predictor of student success in mathematics (Faro-Schroeder, 1995). Since much of understanding one math concept hinges on the understanding of a previous concept, missing instruction inhibits learning future concepts.

Student Motivation and Attitude

A student's motivation and degree of interest is a significant factor that influences learning (Hidi & Harackiewicz, 2000). "Motivation is among the most powerful determinants of students' success or failure in school" (Hardre et al., 2007, p. 247). Therefore, a student's own lack of interest can deter understanding (Koller, Baumert, Schnabel, 2001).

Motivation was a prominent field of study in psychology because psychologists believed it to be the driving force for action (Driscoll, 2005). As researchers progressed in their understanding of motivation, they determined that motivation was influenced not only by physiological needs but cognitive and affective demands as well (Driscoll; Krathwohl, Bloom, & Masia, 1964).

Benjamin F. Bloom developed a taxomony of levels within the cognitive domain, and extended his work to the affective domain in collaboration with David Krathwohl (Krathwohl et al., 1964). Krathwohl is credited with developing the taxonomy for the affective domain, which is still the best known today. In the field of education, a taxonomy is a classification of the different levels of learning that occur. The taxonomy is ordered according to the principle of internalization. "Internalization refers to the process whereby a person's affect toward an object passes from a general awareness level to a point where the affect is 'internalized' and consistently guides or controls the person's behavior" (Seels & Glasgow, 1990, p. 28). Affective learning is observed in the student's behavior (Krathwohl et al.). It can be demonstrated by awareness, interest, attention, concern, and exhibiting values. Krathwohl's taxonomy for affective domain is:

1. Receiving—being aware of or sensitive to the existence of ideas, material, or phenomena and being willing to tolerate them.

2. Responding—committed in some small measure to the ideas, materials, or phenomena by actively responding to them.

3. Valuing—willing to be perceived by others as valuing certain ideas, materials, or phenomena.

4. Organization—relating the value to those already held and bringing it into a harmonious and internally consistent philosophy.

5. Characterization by value or value set—acting consistently in accordance with the values he or she has internalized. (p. 37).

Noting that progress within and between the levels in the taxonomy may be gradual, Krathwohl and colleagues (1964) also derived an affective domain continuum, where the student has: (a) an awareness of a phenomenon, (b) a perception of it, (c) pays attention to the phenomenon, (d) a responsiveness to the phenomenon with a positive feeling, (e) accepted its value and become committed to respond to it, (f) conceptualized behaviors and feelings and organized the conceptions into a structure, and (g) incorporated the growing complex structure into his/her outlook.

Schweinle et al. (2006) indicated that goals important to students have affective associations which pervade the students' whole experience.

> Whether a student seeks to engage in learning or to avoid it, such goals are affectively charged. Emotion is important not only as an outcome of experience but also because it (a) provides information about context (i.e., conducive to, or a deterrence of, goal attainment), (b) provides information about competence, and (c) offers an incentive for performance because students seek activities that are associated with positive affect. Yet, the affective meaning of classroom motivational experience has been largely ignored. (p. 271)

Attitude towards mathematics has been found to be directly and positively related to success in learning (Rives, 1992). Hammerman and Goldberg (2003) suggested that the first problem in remediation that must be overcome is a negative attitude. Because of past experiences, students are afraid of the subject. They feel a sense of helplessness, and because they have failed so many times, they believe they are doomed to failure again (Krzemien, 2004). Many of them fear the ridicule associated with asking a “dumb” question. Therefore, they will not seek help (Warneke, 2000).

Student attitudes about their learning play a significant role in their successful acquisition of math skills. In a study investigating “the relationship between university students’ perceptions of their academic environment, their approaches to study, and academic outcomes” (p. 27), Lizzio et al. (2002) found that “students’ perceptions of their current learning environment were a stronger predictor of learning outcomes at university than prior achievement at school” (p. 27).

Viens and Kallenbach (2004) suggested that when teachers understand the link between students’ beliefs about their abilities and their actual academic performance, then teachers can create opportunities for students to reflect on their strengths and weaknesses of their perceptions. This study focused on this particular aspect, students’ perceptions about their mathematics learning.

Limited research has been published that examines students’ perceptions of what hindered their acquisition of basic math skills in the past and their beliefs of what will enable them to be successful in the future. A report of one qualitative study involving university remedial mathematics students by Weinstein (2004) was found. As a basis for his study, he maintained that “the perspective of mathematics students, particularly remedial students, is often overlooked or ignored” (p. 231). Weinstein interviewed 18 remedial mathematics students at a large midwestern university with the intention of finding their perceptions of mathematical success. He also observed them in the classroom and in their study sessions with other students, help-session leaders, tutors, and their instructor. He found these students spent 8-12 hours a week "studying math." The average amount of time a full-time undergraduate at this university spent on all academic work was 13 hours. He also found that only four of the 18 worked alone. The rest worked with other students, tutors, the instructor, or a combination of these three. His findings dealt with how these students negotiated learning with those who were teaching them. The one teaching wanted the student to reach conceptual understanding. The student wanted "procedural competence." He found that the give-and-take relationship between student and tutor could actually produce successful procedural and conceptual understanding with a change in the students' perceptions of their own success (Weinstein).

There are qualitative studies of students' perceptions of learning in other disciplines, for example: nursing education, medicine, online learning, residential environmental education, nutrition, foreign language education, and science education (Evensen et al., 2001; Ganum, 2004; Lao & Gonzales, 2005; Smith-Sebasto & Walker, 2005; Spector & Gibson, 1991; Starr & Conley, 2006; Tse, 2000; Vecchiarelli et al., 2006). However, qualitative studies investigating developmental mathematics students' perceptions of their unsuccessful and successful experiences, attitudes, and learning strategies in learning mathematics were not found. This study seeks to aid in filling this gap of knowledge in the research.

CHAPTER III

METHODOLOGY

Introduction

This study examined the perceptions and experiences of students who had not been diagnosed with a learning disability and who were previously unsuccessful in learning math skills and who were experiencing success in the mathematics course in which they were enrolled during the study. These students had overcome failure and their perceptions had changed. The focus of this study examined these students' perceptions of the process of change they had experienced in their progress from unsuccessful to successful learning.

A qualitative study is an "approach useful for exploring and understanding a central phenomenon" (Creswell, 2002, p. 648). Phenomenology is a specific qualitative approach that seeks to "describe the meaning of the lived experiences for several individuals about a concept or the phenomenon" (Creswell, 1998, p. 51). Moran (2000) maintained that the subjective view of experience portrayed by phenomenology was a "necessary part of any full understanding of the nature of knowledge" (p. 21). Since this study sought to describe and understand the unsuccessful and successful experiences of developmental mathematics' students and the process of change students experienced in the transition, a phenomenological approach was selected.

The purpose of this phenomenological study was threefold: (a) to describe the experiences, attitudes, and learning strategies developmental mathematics students believe hindered their development of basic math skill proficiency in the past; (b) to describe the experiences, attitudes, and learning strategies these students came to believe were most likely to enhance the successful learning of basic math skills; and (c) to describe the change these student experienced while progressing from unsuccessful to successful mathematics learning.

Polkinghorne (1989) suggested three steps in accomplishing a phenomenological study: (a) gather information from participants who have experienced the phenomenon under investigation, (b) analyze the data for the common elements that are essential to make the experience what it is, and (c) write an accurate research report articulating the common essential themes of the phenomenon. These steps were followed. With all research, however, there are constraints that affected the study.

Limitations

The study was limited by the following.

1. Which developmental mathematics students agreed to participate in the study.

2. The number and nature of assignments, feedback, and tests produced in class. Additionally, previous transcripts showing mathematical performance at other institutions were not available.

3. Students' memories and interpretations of their past experiences, attitudes, and learning strategies were subjective and selective.

4. Students' realization that the information was for the study. This may have produced information that they believed would please the researcher.

5. The researcher's interpretations, as a developmental mathematics teacher,

must inevitably be influenced by her biases, which affected the questions posed, and the way data were collected and interpreted to determine the findings for this study.

Delimitations

This study was delimited to the following.

1. Fourteen adult developmental math students from a western 4-year college of various ages interviewed in 2008.

2. Participants who were currently successful in their developmental mathematics course.

3. Participants who did not have a diagnosed learning disability.

4. Math experiences, attitudes, and learning strategies, particularly those that occur in and are directly influenced by school systems and personnel.

5. Courses with fluent English-speaking instructors with varied teaching styles.

Data Collection

Bracketing Preconceptions

According to Creswell (1998), epoche, or bracketing, preconceived experiences is the first step in the process of data collection and analysis in a phenomenological study. When a researcher recognizes preconceived notions, then it is possible to lay them aside in order to try to view the experience from the eyes of the person who has experienced it (Creswell). Based on information from the literature review and the researcher's own experience, she has formed some ideas about students' previous and current mathematics experiences. Those notions will now be acknowledged.

The researcher is also a developmental mathematics teacher. Based on her experiences with students in the past, she had some expectations for some of the findings, which are among her biases. The researcher expects that early in their education, each of the students experienced a stopping point in their mathematical progression. They never understood that concept throughout the rest of their K-12 education. They developed strategies to hide their not being able to grasp the concept. When the students decided to pursue a college education and realized they had to take mathematics, they decided to try again to learn those concepts they previously did not understand. The researcher expects that the students underwent some internal changes and possibly external changes in order to be successful at mastering these concepts. As the study progressed, the researcher anticipated the emergence of other biases or unwarranted conclusions. To bring these notions to the surface, the researcher kept a reflective journal recording her ideas, reactions and conclusions. This journal served as one data source for the study.

The researcher arranged and provided information about her beliefs and perceptions related to this study by means of a bracketing interview where she was interviewed as each student was. The transcribed interview is in Appendix F. In the process of the interview, it was also apparent that the researcher expected that most students would not choose a major involving a lot of mathematics courses, because they could not complete their education in a viable period of time. The researcher found that some of the students interviewed have chosen majors requiring many courses in mathematics, but these students were passionate about their choice and were willing to spend the time needed to complete the courses for their education.

The researcher is also a mathematics teacher, having taught developmental courses for 35 years. In working with students, she has observed that many of them have previously struggled learning mathematics. They took their required math courses apprehensively, almost expecting an unsuccessful experience. Based on conversations and observations of the students, it was apparent that students' previous experiences and perceptions affected their ability to learn mathematics. Her goal as a teacher was not only to teach mathematics skills but also to help students feel they could succeed. In the process of working with students, the researcher realized that understanding students' experiences and perceptions would greatly aid in achieving that objective.

Selection of Participants

In this study, student participants were selected from developmental mathematics courses at a western 4-year college. Purposeful sampling was the means for selecting participants in the study. Subjects were chosen who were "able to function as informants by providing rich descriptions" (Polkinghorne, 1989, p. 47) of their experiences. Participants were chosen so that a full range of richly varied descriptions could be obtained (Polkinghorne). Students came from both traditional and non-traditional age groups and did not have a diagnosed learning disability. According to Creswell (1998), phenomenological studies have a typical sample size range of between 5 and 25. The researcher selected 14 college developmental mathematics students to make sure the full range of common experiences was investigated while allowing for sufficient time to be spent with each participant to gather a rich data set.

The 4-year college currently has approximately 4,000 developmental mathematics students every semester. Twenty faculty members of the Developmental Mathematics Department at the college were asked to recommend two successful male and female students to participate in the study. The faculty members were asked to recommend students from the traditional (18-24) and nontraditional (25 and up) age groups . From the pool of 33 recommendations, 14 students who had not been previously diagnosed with a learning disability were selected to interview. Based on instructor recommendation and a preliminary demographic survey, students from both traditional and non-traditional age groups as well as from each gender were selected.

In phenomenological research, three sources can be employed to generate descriptions of the experiences under investigation: (a) “the researchers’ personal self-reflections on the incidents of the topics that they have experienced” (Polkinghorne, 1989, p. 46); (b) other subjects in the study who describe their experiences of the phenomenon either orally or in written statements, as a response to interview questions; and (c) descriptions of experiences from outside the research project itself (Polkinghorne). In addition to the student interviews, data in the form of classroom assessments, and the researcher’s reflections and memos were also collected.

Procedures

Before the actual study began, approval from the Institutional Review Board (IRB) at Utah State University and the IRB at the western 4-year college was obtained.

During the 2008 spring semester, 20 faculty members in the developmental mathematics department at the 4-year college were given a written overview of the study

(Appendix E) and its objectives. The researcher first announced the study to the faculty members in a department meeting in December 2007 and then she contacted the instructors personally to ask if they would be willing to help find participants for the study.

During the seventh week of the semester, teachers who volunteered to help in the study were asked to select prospective students for the study based on their assessments of student achievement thus far. Those teachers were asked to identify the top two male and female students in their class demonstrating mastery of the mathematical concepts, who in their view will be successful in subsequent mathematics courses, and who were willing to participate in the study. The instructors explained to these students about the interviews and the time involved. The instructors informed the students that participation would be voluntary and that they could withdraw at any time. The students were asked to fill out an informed consent form (Appendix D) and a preliminary demographic survey (Appendix A). On the basis of instructor comments and the demographic survey, fourteen students who have not been previously diagnosed with a learning disability were selected from the pool of 32 students recommended by the instructors. Students represented the age groups, 18-22 years and 23 years and over.

Interviews

During the eighth week of the semester, participants were asked to come to the researcher's office at UVSC to be interviewed. The interviews were digitally recorded and then transcribed. The interviews were scheduled throughout the course of two weeks and each one lasted approximately one hour. Questions were previously submitted to a qualitative expert for review, suggestions were incorporated into the interview protocol, and a pilot test of the interview was previously conducted to fine tune questions. A preliminary study similar to this one was conducted with three students in a prior semester to ascertain the effectiveness of the questions. Based on the responses, questions were altered to foster more detailed and thoughtful answers.

The face-to-face interview format added the benefit of being able to clarify questions, ask further probing questions, and observe non-verbal communications (Polkinghorne, 1989). The researcher took notes at the time of the interview and made notes of participant behavior observed and added the memos to her journal. The interviews were then transcribed by the researcher. As data were analyzed, follow-up interviews were conducted with two of the students. They were asked to clarify and expand their comments on two of the interview questions. One was a phone interview. The other was conducted via email.

When a participant arrived at the office, the researcher greeted the student and again reviewed the purpose of the interview. The subject was again informed of the right to withdraw at any time and that confidentiality would be maintained. Participants were also asked to review drafts of the written report of the study and give additional feedback to establish the accuracy of the findings. This kind of member checking is one of the procedures for verifying the accuracy of the data (Creswell, 1998).

An interview protocol (Appendix C) was followed. The questions were open-ended. As is characteristic of phenomenological interviews, the subjects were “encouraged to share with the researcher the details of their experience” (Polkinghorne, 1989, p. 49). Probing questions were asked when necessary to gain the rich description needed for the study and to clarify meaning of participant's statements.

Students in this study were asked what experiences they had that influenced how they view their own math skills and what learning strategies they developed while they were trying to learn basic concepts in the past. They were asked if their attitudes have changed and if so, in what way. Students were also asked if there are different learning strategies that they have developed which help them to be successful.

The recorded interviews were transcribed. The researcher's reflective notes of her observations of the interviews were also collected and added to the interview data. Two digital recording devices were in operation in case one of them malfunctioned.

Observations and Reflexive Journals

In addition to the interviews, data in the form of classroom observations for each participant were collected. Using an observation protocol developed by the researcher (Appendix B), she observed the students in class and recorded the behavior in a journal. The researcher prearranged with instructors to observe participants in their classroom. The observations occurred after the student had been interviewed. Students' comments in class were recorded and the researcher's reflections about those statements were compiled. A description of the participants' interactions in the classroom was recorded as well as the researcher's reflective notes regarding the observations. Twelve of the students were observed twice. Due to scheduling conflicts, two of the students were only observed once.

The researcher formed conclusions about the students' experiences as she interviewed them and then as she analyzed the data. A second journal was kept by the researcher. The researcher's memos regarding her observations of students during the interviews and her conclusions as she reviewed the data were collected into this journal.

Mathematics Assessments

The students' formative and summative assessments from the remedial math classes in which they are currently enrolled were collected from the instructors and recorded in a spread-sheet program. Formative assessments came in the form of informal question and answer assessments, which were part of the daily classroom learning format, quizzes, and chapter exams. The assessments were formative in that students had continual feedback and had the opportunity to correct false assumptions or ideas. The summative assessments were the midterm and final exam. Students were evaluated on their performance and these exams formed a "final" assessment of what they have learned. Academic success was mainly evaluated by the summative evaluations, which were departmental exams containing multiple choice and free-response questions involving conceptual and basic skills assessments. The assessments verify the student's successful acquisition of mathematics skills. The final grades of each of the students are listed in Table 1 of Chapter IV.

Three sources comprised the majority of the data collection. The students' interviews comprised the major source. The students' performance in class as denoted by the formative and summative assessments for the course was a second source. Finally, the last source was the researcher's observations and reflections based on her observations of the students during the interviews and watching them in the classroom.

Data Analysis

Phenomenological data analysis involves identifying significant statements of each of the participants and weighing them equally in the analysis. Creswell (1998) called this horizontalization. As the researcher transcribed each interview, she noticed significant statements in their responses. As she read and reread their statements, she began to see common ideas. She went back over the interviews with different colored highlighters, highlighting similar meanings and ideas in the same color. Then she cut out the colored passages and grouped them together. These units were broken down and coded into “clusters of meanings” (Creswell, p. 55) so that a description of the essential features of the experience was gleaned (Polkinghorne, 1989).

The researcher then took each colored cluster and reread the passages. From her focus, she began to see themes and subthemes emerge. Those themes were the common elements that made the experience what it is and “without which the phenomenon could not be what it is” (Van Manen, 1990, p. 107). The researcher organized a written structure of a main theme with supporting subthemes. After reviewing each student’s description, the researcher integrated the participants’ perceptions and experiences in a written format to reveal the themes and tell their story. This process was executed with each colored cluster. As Creswell (1998) suggested, “finally, these transformations are tied together to make a general description of the experience, the textural description of what was experienced and the structural description of how it was experienced” (p. 55).

Procedures for Verification of the Data

Creswell (1998) suggested that there are eight verification procedures for qualitative studies and that at least two of the procedures should be utilized to verify the findings of the study. Three methods of data collection—interviews of the students, observations and reflexive journal entries, and objective data assessments—aided in the triangulation of corroborating evidence, which is one of the verification procedures.

As mentioned, participants were asked to read drafts of the study and provide feedback regarding the accuracy of the information. A written report of the data analysis was given to the students participating in the study. Students were asked if this report accurately described their responses in the interview and reflected their past and present perceptions of their experiences with mathematics. After changes were made, the report was again given to the students to establish the correctness of the findings. This kind of member checking (Creswell, 1998) was used to establish the trustworthiness of the findings and to make sure that the conclusions were grounded in the data and is a second verification procedure.

A thick, rich description also verified the results. “With such detailed description, the researcher enables readers to transfer information to other settings and to determine whether the findings can be transferred” (Creswell, 1998, p. 203).

Creswell (1998) also suggested that an external audit of the data by an outside researcher was another verification of the results. The outside researcher examines the data and the process through which the data were analyzed and assesses the accuracy of the findings. This auditor does not have any connection to the study. A researcher who has successfully completed a phenomenological study was chosen to review the results. His letter of verification is included in Appendix G.

The three facets of data collection—student interviews, student assessments, and researcher observations and reflections and the four verification processes—triangulation, member checking, researcher confirmation, and a rich, thick description aided the researcher in verifying the accuracy of the findings. When there were no more corrections suggested and there was a consensus by the participants that the findings accurately described their perceptions, then the written report was submitted as the final draft.

CHAPTER IV

RESULTS

The purpose of this phenomenological study was to describe what experiences, attitudes, and learning strategies developmental mathematics students believe were a hindrance in gaining basic math skill proficiency in the past and what experiences, attitudes, and learning strategies these students now believe are most likely to enhance the successful learning of basic math skills. This study was constructed to answer the research question, “What are students’ perceptions about their unsuccessful acquisition of math skills in the past and what different perceptions do students now have that will enable them to be successful?”

To gain an understanding of the lived experiences of successful developmental mathematics students who were previously unsuccessful, structured, open-ended interviews were conducted, classroom observations were made, and formative and summative assessments for the students were collected. Fourteen students from a western 4-year college were selected purposefully based on instructor recommendations and preliminary survey results. Approximately 4,000 students registered for developmental mathematics courses every semester at this college. The students ranged in age from 19 to 51. There were eight males and six females. Seven students were in the traditional category and seven were in the nontraditional group. Based on a phenomenological analysis of the data, prevalent themes emerged reflecting students’ perceptions of learning mathematics.

Participants

All of the student participants were given pseudonyms to protect their privacy and assure anonymity. When they came to the interview, the students were informed that they would be given false names in the written results. Other than gender, the names selected have no relationship to the students and will be used throughout the remainder of this research study to protect their privacy.

Amy was 19 years old and came to college right out of high school. She started struggling in math in third grade. She had difficulties with story problems, fractions, and long division. The last math class she took before college was in her sophomore year of high school. She received a B, but she felt she really did not understand the concepts. She avoided taking any more mathematics. Because she wanted a career that was interesting and paid well, she decided to come to college. When tested, she placed into beginning algebra, which she expected. She has taken beginning, intermediate, and college algebra in college and has been successful in all of them. She received an A- in the last course.

Ken was 21 years old and also came to college right out of high school. He started struggling in his math classes in eighth grade. Story problems and fractions were concepts that were hard for him to comprehend. He was placed into intermediate algebra and realized he was placed too high and earned a D in the class. After a 2-year mission for his church, he returned and was placed into beginning algebra, where he thought he should be. He chose a major of business management and knew he needed math for his major and profession. He has taken beginning and intermediate algebra and received A's in both classes. He earned an A- in his last course.

Pete was 21 years old. Pete started encountering problems learning mathematics in third grade. He struggled learning the multiplication tables and felt behind from then on. After high school, Pete served a mission for his church and upon his return he enrolled in college. He is majoring in mechanical engineering and knows he needs multiple mathematics courses. He placed in pre-algebra and expected that placement. He received an A in that class.

Kim was 22 years old and also came to college right after high school. Kim started having problems learning mathematics in third grade. She remembers division and fractions were concepts she did not understand. She remembers getting by in her mathematics courses throughout her K-12 education with C’s or C-’s. She is majoring in biology and wants to be a physician and knows she will need many more math courses. She was placed in pre-algebra. In addition to pre-algebra, she has taken beginning algebra and earned A’s in those courses. She has successfully completed intermediate algebra with a B+.

Sam was 22 years old. Seventh grade was where he remembers that he started not doing well in math. Concepts in algebra and geometry were very difficult for him. All his friends advanced to a higher math class in eighth grade. Because of his performance, he could not take that class with them. The last math class he took in high school was the first semester of his junior year. After graduating from high school, he served a mission for his church. He returned after the college semester had already started. Therefore, when he entered college, it had been more than 4 years since he had taken any math courses. He placed in pre-algebra, which surprised him. He was hoping for a higher placement. He received an A in that course and in the two subsequent courses, beginning and intermediate algebra. Sam is majoring in biology, with the goal of being accepted to dental school.

Tim was 23 years old. He started struggling in his math courses in eighth grade. Factoring and geometric concepts were difficult for him to understand. He remembers passing every semester with a D- in his math courses. After high school, he served a mission for his church and upon returning, he enrolled in college. He placed in pre-algebra, which was a surprise. He was hoping to be placed higher. He did very well in that course and was eligible to take the combination beginning and intermediate algebra class and has earned an A in that course. He wants to be a physical therapist.

John was 23. He remembers struggling with math in second grade and never recovering. Fractions and long division were concepts that he had a hard time understanding. In high school, he decided he would not go to college. He had basketball coaches for math teachers until his senior year and felt they did not care if he learned. He did not care either. In fact, he said he had a bad attitude towards mathematics in high school. In junior high and high school, he remembered doing well on only one test. All the other tests were a bad experience for him. He also served a mission for his church and decided to go to college when he returned. When he came to college, he placed in pre-algebra. He earned an A in that class as well the next two succeeding math courses, beginning and intermediate algebra. His major is biology, a steppingstone to being accepted into medical school.

Mike was 25. Mike remembered experiencing difficulties in math in tenth grade.

Geometry and algebra II were classes in which he struggled. He passed his math classes because homework was a big part of the grade and he was able to copy the homework answers from the back of the book. After high school, he had no desire to go to college. This last year, he decided he wanted to go into helicopter aviation and knew he needed to go back to college. He placed into pre-algebra, which he expected, and earned an A in that class. Because of his performance in the pre-algebra class, he placed in the beginning and intermediate algebra combination class. He received an A in that class as well.

Ed was 28. Ed's problems in learning mathematics began in elementary school when fractions were introduced. Ed was married and has an 18-month-old daughter. He worked as an assistant retail manager. He was a theater major. Ed enrolled in college right out of high school in fall, 1997. At that time, he placed in college algebra. He knew he would not pass and registered for intermediate algebra, but he did not want to go to class and withdrew. Coming back to school in fall, 2007, he placed in beginning algebra, which he expected, and earned an A. He took the subsequent intermediate algebra course and also earned an A.

Jeff was 31. In junior high, Jeff remembered having a hard time understanding algebra, especially square roots and radicals. He remembered his report cards showing D's in math. Pursuing a college education was never emphasized in his home. He referred to himself as a nontraditional student, coming into college after being out of high school for an extended period of time. When he got married, it was understood that he would go to school and get an education to support his family. He now has two daughters. Upon registering for college, he placed into pre-algebra and was surprised he did not place lower. He earned an A in that class and in the following two math courses of beginning and intermediate algebra. Jeff was majoring in biology with the goal of being accepted into medical school.

Terri was 36. Terri remembered beginning to struggle in junior high when taking geometry. She had trouble remembering formulas and concepts beyond basic algebra. She went to college right out of high school and did not pass her first math courses and had to retake them. After getting married and having four children, she entered college again and just graduated with an associate's degree. After being tested, she was placed in the beginning and intermediate algebra combination class. She earned an A in that course and in the subsequent college algebra class. She decided to pursue a bachelor's degree and to major in mathematics education.

Lisa was 39. Lisa began having problems understanding mathematics in seventh grade. She saved all of her grades in elementary, junior high, and high school and showed the official transcripts to the researcher. The grades in math were in the C range from seventh grade on. She felt she missed essential concepts that stopped her progress in mathematics. She married at 19 and had five children and is now coming back to school. When tested, she placed in pre-algebra, which was a surprise to her. She thought she would place lower. She earned an A in that course and placed in the combination beginning and intermediate algebra course and earned an A in that as well. She was majoring in elementary education.

Sue was 43. Sue remembered not understanding mathematics in high school. She remembered taking accounting so she would not have to take a math course. After high school, she went to school and earned an associate's degree in accounting. To acquire that degree, she only had to take one financial math class. Then she married and had four children. After 25 years of being away from school, she returned. She placed in intermediate algebra, which surprised her. She thought she would place lower. She earned an A in that class and an A in the subsequent college algebra class. She was an elementary education major.

Mary was 51. Mary remembered having trouble with algebra in high school and passed it with a D grade. After graduating from high school, Mary went to college, but did not finish. She married and had children. Two years ago, she started back to school. In order to acquire a degree in history, she had to take math to graduate. She eventually wants to attend graduate school and knows she will need more math courses to complete that goal. She initially took math through independent study courses and that was not a good experience. She registered for math classes on campus and tested into the beginning and intermediate algebra combination class. She wanted to make sure she had a good foundation and elected to take pre-algebra first. She received an A in that course.

The students' experiences fell into two natural divisions, unsuccessful and successful. Each category was considered separately with the emergent themes. In each category, the students had common attitudes and behaviors. The themes in each category had the same title, but the students' experiences reflecting those themes were completely opposite from those in the second category. The five major themes in each category were: *turning point, attitude, motivation, learning environment,* and *learning strategies.* The first category considered is unsuccessful experience.

Unsuccessful Experience

Turning Point

All the students possessed the common experience of having a definite turning point where they began to have problems understanding mathematical concepts. As mentioned in chapter three, each of the students recalled the time in their educational experience when the struggling began. John recalled that his problems comprehending mathematics began in the second grade and he remembered what concepts were difficult.

> Actually, the first thing I ever remember about math is when I was in second grade and we started learning about fractions. And that really threw me through a loop, because before then we had always just talked about apples. And my teacher started saying things like, “If you had half of an apple and three pieces of another apple, how can you make another whole apple?“ And I went, “What? What are you talking about?“ That was where it really scared me. And then we automatically went from there into long division and things like that. And so I always struggled with math of that sort, like the theoretical math per say. I always really struggled with that all the way through everything. I could never grasp it, no matter how hard I tried. Every time I think about where I went wrong, I go back to that day—sitting at my desk, going “Oh My! What is going on? What are you talking about?”—so, ever since then.

Kim remembered that third grade was where her troubles began.

> I feel like in the first part of math, like in the earlier grades, I did pretty well, like second grade. In third grade, I struggled with division a lot. I had an adjunct teacher. It seemed like our class got her really upset and she'd leave a lot. So, I really never got a really good base knowledge of just simple, like long division. I've always struggled with that and fractions. I think that's where my downward—that's where I started to go downhill with math because I didn't get that base knowledge that I needed.

When asked when his math learning difficulties began, Pete immediately responded.

> Third Grade! I think third grade was the major *turning point* because I went to a public school in first and second grade. I went to a private school in third grade

> and this is not the earliest recollection. This is just one of them. I remember we were learning the times tables, and I got frustrated. I didn't learn them. And so, I just got frustrated and I stayed pretty much behind since then.

Amy also remembered third grade as her turning point:

> I remember in third grade that I was doing a simple addition problem. It was like a story problem. It was so weird. It was a spider's web and somehow the numbers lined up and you were supposed to add them together. And I didn't get it. And my sister said, "How in the heck do you not understand that?" It was frustrating and embarrassing.

When Ed was asked about his earliest memories of learning mathematics, he recalled having trouble learning fractions in elementary school. Lisa recalled that seventh grade is where she began to struggle:

> Well, that's interesting because before I came here, I got out all my grades from elementary school through high school and looked at all my math scores and grades. And about up to sixth grade, I still had like B's and A's, but in seventh grade, I started getting C's.

Sam's earliest recollections were of doing well in mathematics until seventh grade.

> Learning mathematics, Wow! Flash Cards! From.... Wow, I don't even remember how young I was then. I had a really good kindergarten teacher. She was really cool. I learned a lot of reading from her, but math I remember some flash cards—just the basic 2 + 2 kind of thing. In third grade, we started to hit it a little bit more and math never really became an issue or anything that really bothered me until middle school—until about seventh grade.

Eighth grade was where it started for Ken:

> I think about the eighth grade, when I first got into algebra, I went throughout pre-algebra fine and I was fine all through elementary school. As soon as I hit eighth grade algebra, I don't know what happened, I just couldn't figure it out.

Tim recalled the math class in eighth grade where his turning point began:

> I distinctly remember being in Mr. Z.'s class, his algebra class. When he was explaining things, I remember just thinking, "Man, that's really hard. I can't do that." That has really stuck with me, that I couldn't do it. I think from eighth

grade on, I just did horrible in math.

Jeff remembered that algebra in junior high was where he began to have problems.

> I have always had a really hard time with Algebra. Geometry I did OK with, because it was something I could picture in my mind. Algebra—when you see a problem that has far more letters than numbers, that's when I start to get frustrated.

In high school, Mary remembered struggling in Algebra:

> Algebra was difficult. I took geometry, and we had to know algebraic theorems. And as I was able to apply them to geometry and see a model and apply them, I was able to do that. It was amazing. But to just have algebra on its own, I couldn't do it quickly enough, as quickly as we were learning it. But, when we could apply it to geometry, because I loved to draw—I loved art—for some reason, it made sense in my mind, and I was able to do that. I don't know if that makes sense at all, but that really happened. In high school, I took algebra and then geometry. I earned a D in high school algebra. I earned a B in geometry.

Mike's memories of algebra in tenth grade are similar:

> Geometry was kind of hard for me at first. Algebra 2—I think I just kind of wiped that out of my memory. It was such a bad experience. As soon as you start putting English and math together. "X is equal to this." How am I suppose to read these?... I hated working with numbers, besides the simple this plus this equals this and times tables or anything like that. I could do an average fine and dandy, but as soon as you started doing equations or manipulating with variables or formulas or anything like that, I was done.

Sue remembered that she received good grades in algebra in high school but she did not understand it.

> I had a really nice math teacher for my sophomore year. That was Algebra 3-4. He was a really old man and he was really nice. I didn't like it very much. I always got really good grades.... Sometimes I was confused. But my grades reflected that I understood. So, I was confused. I remember specifically that I didn't understand some of it.

Terri recalled not having problems in elementary school, but by the time she got into algebra in high school, she had to drop out.

> I didn't [struggle] in elementary. Junior high—kind of but not really. But in high school, I did. I struggled. I did geometry and passed with like a B or a B-, but I struggled getting that grade and then went to honors algebra II and had to drop out because it was just more than I could take.

As the students reached the point where they no longer understood mathematical concepts, their attitude towards learning mathematics also changed.

Attitude

In the course of their interviews, the students all evidenced an inextricable link between their understanding and their attitude. The association between the two was positive. If they understood what they were learning, they enjoyed learning it. If they did not understand, they disliked trying to learn and eventually disliked mathematics altogether. When the students were unsuccessful, all of them evidenced a negative attitude. The following excerpts reflect the students' attitudes during their unsuccessful period.

> I hated math. That was my main one. I didn't like it. If you don't understand something, it makes you not like it. (Terri)

> I hated math. I hated going to class. (Sam)

> Didn't like it [math]. (Sue)

> Oh, I didn't like it. I hated math! I always thought that math was like interesting and amazing. That's just what I always thought it was, but I never understood it. So, I respected it. Does that make sense? But, I didn't like it, probably because I didn't understand it. (Pete)

> It was bad! A bad experience! I really didn't like it, mainly because I didn't understand what was going on. (Mike)

> I just hated it with a passion. I hated it like none other, because I couldn't get it.

> That's why I didn't like it. When it came to science or math or doing anything with numbers, it was just very confusing. And I just didn't like it. (Amy)
>
> In junior high and high school, I didn't understand it [math], so therefore I didn't like it. (Tim)
>
> Hated it! In high school, I can even go back further than that, I'd say in junior high years, I was always in the lower level math classes. I just didn't get it. They put me in special math classes. (Jeff)
>
> Bad! I did not ever want to do math homework. I did not want to study. I did not want to participate in anything in class. (John)
>
> Fear! Yeah fear! Because who wants to go into a classroom where immediately you're going to feel stupid. (Lisa)
>
> I did feel like a failure. . I believe that I had feelings that I couldn't do it. I was convinced that all I could do was fail in algebra, and so I didn't try. (Mary)
>
> I just didn't like it, mostly because it was hard.... Math was always something kind of scary to me, just because it was hard.... Yeah, it was difficult for me, so I didn't like it. I tend to like the subjects that I understand more. And so, since it was more difficult to do the problems in math and I could never get the right answer, it was just frustrating! (Kim)
>
> All that I really can remember is that I hated it and that I couldn't do it very well. It was something that I have always struggled with. (Ken)
>
> Like I mentioned on the preliminary survey—a severe dislike of math, mainly, because I felt that I just didn't understand it well enough. So, I just didn't want to deal with it. (Ed)

The unsuccessful experience was marked with a negative attitude. There was not one student who was at all positive about their attitude towards learning mathematics after they had experienced the turning point. Many of them linked their attitude to their inability to understand at the time. Besides outright dislike, even hatred, emotions of fear and frustration were freely expressed. This attitude influenced their motivation to learn as well.

Motivation

When students reached this turning point, they experienced a lack of motivation to learn mathematics. Many of the students mentioned that they were not motivated to succeed in their math classes. Some expressed that they did not have support from home to motivate them. Others did not see the value of their education for their future or how learning mathematics would apply to their situation, which consequently reinforced their negative attitudes towards having to learn mathematics.

John and Sam went to math class because they felt compelled to go.

> In high school, I went to class because you got in big trouble if you didn't. I didn't care what was going on there. Especially in math, I could care less in high school. (John)

> In high school, I would have skipped every math class if I could have. I liked math, but I didn't like learning it. It intrigued me but not enough to where I wanted to go to class or anything in high school. (Sam)

Jeff also mentioned that he felt like he wasted his time in high school because he again was not motivated.

> I had a lack of motivation in high school.... In high school, all I was doing was wasting my time.... I just needed motivation. I didn't have that. I don't know how you could have instilled that in me, to be honest with you.

Kim's desire to play sports in high school provided enough motivation to barely pass her math class.

> I didn't try at all. I don't think. I just did the minimal amount to get by. I mean, I was an athlete, and I just wanted to play sports. So, I had to have a 2.0 GPA to play. So, that's all I was worried about really.

Sam's experience was similar to Kim's. He was also involved in sports.

> I just kind of brushed it [math] off. I played a lot of sports. Once I was out of school, all I cared about was playing sports; so when I was in class, I worried

> about it. [math] When I was out of class, I didn't care.

The apathy connected with the motivation towards learning mathematics was expressed by many of the students in one form or another.

> In high school, I didn't care. I just thought, "I don't care if I pass the class then. I get to move on and I can graduate. I don't have to get an A. I don't have to get a B. I can get a C- and still pass. I don't care." That was kind of my attitude towards it then. (John)

> Because going to school in high school, it is like "Oh, another day of class"—I'm not going to learn anything today either. (Mike)

> I know my senior year, I passed my geometry I think I was taking—I passed every semester with I think like a D-. I would do the most minimal to get by. And that would drop my GPA down bad, which was not a good thing. (Tim)

As an expression of lack of motivation, some students just gave up. Mary recalled, "I was convinced that all I could do was fail in algebra and so I didn't try." Pete mentioned that when he was so far behind, he would just give up.

> If I get behind in one concept, I won't be able to do any of the other ones. That was normally the case—I'd be behind from the very beginning. Like sometimes, I would try to learn throughout the semester, but I would be too far behind, so I'd just give up. (Pete)

Some students felt they did not have the support at home to provide motivation to learn mathematics. Pete stated, "But, maybe, if I was pushed more by my family to do homework and if it was more of a serious thing, that would have helped." Ed's parents could not help him with his math homework.

> And sometimes I didn't really feel like I had much support. Both my parents did everything they could to help me with my homework. My dad was an English major and my mother was a theater major. So they both didn't have as much of a grounding in math as maybe someone else. But, they, of course, did everything they could to help me with that.

John also mentioned that parental support was lacking in his K-12 experience.

> Parent involvement was a huge thing. My parents were both very busy people. And they got divorced when I was eleven, so I only had my mom. So, I was on my own. My mom's an English major, so that was ingrained into us. I never had a problem with English or history or anything like that. It all went together because reading and comprehension was so easy because it was burned into my brain. "Cory and me are going to the store." (Correction from mother) "Cory and *I* are going to the store." You know, it was just burned in. I had no problem with it, but when it came to math, it's totally new and especially when I had problems in second grade, third grade, fourth grade, fifth grade, all the way on, I never rebounded from it. So that was a big problem that I didn't have kind of a structure. "Come home and do your homework. I'll look it over and help you figure out what's going on." That structure was lacking. My mom didn't know how to do math any better than I did. I got all the odd problems right because they're in the back of the book. That was a big thing.

Terri recalled that her "parents weren't very helpful because it had been too long since they were in school."

Jeff's parents did not see the value of further education and encouraged him to be ready to get a job after high school.

> There was no motivation. My history is a little unique. I'm the first of both of my families to attend college. In growing up, higher education was never emphasized, ever. There was always this underlying belief that we were not intelligent enough for it. When you're done with high school, you can go and get a job. All my family are blue-collar people.... So, I really never even had the motivation to try really hard until now.

Amy's parents did encourage her to take more mathematics in high school, but that was not enough incentive for her to do so.

> When I was signing up for classes for when I was going to be a junior, and I noticed that I had my math requirements passed off. Well, I was like, "Oh! I'm free! I don't have to worry about this anymore." My dad said, "Well, that's going to catch up to you in college." I was like, "I don't care." I just ignored it, and that was all the experience I had in high school.

Motivation to learn mathematics was also influenced by students being able to see the applicability of what they were learning. The students' conceptions of how education would benefit them and how the mathematics they were learning would apply to their situation affected their attitude towards learning mathematics resulting in a lack of motivation.

Ken said he kept asking, “Why do we even have to do this stuff?” After trying to learn some particular math concepts in high school, John exclaimed, “Those are the devil! I don’t understand what they’re for, who invented them, why they’re there.”

> In elementary school in the public education system, math was always my least favorite subject. A lot of it was I didn’t understand maybe how it applied. Applicability has always been a problem. (Ed)

> Honestly, I don’t think it was that big of a deal to me. I just thought, “I don’t understand math. If I don’t know it, that’s fine with me. I’ll just do something else, something that catches more my interest.” I just didn’t think math was that important. (Tim)

> It seemed like all the teachers were doing were preparing me for college. They weren’t really giving me any kind of, “This is going to help you in this way because...” type of thing. It’s just, “OK. Do the problems and you will be good.” They were teaching me the procedures and not the understanding. (Mike)

> In high school, they kind of just push it at you and say, “Take care of it! I’m not going to tell you what it’s for or why, just know that you have to do this!” It needs to apply. Why would you want to learn something that you will never use? What’s the point of that?... I can’t relate to the non-applicable math plus it’s a waste of time. Why do I need to know something that I will never use? There’s no reason for it other than to pass the test and that’s ridiculous. It shouldn’t be on the test if you’re not going to be able to apply it. (John)

When students were unsuccessful, they had no motivation for learning mathematics. Some felt they were forced to be in high school. Some did not receive support at home. Others did not see how math applied to their situation. Their negative attitude and lack of motivation were reinforced by their learning environment.

Learning Environment

Class size, the home learning environment, and teachers and classroom atmosphere were mentioned by the students as contributing to their unsuccessful experience. Some of these factors were mentioned by only a few students, but they felt that they did have a big impact on their unsuccessful experience. The home learning environment will be considered first.

Home learning environment. Sue's first recollections of learning mathematics are at the kitchen counter with her mother trying to teach her math concepts.

> I remember sitting at my counter with my mother and we're working on some kind of homework in math. We'd work through a problem in math and she would say, "Do you get it?" I'd say, "No, I don't get it." Then we'd do another one, and she'd say, "Do you get it?" And I'd say, "No, I don't get it." And then we would do several and all of a sudden, it would click on, "Oh, I get it!" And then after that, I could do the homework. So, she would sit there with me and keep trying over and over again until I could get it.

From this experience, Sue realized it would take her longer to understand concepts than others, and for her to understand, it would take lots of practice and work.

Lisa was home-schooled by her mother in her eighth grade year. Her dislike of learning mathematics had already started in seventh grade. She was able to manipulate the learning situation to her advantage, or so she thought, by not learning all the mathematics she should have. When she returned to the public school system in ninth grade, she had not learned many of the concepts that were needed to understand the mathematics she was trying to learn.

> And then in eighth grade, I was actually in home school and I knew how to work my mom. And I didn't like math at that point and so I got away with not doing as much as I should have. And then I went back into public school in ninth grade and had a lot of holes in my education. And also when I would sit in class, I would

> think, "OK. I do have to learn this." I would get ready to take notes, and about 15 minutes into the lecture, I would feel like I was in a class that was Greek. They were speaking a foreign language. And somehow, I was going to be held responsible to understand it and to do things with it. And I remember just sitting there getting very discouraged, to the point of tears. And then I remember my math teacher trying to work with me, being willing to meet with me after school. But, it got to the point where I just was giving up and running away from it—which was frustrating, because I always wanted to go to college.

Lisa did seek help from her teacher. The teacher did try to help her learn but there were too many gaps to learn the level of mathematics she was taking.

Class size. Mary recalls that her class size was big, which made it difficult for the teacher to take time to help her.

> There was not much help from the teacher because those classrooms were large. If classrooms had been much smaller, I would have felt more comfortable asking for help, and I think it would have been easier for me to focus on what the teacher was saying.

Because her high school teachers had eight classes a day and each of the classes were full, Terri felt she could not get the one-on-one help she needed.

> The teachers in high school have so many students, not like they don't here. But they have eight classes a day of students all in a row, and I just think that they try to keep everybody at the same time, and if you're falling behind, well then it makes the teacher feel like the whole class is going to go behind if you keep asking questions rather than to try and get that one-on-one time.... You could go talk to the teachers but most of the time, it's not like they do now where they have time to sit with you where they have office hours. It was come before school and most of the time, you had an early morning class so you didn't have time and you couldn't stay after, so you just had to kind of fight your way through it and hope you did OK.

Teachers and classroom atmosphere. Teachers and classroom atmosphere were mentioned as contributing to the students' unsuccessful experience. Some of the students felt that their teachers were good, but they were hampered by large classes or many classes. Some of the students had teachers who passed them even if they did not understand. At the time, the students were just relieved that they passed, not realizing the later consequences. Other students experienced poor teachers.

Mary remembered having good teachers, but she was easily distracted in her classroom. As previously mentioned, Mary's classes were large.

> I don't remember any teachers that I didn't like or who didn't try to help me. They were all excellent. I was very lucky to have good teachers.... As a child—still I am easily distracted—I think I was easily distracted by other children talking and doing things and other distractions in the room. My eyes would wander. I'm an artist. I like to look at the bulletin boards and had the room been smaller and had I been able to choose where to sit, front and center, it may have been more helpful.

Lisa remembered her math teacher "trying to work with me and being willing to meet with me after school, but it got to the point where I just was giving up and running away from it." She said she "just got further behind and felt very stupid."

Sue recalled that she had teachers she liked, even though she did not like learning mathematics. She received good grades but did not understand some of the concepts.

> I remember my seventh grade math teacher, Mr. B. And I remember my ninth grade math teacher, Mr. T. I really liked him. That was geometry. I had a really nice math teacher for my sophomore year. That was Algebra 3-4. He was a really old man and he was really nice. I didn't like it very much. I always got really good grades.... Sometimes I was confused. But my grades reflected that I understood. So, I was confused. I remember specifically that I didn't understand some of it.

Mike and Kim were able to pass because their teachers graded in a fashion that allowed them to pass without understanding the mathematics concepts. Mike remembered passing most of his math classes, even though he did not comprehend the mathematics.

> Most of my math classes I passed with B's.... It was the way that the teachers graded. The teachers would say, "All right, we're going to give you twenty

> through thirty and odds (answers) are in the back of the book." So, as long as I could do the odds, I would look in the back and, all right, we're good to go. He would do a lot of the evens in class for us. So, it was just the way that he graded. I didn't understand it. It was just memorization. You can memorize procedures as long as you want, but as soon as they change that and you actually have to understand the concept behind it, then you're done.

Kim took the same instructor every year, because she knew that all she had to do was hand in the homework and she would get credit even if it was not correct.

> I know I kind of always coasted through math classes. Like in high school, I got the same instructor every year, because I knew that instructor. We had to do the homework, but we didn't have to get the right answer. We just had to show the work and that's how we got credit. And so, I'd get a "B" in math, because I could just do work. I didn't have to get the right answers and then like get a "C" on the test and just kind of coast through it.

Pete and Amy both had experiences early in their education, which paved the way for their growing negative attitude towards mathematics. Pete went to private school in third grade. His frustrations over not being able to learn his multiplication tables were the beginning of his feelings of mathematics inadequacy. Pete went back into the public education system for fourth grade and had an embarrassing experience in front of the class. "In fourth grade, the teacher asked me to go up to the front of the class and do a math problem. I had no idea what to do. I was really embarrassed about that." Amy had a similar experience in fourth grade.

> But also in fourth grade, my teacher, Mrs. M., had a laminated paper and it had different problems on it. It was coordinated with the problems on the white board. She would ask us to go up to the white board and do some of the problems. I remember I was always scared doing that. Most of the time, my problems were wrong and she always graded them.

Sam does not "remember his teachers being very good." Tim felt like his teachers did not seem to care about his progress.

> Maybe they needed to be a little bit more personable and take more time, not just instructing in general, but instructing the individual and helping me out personally. “Look Tim. I can see that you’re falling asleep or that you’re showing up late. What do I have to do to get you to my math class on time?” or “What do I have to do so that you understand this concept?” Not just be, “Well, I taught it in class, so if you didn’t get it, go home and do the homework. Ask your mother or something.” Maybe if it would have been a little bit more personal, the instruction, then I think it would have been better for me.

Mike was very shy in high school. In his classes, he was afraid to ask questions. He was afraid of being judged by the questions he asked. The atmosphere was very formal. To him, it was almost as if the teachers presented themselves as “Gods in a sense” as if “they were infallible.”

John felt like his teachers really did not care about his progress in mathematics.

> I just don’t feel like any of my teachers really cared about what they were teaching. They were just there because they had to be, sort of thing, and I didn’t respond to that very well. So, I had a hard time with that.

John recalled that he felt rushed and anxious in math class. When he asked questions, the teachers did not attempt to explain the concepts differently, only in the same way that he did not understand the first time.

> I always felt rushed. I felt really anxious and never felt like I was doing it right. And no matter how much I’d ask my teachers, they would just say the same things to me they had already said in class.

John said that most of his teachers were basketball coaches for the high school. When he would try to get help from them after class, he only found it more frustrating.

> My teacher—he was a basketball coach, first of all—so he could care less about teaching math. The only reason he was there is so he could coach basketball. He had his math degree and so what he would do is he’d say, “OK, here’s an expression and I’m going to show you all the ways I know how to solve it, because I’m a genius.” So he would show me nine different ways to solve the same thing and I’m like, “Dude, I only need one! Just give me one way.” So that was really annoying to me, because everything gets confused. I jumble everything

> up. And so it's like factor, complete the square, quadratic formula—those are three ways to solve the same equation, but they all give you the same result and they're all similar to each other. So, he'd stand up at the front of the room and say, "X squared plus four X minus one. Here's a hundred ways to do it." I'm like, "Dude, slow down, first of all. You're flying through this. I don't understand what you are saying. First you were talking about this and now you're on that." He was the worst teacher I've ever had in any subject. He could care less, and I went to his class after school probably twenty times. I'd ask him a question and he'd grab my paper and write the answer. "There ya go!" I'm like, "OK, I'll just bring my test to you when it's test day and say, 'Hey, I got a question here.'" So that was really frustrating for me.

Terri stated emphatically that the "number one difference" for her between being unsuccessful and being successful was the teacher.

The unsuccessful students' negative attitude and lack of motivation coupled with their learning environment encouraged an unsuccessful learning strategy.

Learning Strategies

The lack of motivation exhibited by the students is evidenced by the strategy they developed to cope with their difficulties in mathematics. Their actions could be summed up by one term—avoidance. That was the one prevailing learning strategy that emerged in the analysis of the data. Students avoided participating in class. Students avoided doing any more homework than necessary. They avoided studying. Many of them avoided asking for help. They avoided taking any more math classes than were necessary to graduate. This characteristic of avoidance emerged in the case of every student in one way or another.

The following excerpts from the interviews exemplify the students' strategy of avoidance.

I would normally try and avoid math where I could. It was one that I really didn't enjoy. So, I'd always try and avoid it.... I was never really one that would go to the teacher after school to try and get the help that I probably should have.... Most of the time, I just would put off doing my math homework. A lot of times, it wouldn't get done until my parents got on my case at midterm when I'm failing all my classes and then I'd rush to do something. Once, I got into college, I put off taking math courses as much as possible. (Ed)

Like I mentioned, I got the same instructor every year in high school, that I knew didn't grade on right or wrong answers. I just almost ignored the difficulties. I would do the necessary things to pass, but I skipped over the fractions and that kind of thing because I had no idea really how to approach them or anything. (Kim)

I remember just sitting there getting very discouraged, to the point of tears. And then I remember my math teacher trying to work with me, being willing to meet with me after school. But, it got to the point where I just was giving up and running away from it.... [To cope with my difficulties, I] avoided Math! Even though I knew that was not the right strategy, but I didn't feel like I had any other choices. And, of course, I felt like the teacher hated me and looked down on me, which was not the case, but at the time, that's how you feel. I just avoided it.... [I had] poor study skills. When you avoid one hard thing, it can bleed over to the other things. I didn't have good study skills, which I'm sure was a factor in the math. (Lisa)

I did not ever want to do math homework. I did not want to study. I did not want to participate in anything in class. (John)

Back then, when I did not get it, I just scraped by. I did the absolute bare minimum to get by. I think I can recall doing homework a dozen times in school. (Jeff)

But when I was signing up for classes for when I was going to be a junior, and I noticed that I had my math requirements passed off. Well, I was like, "Oh! I'm free! I don't have to worry about this anymore." My dad said, "Well, that's going to catch up to you in college." I was like, "I don't care." I just ignored it. (Amy)

Like sometimes, I would try to learn throughout the semester, but I would be too far behind, so I'd just give up.... I didn't cope; I just didn't do it. Maybe I had the attitude, "I'll learn it later." (Pete)

I was just glad to get my math classes over with. I didn't like math much and it showed in my work. I have anxiety when it comes to tests. I didn't care much on my scores. (Terri)

> I did not pay attention in class. I would do the minimum to get by. (Tim)

> I believe that I had feelings that I couldn't do it. I was convinced that all I could do was fail in algebra, and so I didn't try. There were times when the test would come to me, I would sign my name and hand it back in, because I knew I couldn't do it. So, I didn't try. (Mary)

Mary also mentioned that she would sit at the back of the class and be very quiet. She would not ask questions. It was almost as if she did not want to be noticed by her teacher and classmates.

Sam, Mike, and John all mentioned that they copied the answers to the odd problems for their homework out of the back of the book. They did not understand the homework, but they got it done in order to do the bare minimum to pass. Ken alluded to the fact that he did not take math seriously in high school; so he did not study and he did not try.

After considering the students' avoidance strategy, the researcher noted in her journal that the students seemed to give up because they had no confidence that their efforts would yield success. They had had too many previous experiences that proved otherwise. It was almost an attitude of "Why try when it won't pay off?"

Upon analyzing the data, it was apparent that as students reached the point where they began to struggle, they gradually lost the desire to try. They saw no purpose in learning mathematics and felt that since they did not understand it anyway, they quit trying. In essence, their motivation to learn was gone. They developed negative attitudes towards learning mathematics and developed ways in which to avoid it.

Successful Experience

Since all of these students are now successful, it was apparent that some changes must have occurred which enabled them to alter their course. As the interviews were analyzed, the same five themes emerged, but this time the experiences that formed the basis of these themes were completely different. In fact, some were completely opposite to those that the students encountered before. The five themes considered again were *turning point, motivation, attitude, learning environment,* and *learning strategies.*

Turning Point

The students' K-12 education was compulsory. They were required by law and by their parents to go to school. Many of them had no idea what they were going to do in the future, nor were they even thinking about it. They saw no need for learning mathematics then, because they were not anticipating a future vocation.

In contrast, when the students were faced with the reality of having to choose a vocation, all of them realized they would need a college education to go into the field they were interested in. They began to see the value of education. As a result, all of the students made a conscious, voluntary decision to come back to school. In an effort to explain that once he understood that he must plan and execute his own future, Pete summed up all the students' sentiments. "I think my vision of the future is a whole lot bigger and it's more serious now."

Even though Amy was just 19 years old and had not chosen a major field yet, she realized the importance of education to achieve her goals.

> I eventually want a really good career or job that pays well, and that I enjoy. I know I can only achieve that goal by gaining an education and being smart about how I use my time while I'm still young and don't have as many responsibilities (marriage etc).

With the completion of the present course, Amy has now satisfied the general education requirements for mathematics. Whether she needs to take any future math courses will depend upon her choice of major.

All of the other students have chosen a major and are actively pursuing their educational goals. The students with their corresponding majors are listed in Table 1. Ed was a theater major and passed his present course with an A grade. He needed one more math course to fulfill his math requirements. Mary had chosen a history major but had plans to go to graduate school and knew that she would be required to have more mathematics' courses than the general education requirement. Sue was majoring in elementary education, but she was also thinking of completing a bachelor's degree in accounting. She just needed business calculus to finish her degree. All of the other students had chosen majors that required more mathematics than the general education requirement of the college. Four of the students had chosen a major in the biological sciences with the goal of later going into a medical-related field. Pete chose mechanical engineering, which required an extensive mathematics background. Terri had chosen mathematics education.

Many of these students had chosen majors that required much more mathematics than the general education requirement for graduation. This was contrary to the researcher's original supposition that students who needed to take developmental mathematics in college would not choose majors that were math intensive. The

Table 1

Participants

Student	Age	Gender	Major	First experienced problems	Placement course	Present course	Final grade
Amy	19	Female	Undeclared	Third grade	Beginning algebra	College algebra	A-
Ken	21	Male	Business management	Eighth grade	Beginning algebra	Intermed. algebra	A-
Pete	21	Male	Mechanical engineering	Third grade	Pre-algebra	Pre-algebra	A
Kim	22	Female	Biology	Third grade	Pre-algebra	Intermed. algebra	B+
Sam	22	Male	Biology	Seventh grade	Pre-algebra	Intermed. algebra	A
Tim	23	Male	Physical therapy	Eighth grade	Pre-algebra	Beginning and intermed. algebra	A-
John	23	Male	Biology	Second grade	Pre-algebra and beginning algebra	Intermed. algebra	A
Mike	25	Male	Helicopter aviation	Tenth grade	Pre-algebra	Beginning and intermed. algebra	A
Ed	28	Male	Theater	Elementary school	Beginning algebra	Intermed. algebra	A
Jeff	31	Male	Biology	Junior high	Pre-algebra	Intermed. algebra	A
Terri	36	Female	Mathematics education	High school	Beginning and intermediate algebra	College algebra	A
Lisa	39	Female	Elementary education	Seventh grade	Pre-algebra	Beginning and intermed. algebra	A
Sue	43	Female	Elementary education and accounting	High school	Intermediate algebra	College algebra	A
Mary	51	Female	History	High school	Pre-algebra	Pre-algebra	A

researcher noted that these students had gained a confidence that they would be successful in future mathematics courses. This confidence was notably lacking before. When students were unsuccessful, they were diffident. It manifested itself as apathy, fear, and frustration.

Motivation

Motivation is the actual word used by many of the students as the reason they are successful now when they had not been successful before. It was mentioned more than any other reason. Although the particular needs and goals that fueled the motivation may have been different for each student, they were the impetus that spurred the students into active learning.

Ed mentioned that his own desire to complete his educational goals and the support of family and friends were the motivation for him to be successful. The gratifying feeling of success had also fueled his confidence.

> A lot of it I think has been half and half my own motivation and as I said having the motivation to stick with it this time and having the support of friends and family to help me through the times when I am reverting back to the type and wanting to avoid school and work. At the same time, the feeling of success that I am getting now that I am being successful and feeling that I actually can do this and kind of understanding more in a general sense where this is helping.

In a reflective moment, Ed said that both the internal and external motivation were necessary and essential for him to be successful.

> It does have to come from within to begin with, because there have been a few other start-and-stop semesters since I've been married, where I felt I had the internal motivation and halfway through the semester, I just stopped going. So, the initial motivation to stick to it does have to be there and then there has to be the strength to turn to my wife or my parents and say, "Hey, I don't want to go to class. I want to play this video game, or I want to watch this movie, instead of doing my homework." And having them help me and say, "Now, we gotta sit down and do this homework." The internal motivation has to be there to begin with; otherwise, the external motivation won't do a thing. You'll find a way around it. But, I think having both working together is an absolute need.

When Ken realized the value of education, he "took it more seriously" and committed himself to "focus, study, and work hard" to achieve his goals. Kim also mentioned that her educational goals are "the motivating factors" for her success. When asked why she was successful in her present course when she had not been in the past, Lisa replied, "I'm motivated because I have to succeed in math any way to be able to do my program. I think that's the first reason, because I am very motivated."

When asked the same question, Jeff again said motivation and cited his family and their dependence on him to succeed and his own competitive drive as components of his motivation.

> Motivation! I think that's 90 per cent of it. Whenever I get frustrated or don't feel like doing my homework, I just think of my little girls and they're counting on me. So, it's not an option. I have to succeed. Especially, since I've now changed my emphasis to a pre-med, that also has been a huge motivating factor for me. I'm also very competitive by nature. And whereas before, I really didn't care about the grades I got, but now I really do. So far this semester, I have yet to miss a question on any test I've taken.
>
> Motivation was also John's answer and his family was the driving force behind it.
>
> It's a motivation thing for sure. Like I said, I have a family now, so they're counting on me to not screw it up. But if you want to work, then you're going to do it. And the only reason I do it is because I need to take care of my family. . Now I'm trying to get into medical school. So if I don't get A's, I'm not going to get in. So I don't have an option. I don't have a choice.... You just gotta care. I mean if there is no reason to work hard, then why work hard? It's all intrinsic. No one in college cares if I pass my class. In fact, the university would probably prefer that I don't pass my class because then they get an extra $900 for me to take it again. You gotta do it for you. I can honestly say if I didn't have a family, I wouldn't even be in college. That's it.

Amy said that her belief that higher education will provide the means to have a career that she "will enjoy and that will pay well" has provided her incentive to actively learn mathematics. Mary stated, "Her motivation is completely different now than it was as a child." She has goals to go to graduate school and is committed to understanding mathematics because she knows she will need it there. Terri, who has decided now to major in mathematics education, explained that succeeding in each math class provides the impetus to succeed in the next. Her whole motivation has changed from high school to the present.

> I'm more ready to take on whatever comes along, rather than just trying to get through it. Rather than just thinking, "Oh well, I'm almost done. That's all I need," now it's "OK, this is a stepping stone to the next class." And then when you get to the next class, that's your stepping stone for the next class. I honestly try to be the best. As I wrote in the preliminary survey, I have to be number one, and if I'm not, then I'm in trouble because then I'm not putting my all in it.

When Sam began his college education, he "was looking forward to learning." He had "a stronger desire to do better." With his major, he knew how important it was for him to get good grades. His need to support his family supplied his motivation with additional incentive, a thought that apparently did not occur to him in high school.

> My motivation is definitely different. I have a lot more things that I care about now than I did then. I wasn't planning on getting married in high school and supporting a family eventually with a degree in something. With dental or medical school, you have to have good grades to get into a good school. Your family depends on that.

Sam's level of commitment had also increased because he was responsible for funding his education.

> My commitment level is a lot bigger now than it was before—a lot of it too because I'm paying for it myself. I work for it. I pay for it, and I can't afford to not get good grades, when I'm paying for it out of my own pocket. A lot of kids have their parents pay for it, not that it's a bad thing, because I would love to pay for my kids' school eventually, but I'm not going to pay for it if they are not getting good grades. A lot of kids just use their parents' money to socialize in college. That's not what it's about. It's about getting there and getting out and working.

The researcher noted that Sam seemed frustrated with the students around him who did not see the value of education and the importance of being committed to learning. Sam reflected on his own lack of motivation in high school and realized he was in the same situation these students are now. He also lamented that he did not really think about the future in high school.

> I chose to be here, but I could have had a lot more options, if I had just worked harder [in high school]. If I had just thought about my future more, instead of—I mean I knew the future was important in high school, but I didn't realize that if I had just learned stuff in high school, I wouldn't be relearning and paying for it in college. I could have saved myself some money and some time.

John made a similar observation about the students in his math class.

> I look around at the kids in my math class. They don't do their homework. They get C's on every test. They're barely passing. At first, I found myself thinking, "What are they doing here? Why are they not working?" Then I think, "Hey, you were the exact same way." They're here to meet girls and boys and go on dates and have fun and they're only in math because they have to be. But anyhow, it's all about motivation.

Jeff was also troubled by the number of students who were not trying in college.

> I look at the lack of work ethic and apathy in college students and it just blows me away. In high school, all I was doing was wasting time; I wasn't wasting money. Here you are wasting a lot of money and precious time. I just can't fathom or understand that. For me, it's all about motivation. It's all about what are your motives for being here.... I look at these other students that aren't doing so well and they have nothing else really to do other than school. And they're not doing it. I think really it's just motivation and why are you here. I've had people in biology class come and talk to me and say, "Well you have a lot of time. You just have all this time." Well, I'm a father of two; I work. I'm the Second Counselor in the Bishopric. I work out at least an hour every day. But I find the time. But what do you do? Well, I'm just a student. Well, you're obviously socializing too much. I think it's just all motivation. And there's no way to instill that in a person. They have to figure that out on their own. If you try to motivate them, it will just come across as patronizing.

Five of the students mentioned that seeing how the mathematics they were learning applied to their situation and to their prospective vocation gave them added incentive to learn. Similar to the other students, Mike also stated that for his major, "It's not an option to fail." Mike had seen direct applications of the mathematics he was learning to his part-time job. He had also seen application problems related to his major field.

> The other big thing is that I realized how important math was outside of school. I started getting into the work force, working a lot with CNC as well as wood and radiuses and pitches and different things like that. I just realized how much math goes into those types of things. And I started being able to see the ends to the means, whereas before I could not see that. So, I was like, "Man, I wish I really would have paid attention in my geometry class. I really wish I would have learned stuff in my algebra class." And so having that mindset that knowing math really does apply to the world—that I'm going to learn this so that I learn how to apply it to my life. And I know how to apply it now because I've been there.

Pete worked part-time as an apprentice plumber. He had seen direct applications for his work as well.

> Some of the things I've learned I've already applied in work and stuff—like simple stuff like averaging how many miles to the gallon. That's kind of cool to know. Or, I thought it was really cool converting. We're doing proportions—how many meters are in a mile—from metric to English measurements.

John commented on the word problems he had to work in his class. He did not see direct applications in some, but others were very applicable.

> There are usually word problems at the end of each chapter in my book. But I can see how these kinds of problems can apply. If I only have 4 gallons left in my tank and I get 30 miles to the gallon and I've got this many miles to go, am I going to make it? That's the kind of thing that they are giving you, which is good, because you will use it. Some of the problems are really stupid, but most of the problems are real problems and you don't get that in high school. I can't relate to the non-applicable math plus it's a waste of time. Why do I need to know something that I will never use? There's no reason for it other than to pass the test and that's ridiculous. It shouldn't be on the test if you're not going to be able to apply it. To have the course well delineated as to what you need to know for the particular profession you are choosing has been really nice in this department.

Jeff, whose major was biology, got excited when a symbol in a formula he learned in biology class was explained in his math class.

> We were learning a formula in my biology class where there was a triangle symbol in some of the parts of the formula. I'm taking Dr. C. She is a fantastic teacher, but she is from Argentina. There are some language issues there. She kept saying delta G. I didn't know what that symbol meant. The next day my math teacher throws it up on the board and I now know it means "change in." That was brilliant! All of a sudden, I got excited about math because I can apply it. So, I would say that if I could do something, I would have the science teachers and the math teachers get together and go, "How could we have what they're learning in math be used in science?" I got so excited about that, and we're learning another symbol that I've seen in chemistry books and I'm anxious to get to that chapter because I want to know what that symbol means. So somehow just not only learning it but applying it—having problems you're applying it to.

Tim realized that physical therapy was going to require mathematics. He also realized that mathematics will apply to the subjects he has to study as part of his major program.

> Going into the medical field, I know I'm going to have to have a decent knowledge of math and then later on more practice in the field and stuff. I'm going to have to know a lot of chemistry and a lot of physiology. And that's math but applied to the human body as to the way it functions and things. To me, math is very important now, because I have to know it in order to keep going in the field that I want. And then of course, if I decide to maybe after radiology, maybe that's just not for me, if I decide to be a doctor, then I'm going to have to know really a lot—a lot of everything. And I feel with math, I'll be able to understand a lot of that.

In his present class, Tim had recognized that there were many applications of mathematics in the real world.

> In all these little concepts we are learning, you use math in everything. Math is everywhere! You can't do anything without math really so it's kind of opened up my eyes these last two semesters of my math, how important it is. In junior high and high school, I didn't understand that.

When the students were asked the question, "Why do you think you are successful now when you were not successful before?" the researcher fully expected that the students would blame a previous negative learning environment as the culprit for stifling their mathematics learning. Contrary to what she expected, the students surprised her with the answer of motivation. As mentioned previously in the literature review, motivation is a big factor in determining student success or failure (Hardre et al., 2007), but the researcher noted in her journal that she did not expect the students to recognize the motivation factor in their own experience.

Several of the students reflected upon the characteristics of motivation. John summed up their thoughts nicely.

> If you're not motivated, then what's going to drive you? This motivation can't come externally unless you're going to bribe people. "If you get an A this semester, then you can take the next class for free next semester." Maybe that would work, but I still doubt it. It's the chicken or the egg thing. Are people successful because they're smart or are they smart because they're successful? There will be people who you could beg them, "Please do your homework. I'll give you anything you want." They'll say, "No, I don't think so. I don't feel like it." And there will be people who will be begging you, "Let me study more. I need more. I want to learn more." It's going to be the type of person that you are dealing with, where they're coming from, and why they're here.

Attitude

An analysis of the data relating to attitude revealed two subthemes, *enjoyment* and *confidence.* With the exception of one student, all of the students said they now enjoyed mathematics. That enjoyment tied closely to understanding and their understanding was validated by their success in class. Confidence in their ability to learn mathematics was expressed by all the students.

Enjoyment. In describing his attitude towards mathematics now, Sam mentioned the big difference between his attitude in high school as compared to the present. "My attitude toward math is totally opposite than it was in high school. I enjoy learning and knowing math now. I enjoy my math class." John made a similar comparison. "My general attitude towards mathematics in general is not even close to what it was. It's kind of nice. Math is one of my favorite classes right now." Pete echoed these same sentiments.

> I'm excited about it. I like it a lot. I think I have the same attitude of respecting math the same, but now I like it. Now, I actually enjoy it. I don't hate it like I did before.

Mike mentioned he did not like being in high school either and he blamed a lot of that on his attitude.

> A lot of it was my attitude. Being able to change my attitude earlier on would have helped.... As soon as you have an open mind, you're ready to learn. Because going to school in high school, it is like "Oh, another day of class—I'm not going to learn anything today either." If I could have gotten that mind set gone, even if I didn't like the subject, maybe I can learn something today. Maybe, there's just a slight bit of hope. The channel is open, and now information can flow and otherwise every time, it tries to go in, you just push it away. It's like hitting a wall.... And now that I have consciously made the decision that this is what I want to do; this is where I want to be, it's fun! It's fun to be here! And it's fun to learn!

When he decided to go to college, he made a conscious decision to change his attitude. He described his feelings about mathematics now. "I think it's pretty cool!"

Tim mentioned that his attitude was the difference between him being unsuccessful in high school and successful now.

> In junior high and high school, I didn't understand, so therefore I didn't like it. When you learn something and it's interesting, you tend to like it, but when you have the mindset that you can't learn something that's presented, then it doesn't become something interesting to you. It doesn't become something that you like. And I think that was my attitude before, but it's very different now. I honestly like math. It's very fun.

Terri also felt that her attitude was a factor in her success now.

Lisa also noted a big change of attitude from her unsuccessful experience to now. She is excited about learning math now, which is a definite contrast to the fear she experienced before.

> I was so afraid to come back to school, mainly because of the math, because I hadn't been successful. It's a definite change from before. It's exciting to feel my brain working in ways that it never has or that it hasn't very much anyway. It's a game to me. Sometimes, I'd rather not play it because it's not my love. But, it is exciting!

Although Amy does not consider math to be her favorite subject, her "attitude has improved." She mentioned that a positive "attitude is the key" to being successful in learning mathematics. Jeff still considered his math class his "most frustrating class," but as he has seen the applicability, he said he has been "excited about that." As a side note, Jeff received a perfect score on his final exam for his class.

Sue was the only student who never admitted to enjoying mathematics. Sue said she did not like math in the past and she "still doesn't like it." However, she planned to take calculus to finish her bachelor's degree in accounting as well the math classes required to finish her degree in elementary education. Her grades have been straight A's in all her math courses and she did say, "It's not as bad as what I imagined it would be."

When asked to describe his present attitude towards learning mathematics, Ken replied, "I actually kind of look forward to the class. For the most part, I enjoy learning math and learning new things." Mary reiterated, "I'm very happy. In fact, I look forward to the class." Tim responded similarly. "I really like math! There are so many things to learn, concepts to apply. When I think about it, math is actually quite fun when you pay attention."

Ed said he liked mathematics now because he had understood, and consequently he has done well. "I'm actually rather enjoying it. Again, I think a lot of it is because I'm actually feeling successful." The feeling of success has fueled his enjoyment. Kim expressed the same idea. "I can almost say that I'm enjoying it now, just because I understand it. It's easier!" Tim expressed the same idea simply. "Because I understand, I like it!"

Terri has had a complete transformation in attitude. She "hated math" before and now is majoring in mathematics education on the secondary level.

> I am very excited about math. I love learning and understanding what I am learning. I've changed my major to secondary education with mathematics, because I love math now.... I love it. I'm enjoying it a lot.

Confidence. Every student expressed a confidence in being able to learn mathematics. Confidence was the actual word used by some of the students to express what theorists would call self-efficacy (Bandura, 1986; Driscoll, 2005; Hall & Ponton, 2005). Some were amazed at their own progress and their being able to understand mathematics concepts. Many felt comfortable learning mathematics and secure in the knowledge that they could succeed. They were not fearful of taking a subsequent course, but were actually looking forward to it.

Ken expressed his astonishment at being successful and at the same time declared his confidence that he can understand concepts and has the ability and skills to solve problems.

> I really sometimes wonder how I got to be so successful. I don't know how it happened. One day, everything that he (teacher) taught and the methods he used just clicked with me and ever since then, I have been able to figure out how to work the problems, how to take the time to really look at what the problem was

asking and just kind of find my way through.

Lisa also expressed her amazement at being able to be so successful. “It’s an amazing feeling having been so low and then I got a perfect score on the midterm. I was just floored! I almost started crying! I did study a lot. I can do this!”

Because of her present experience in mathematics, Mary felt she could learn mathematics. “Because I am grasping every concept and because it’s going at my speed, a speed that I am comfortable with, I feel like I am succeeding. I feel confident in my ability to learn math now.” Mike indicated his confidence this way. “I know I’m going to pass.”

Tim stated quite emphatically, “I like doing math now because I *can* do it.” Kim also stated that she knows she can accurately solve mathematics problems.

> I can almost say that I’m enjoying it now, just because I understand it. It’s easier! It’s almost easy, just because I know I can look at the board and do the problems, instead of being just completely confused by it.

John felt secure in knowing that if he put forth the effort, he would be successful.

> If I study and know the stuff, then I’ll get an A. And that’s nice to know. So that’s a very nice thing about math. It’s reflective of your efforts. Because if you understand the concept, then you can figure it out. It’s comforting!

Pete also found security in knowing that he can succeed.

> I think it’s great being a successful math student. Just knowing that I’ll be able to stay on top of it to where I will feel comfortable once I get into an environment where I’ll have to use the math. Just the security that it brings is great.

Ed indicated that the feeling of success and the understanding of where the mathematics applied nurtured his confidence.

> The feeling of success that I am getting now that I am being successful and feeling that I actually can do this and kind of understanding more in a general

> sense where this is helping have all contributed to me being able to do this.

Terri was confident enough to major in mathematics education on the secondary level, which requires many more mathematics courses. Sam was also thinking of acquiring an academic minor in mathematics. Even though Sue "didn't like mathematics," she was confident enough to complete a bachelor's degree in accounting and a bachelor's degree in elementary education, comprising at least three subsequent math classes.

> I know I can do it. That is why I was actually thinking of getting a bachelor's degree in accounting and finish it off. I think I have to go up to calculus. I think I could actually do that although the word calculus is frightening to me. I don't even know why. But I thought, "I could do that!" I could get a bachelor's degree in accounting and elementary education. I am confident that I can do it if I just work really hard.

The growth of confidence was similar for all the students. Amy's experience is representative of what happened to these students as they began to understand the concepts and gain the skills to solve problems.

> The last math class I took was in my sophomore year, because I passed the requirements to graduate. So, my attitude was not to bother myself with math because I was 'done.' But, when I started going to college, I was placed in beginning algebra. My thought was, "If I struggled before, then I will definitely struggle in college." I was wrong! The concepts that were taught started to 'click,' and it wasn't as bad. Slowly, my confidence started to grow because I was understanding the homework and doing well on the tests—something that has never happened to me before when I was taking math. So through each semester, I have been steadily climbing up the ladder, understanding more and more. My attitude about math has definitely changed throughout my freshman year of college. It's still not my favorite subject, but it has become more bearable and my *confidence* has grown significantly. If I had to take another math class, I think I would survive now.

When students were unsuccessful, they unanimously expressed a negative attitude towards learning mathematics. Now that the students are successful, there has been a dramatic change in their attitude. Most of the students expressed an excitement and enjoyment about learning mathematics. There was one student who said she still did not like learning mathematics but it was not as bad as she had anticipated.

All the students expressed the confidence that they were now able to succeed in their mathematics courses. Some of the students mentioned that consciously changing their attitude was one of the reasons they were successful. Many of them said they looked forward to going to math class and actually enjoyed being there, because they now understood it. One student even said she loved learning math now and had changed her major to secondary education in mathematics. Another thought of completing a minor in mathematics. The growth of confidence definitely brought about a change of attitude.

Learning Environment

Based on the student responses in their interviews, the learning environment was a critical factor in their success. Three aspects of the learning environment were mentioned frequently as contributors to their successful achievement. The three subthemes that will be addressed are *accurate placement*, *teachers,* and *learning resources.*

Accurate placement. Before students at the college can register for a math class, they must either take the placement test or demonstrate that they have successfully completed the preceding math course within the previous 2 years. All of these students were required to take the placement exam. Table 2 displays a summary of the students' expectations of the results of the exam and their opinion of whether the placement was accurate or not.

Table 2

Placement Exam Expectations

Student	Age	Placement	Expected placement (higher or lower)	Accurate
Amy	19	Expected		Yes
Ken	21	Expected		Yes
Pete	21	Expected		Yes
Kim	22	Surprise	Higher	Yes
Sam	22	Surprise	Higher	Yes
Tim	23	Surprise	Higher	Yes
John	23	Surprise	Lower	Yes
Mike	25	Expected		Yes
Ed	28	Expected		Yes
Jeff	31	Surprise	Lower	Yes
Terri	36	Surprise	Higher	Yes
Lisa	39	Surprise	Lower	Yes
Sue	43	Surprise	Lower	No
Mary	51	Expected		No

As can be seen from the table, six of the students expected to be placed in the level of mathematics that the exam diagnosed. Five of those students felt the placement was accurate and took the recommended course. Mary, however, actually registered for a lower-level math course than the one in which she was placed. Since her plans were to go to graduate school, she wanted to make sure she had a solid mathematics foundation. She felt her self-selected lower placement was the accurate placement for her.

> I decided to take a lower division class. It has been good to take that class. It has given me a good foundation, and I intend to take the next class up. My plans are to go to graduate school, and I will need to take a test that will require some math, and so I am learning math again.

Eight of the students were surprised by the results of the placement exam. Half of them thought they should have been placed in a higher-level math course. Tim and Sam hoped to place in a higher-level math course because the developmental mathematics course credits do not count towards a degree in their major field. After taking the recommended courses, they both thought the placement was accurate.

> Now that I think about it, it was probably better, even though I've spent more money getting to where I'm at, it's better. I got an A in pre-algebra. I got an A in beginning algebra. I've got an A in intermediate algebra right now. And I'm doing fine. I personally think it was best. I mean I wasn't happy with myself with the way that I placed, knowing that it was such a low class. I was pretty upset, but now that I look back on it, it was the best thing for me, because I could have gone to intermediate algebra now and would have been completely lost. (Sam)

> You know I wanted to test into intermediate algebra because these math credits before intermediate algebra, they don't count towards your grade or something. So I was really hoping I could just go right into intermediate algebra. But looking now at what I learned in pre-algebra and at what I'm doing right now in beginning algebra and intermediate algebra put together, there is no way!--no way I would have been able to handle intermediate algebra my first semester. Pre-algebra helped me to remember and helped me to learn just the little subtle things of math so I could apply them later. So yes, it was a good placement. (Tim)

Kim and Terri both thought they were capable of taking a higher-level math course because they had previously progressed to higher levels. The placement exam results surprised them both, but after taking the course in which they were placed, they agreed with Sam and Tim that it was the right placement.

> When I first enrolled in college, I got placed in pre-algebra and that was a surprise. Going through the class, it's really basic. I was like "Gosh, I did this in junior high!" But it seems like it's helped in the long run, going back and doing those things. Now, I think it was a good placement. When I was currently in it, I was like, "Oh, I feel like a big dummy. I know how to add. I know how to subtract." But, it really helped me in those things I struggled with, like long division and that sort of thing. (Kim)

> I thought the placement was kind of a surprise, because I didn't think it was accurate—I can't say accurate, because obviously it's very accurate. But I thought I knew more than I did until I took the test and realized I don't know half the stuff

> that was on there. I definitely think it was a good placement because I think it helped me go back and relearn the concepts that I had learned back in high school and in the first years of college and work my way up to where I'm at now. (Terri)

The other four students were all surprised that they placed as high as they did. In fact, they all expected to be placed in the lowest level math course, arithmetic review. Sue indicated her surprise into placing into intermediate algebra. "I was surprised to get into intermediate algebra. I thought I'd be in arithmetic review or pre-algebra, like everybody else." The other three students had similar reactions.

> Well, I'm 31. I'm kind of a non-traditional student. I've got two kids and what not. When I decided to come back to school, I placed in pre-algebra barely. And to say I was surprised by that—absolutely not. I think there's even a course lower than that. I think I honestly thought I would place in arithmetic review or something. (Jeff)

> I was surprised I placed as high as I did, because going into the Compass, I didn't think that I even had a chance. I thought that I was going to start in arithmetic review and just have to take class after class after class. (John)

> Well, it was a surprise that I got placed higher than I thought, which was pre-algebra; so it wasn't high. But I couldn't remember how to do long division, because I've been a mom for 18 years.... But I could remember sitting and taking the placement test and going "Nope, I don't know that one. Nope, I don't know that one." I remember the same old dumb feelings coming back and when I was placed in pre-algebra, I thought, "Oh, well maybe I'm not so bad!" (Lisa)

John, Jeff, and Lisa all said that they felt the placement was accurate. John stated that based on his placement, the advisors gave him the option of determining his pace and course selection. He decided to take the slower pace to make sure he learned the fundamentals and earned good grades, which were essential to get into medical school. Jeff indicated that he would not have been prepared for higher-level math courses. "Without question, it was a good placement. In hind sight, beginning algebra would have just blown me out of the water, to come in and try to do that." Lisa agreed that her placement was right and was amazed at what she had learned.

> Yes! The placement was excellent. Absolutely! It was challenging, although I look back and I think I could really ace that class now, because I learned. It's a good feeling to look back and say, "I've come a long way!" Very, very wonderful!

Sue was not sure that her placement was accurate because she felt there were several concepts with which she was not familiar but was expected to know them for her class. With extra effort, she was able to learn them and do well in the class. When Sue was asked if she felt the placement was not accurate, she indicated that might be the case.

> Possibly. I did fine in the course. And I understood, but I had to work really hard, harder than anyone else. I had to pick up new things every single day. Every single day, I had to pick up something new. It was totally a new concept all along the way.

Accurate placement was viewed as critical by all the students in being successful because students are then placed at a level where they can build upon the concepts they already understand and where they will not have gaps that are too big to overcome. Pete, referring to his placement, said it succinctly. "One big thing is that I'm starting where I *can* start."

Teachers. Caring, capable, and patient teachers were cited by students as contributing to their success. The teachers described by the students provided a comfortable classroom atmosphere where the students felt free to ask questions. Many of them mentioned working with their teachers one-on-one in their offices when they needed clarification on a concept or help solving a problem. The researcher observed that some of the teachers had mandatory study groups in which the students participated in class and outside of class. Students in those particular classes mentioned how helpful the study groups were.

In her classroom observations, the researcher also noted that every teacher knew the names of their students and showed a definite interest in how they were progressing and what was happening in their lives that might affect their learning.

Students mentioned their teachers were better than the ones they had in high school. John made a comparison of his high school teachers to his college teachers. “My teachers are a thousand times better than I’ve ever had before.” Jeff had a similar comment about his college teachers. “Luckily, I’ve had excellent teachers up to this point in college.” Sam echoed their sentiments. “I like the teachers I’ve had over the past three semesters of college math. I’ve learned a lot more.”

The students referred to the rapport they felt between their teacher and themselves. Mary felt her teacher cared about each student. “I have a teacher who is very encouraging with the individual student. He is really good.” Mike mentioned that his attitude towards mathematics was affected by his teachers. In high school, he felt his teachers were distant and did not care, but his college teacher had encouraged him to think about his mathematical ideas and Mike felt free to discuss them with him in his office.

> I think one of the major differences in my attitude towards mathematics is my teachers. I don’t feel like they are Gods in a sense, like I did in high school that they are infallible. And especially with M. (teacher), being able to talk to him just after class—we’ll walk all the way to his office and just talk about math. He’s very open to different ideas, and I work very well in that atmosphere. If I were with somebody that was like this: (Snap fingers) “Class, it’s time to start,” I don’t think I would be doing as well as I am, just because I’m the kind of person that really has to have somebody that is just as open to ideas as I am. Otherwise, it’s just like you’re telling me this because this is the way it is. You’re not really explaining it to me. It’s just like going back to high school.

Mike said his teacher's obvious interest in them and his desire to hear their ideas and learn from them had a definite effect on the entire class.

> Having teachers that allow creativity to flow has been beneficial. Being able to talk about your weekend before class starts and it kind of goes a little bit over and not snapping at you (snapping fingers) and cutting you off and getting in your way and then transitioning into learning mode. Being able to have that, all of a sudden, you're not afraid to ask questions, because they're not judging you. They're not judging you off the questions that you're asking. And the more questions you ask, the more excited somebody else is to ask questions as well. And everybody begins to learn a lot more. And one of the funnest things with M. (teacher) is that he does do that, and he's learning with us. And when he's learning with us, it's exciting, because he's learning, we're learning, and everybody's learning. And it's like synergy. Everybody starts to build up. And it's like Sara was saying, "This is the funnest math class I've ever been to!" It's exciting! I love to see him every day! We talk about the weekend and things, and then we talk about math. He helps me with, "OK, I see it this way," which M. is used to seeing it this way, and so I get different ways to do it.

Tim reaffirmed that the rapport that the teacher established with the students made a difference in learning for him.

> I think it's the teachers, the way they present or the way they associate with the students. I mean, yes, it's a teacher-student relationship, but if they can't have fun and they can't be relaxed while you're in class, it's very hard for me as a student to relax, to become not just a student-teacher, but maybe like a teacher-student, but you have a friend kind of relationship. And honestly, I feel that way with Professor L. I feel like she is more than just a teacher. She's a good friend; that if I needed help in something, I could just go to her. And also with C., she's really, really funny and she's got a good sense of humor. And the way she applies her humor to the math helps me in understanding. And obviously, it's helping people in the class because we're all doing well in learning the concepts that she's teaching.

Pete and Jeff said they were able to establish a connection with their teachers, but some of the other students in their class did not relate to their teachers as well. But because they felt a rapport with their teachers and understood how they taught, they were successful. Jeff described his teacher as "awesome. He is such a good teacher. I am just blown away by how good he is. I know he doesn't relate to some students, but for me he's fantastic!" Pete researched his teacher before he signed up for the class but made his decision by how well he thought he would learn.

> I remember when I was signing up for math—I was online and I was on the "Rate My Professor" page—it was between my teacher, B., and someone else, I can't remember the name. One of them was on "Rate My Professor" was like, "This is a great teacher!" That wasn't my teacher. And I saw my teacher, and everyone was complaining about him. And still a lot of people do. But, I think it's more of a desire to learn. I don't know that much about math teaching. I mean I'll see different ways of teaching, but at first, it was hard for me to learn from my teacher, but as I learned how he taught, then it helped me out a lot. Then the criticism from other people didn't really matter, because I was really learning. I think that having a open attitude towards it; I could have gone for the easy teacher—where everyone's like he's an easy teacher—but I don't know if I want the easy route, because I want to learn the math, because I'm going to need it. If I don't learn it, I don't want to get in another class to where I'm like, "Oh Crap! Now What!" (Pete)

Pete indicated that there was a connection with his teacher and with the way he taught. Ken also noticed that the concepts his teacher explained made sense. Once he understood his communication style, he was able to grasp the concepts from then on.

> One day, everything that he taught and the methods he used just clicked with me and ever since then, I have been able to figure out how to work the problems, how to take the time to really look at what the problem was asking and just kind of find my way through.

Because Amy had established a strong communication connection between herself and her teacher, she chose to take all her math classes from him. Based on the researcher's classroom observation and a review of his exams, the researcher found that he was very rigorous in his lectures and exams, but also very clear in his explanations in class and very approachable for one-on-one help. Like Pete, Amy selected him because she wanted "to learn the math."

Terri indicated that she and her teacher connected right away. Her teacher took an interest in her test anxiety problems and helped her overcome them.

> I think I got along with her. We kind of clicked, and so I think that helped me. I get anxiety over tests. She just kept saying, “It’s just another test. It’s just another assignment. It’s not a big deal. Take each step at a time as it comes and just get through it. And then worry about the next one when the next one comes.”

Several students mentioned that the teachers presented the mathematics content in an organized and appealing format and taught so that the students were actively learning. John mentioned that his teacher built each concept step-by-step. “The classes and the curriculum are all very organized. You move from one thing to the next very well. It’s very structured that way.” Speaking of his math teachers, Jeff said, “I find that my teachers have been able to make it more alive.” Stating that he had a very good teacher, Ed commented on her lectures. “I actually look forward to attending M’s class. The lectures are very engaging.”

In addition to providing a comfortable atmosphere, establishing a good rapport and communication with the students, and providing clear, well organized presentations of the mathematics concepts, students mentioned that it was critical for them to know that their teachers cared that they learn. John stated emphatically, “My teachers are good and smart and they care.” Sue reflected about her idea of caring, patient teachers.

> You could tell they were always very smart. Yet they’ve never belittled. I’ve never seen a good teacher belittle a student. I’ve seen it with other teachers. And I never think that even if someone has a doctorate, I’ve heard that actually today, “Well, I have a doctorate, and so I know so much.” But, I really don’t care how much that person knows, until he tells me, “This is what you can do! This is what you can do to learn it.” So, that’s not important to me. It’s the people that say that, I know that they are very smart, yet they’ve never said, “Well, I’m smarter than you and this is the reason.” They will take the time to say, “This is why this is happening. Or this is why your thought process isn’t working. Or this is where

> you’ve gone wrong.” You know, just to correct me and get me thinking in the right direction.... All of those teachers that I could name off were very patient and they answered my questions even though they may have seemed dumb, but I could tell that they were interested in me learning what I was doing, not just trying to pass the class or pass their time or whatever.

In all of the classroom observations, the researcher noticed that all the students asked questions, but Sue asked the most questions by far in comparison to any other student. When asked about it, her instructor stated she always asked a lot of questions, but “it paid off for her. She is a straight A student.”

The willingness of a teacher to spend time helping a student was noted as evidence of a caring teacher.

> C. is just a fantastic teacher. He has office hours right after our class and so I’m bugging him pretty much every day. Bless his heart, he is really patient with me, and he listens and he’s more than happy to go through things. (Jeff)

> My teacher was incredible! He still teaches here. He needs a raise. He needs to be the department chair. He needs whatever he needs. He’s incredible! He’s the best teacher I’ve ever had! Period! Just period! Of any subject! He was awesome! He took the time. He was just so foreign from any math teacher I’ve ever had before. Before it was like, “Today, we’re doing these three sections, and if you don’t get it, too bad, because tomorrow, we’re moving on to the next three.” But he would take the time and say, “Look, if you don’t understand it, we’ll just sit here until you do.” He would write a hundred problems on the board if he needed to.... So, I actually got the best grade in the class in that class. And I was like, “Yeah, Baby! I’m not stupid!” So, it was good! I loved it! I got A’s on every one of my tests. He tested me on what he taught in class, which was nice. I’d never had that before. And so it was excellent. It was very nice. I liked it. And Miss B. is awesome too. I love her to death. (John)

Several students mentioned that the teacher played a significant role in being successful. When asked why he thought he was successful now when he had not been before, Ken said, “A lot of it has to do with my teacher. His teaching style is one that I can relate with.” Jeff and Terri also indicated that their teacher made a difference.

> I've been very pleased with the teaching staff. C. was gone not too long ago. A couple of times, we had some substitutes. A couple were great. One was terrible. It made me realize how important for me the math teacher is. I've heard that they have done studies where they have shown that 10, 15, 20% of your grade is really relative to the teacher you're taking and I agree with that. But in classes that a person struggles with, I think the teacher plays more of a role. And for me, that's math. In biology, I could not even go to class and probably do just fine. But with math, I need that lecture. I need someone that I can relate with. It was a real eye-opener when C. got back, how much we needed him. (Jeff)

> Honestly, my number one thing would be the teacher. I know they say when I went to a math orientation that it's only like 25% or 20% teacher. I really think it's at least half that is your teacher. I feel like that if you have a teacher that you can respond to and that you can understand or that gives you the time of day, that it makes you feel important and it makes you feel like, "Oh, I can do this!" If I put some time into it, I can learn it. And that's how I've learned.... If you can't get along with your teacher or you can't understand or they teach in a different way—like at the beginning of the semester, I had a different teacher, and I didn't like the way he was doing things. So I dropped it within two days and got into P's class. I've heard really good things about P. I didn't know who he was. I'd heard of him, but that was it. I thought, "Well, it's better than this guy." So, I switched as soon as I could, and it's made a big difference. He's the one that talked me into changing my major. He's the one who said, "You know, you are doing really well. So I think you can do this if you want to." (Terri)

Learning resources. Students were very proactive in using available resources to aid them in learning mathematics. Among the resources the students enumerated were the math lab available at the college, tutors, and the online math program associated with the textbook.

The online math program was available to two of the students. Some of the texts used did not have online ancillaries available and therefore teachers could not make it available to their students. Other teachers preferred not using it. The teacher had to have a working knowledge of the program in order to register students into it and to use the program as an evaluation tool. Only some of the teachers who had training in using the program made the online math program available to students. The online program has the textbook, instructional videos, homework problems that can be assigned by the teacher, and sample exams. Homework problems are immediately graded by the program. If a problem is incorrectly answered, the program gives immediate feedback and an explanation of how to correctly solve it. It also gives example problems like the one missed and refers students to the textbook where the concept is explained. The math lab has computers designated for students to use the online program. Students can then go work homework problems and also have the aid of the math lab tutors to help them, if they have trouble. Although John found that there was a definite learning curve with the online program, John found it extremely helpful when working in conjunction with the math lab tutors.

> There's computers in the math lab, so I can do my homework in there and still have the tutor working alongside with me saying, "This is why. What don't you understand? Let me help you through." And things like that. And the good thing about My Math Lab is you do get instant feedback and I like that. So if I miss a problem, I know immediately and I can know, "OK. I need to try that one again." I can do the exact same sort of problem again until I know how to do it right. And that is excellent.

When asked why he thought he was successful now when he had not been successful before, Ed emphatically replied that the difference was the online program.

> My Math Lab, absolutely! The way the online homework is set up is basically what I feel I have needed. I didn't realize this until I took 990 last semester as an online course. The fact that I get immediate feedback as to whether or not I got the problem right, so I know, "OK, so I didn't get that one right," the helps, the "give me an example," the "help me solve it," access to the book immediately there, the videos that are on there, are very helpful. And it's ideal for the way that I feel I learn, because I can go right when I didn't get it right, I can step through the example to figure out what I did wrong. I can do the "help me solve this," and the fact that I also have the similar exercise option so that I can do that as many times as I need to until I can get the problem right without using any of the helps. And that's been a great help because that way I'm actually learning the concepts and understanding them and getting the practice I need that I would actually avoid

> in earlier courses.... I really enjoyed My Math Lab experience and very definitely, it has been a key factor in my being able to turn around in math.

Although the college math lab offers tutoring services, several students found others who could help them understand concepts. Kim said she had received help through tutoring. Josh said his sister-in-law helped him at the beginning of his pre-algebra class, when he “was reviewing long division and multiplication.” Sue mentioned that her children help her with her homework sometimes. “They are very smart.” Lisa said three of her children as well as her husband have tutored her.

> I have three kids that can help me with math.... It’s embarrassing because I’m asking my children for help. They all got their dad’s brain.... My husband is a very good teacher. He got a physics degree, but he’s also a good teacher, which is I think is a rare combination.

Amy recruited a family member to tutor her. “My sister-in-law has a PhD in physics. She helps me whenever she’s at my house. I’ll ask her a couple of questions and she’ll be willing to help me out.” Mike’s friend has helped him.

> He’s always been really good in math. And I guess just knowing that he’s really good in math; I mean he’s going to be graduating this year and so he’s gone all the way through calculus and everything. He just loves it, loves it to death.

Mike said that “knowing that he was so far ahead and that I could go to him any time I wanted and ask him questions” was a big comfort for him in coming back to school.

Nine of the students specifically mentioned that they used the college math lab as a resource for help in learning mathematics. The math lab has study tables designated for particular courses. For example, a group of tables will be labeled “Beginning Algebra Students.” Each table has a flag that can be set upright in a holder when students need help. A tutor will then come to their aid. The students have the benefit of a study group at their table as well as tutoring. In addition to the tutors, that math lab also has study group rooms, workshops on test anxiety and troublesome math concepts, computers with the online math program and online white-board tutoring. The math lab resource is advertised heavily in each class at the beginning of the semester.

Students mentioned that they went to the math lab consistently and that it was very helpful. Terri said that she tried to go to the math lab every day if she could. John was very positive about the math lab. “The math lab is awesome! I basically lived in the math lab last semester.” Pete said he used the math lab as he needed it. He commented about the math lab atmosphere. “I like the fact that it’s not all serious and everyone has to be quiet. I like the fact that I can talk.”

Amy was pleased with the people who helped her. “The math lab has helped me a lot because the people there are great. They are really patient. They are really nice. And so that’s helped a lot too.” Sue agreed.

> I work really hard, really hard. I spend a great deal of time in the math lab.... The tutors are very good and they are very patient and they let you figure it out one little step at a time and maybe give you little clues as you go along.

Jeff and Sam found it very effective to go to the math lab right after class and complete their homework.

> Doing homework immediately after lecture. That is crucial. I would say that probably the best thing this college has is the math lab. I use it every day. Some of the tutors are better than others. I keep an eye out for the ones I really like and that’s when I throw my flag up. (Jeff)

> What I tried to do was space my classes out to where I had—I did this for the first two semesters, but I wasn’t able to this semester—space it to where after math class, I had at least an hour to just go straight to the math lab and work on my math right after class, so obviously that’s the best thing because it’s already there in your head. You’ve already been thinking about it for the past hour. You might

> as well work on your homework that you've done, and it just kind of locks it in there and helps me out a lot better. That's what I did for the first 2 years. This year, I wasn't able to do that and I've noticed the difference. Going to do my math homework a couple of hours later, a day later—not a good idea. I don't recommend it. (Sam)

Tim went to the math lab with a friend. He described how they use the math lab together.

> I go to the math lab all the time and I have a buddy named S. We're always going in together to do our math and he's in beginning algebra, but I'm in beginning and intermediate algebra combination. So we're still covering sort of the same things. And he'll have questions for me and I'll have questions for him. It's just kind of nice, even though he's not a tutor, but he's someone there to help me if I have a question. If he doesn't know the answer, then the flag will go up. "We need some help."

Tim reflected on the value of taking advantage of this "free" resource.

> I go into the math lab every day, if not every day, every other day, because if there's a concept that I'm struggling with or something that I don't grasp very well, I know that if I go into the math lab and try it out and I still can't figure it out, someone's going to be there who can help me and walk me through it. I guess I would spend at least four hours in the math lab a week. I spend at least an hour every time I go in there to do my homework. I like that resource. That's great because it's free tutoring. Who doesn't like free tutoring?

Learning Strategies

The learning strategies exhibited by these successful students were markedly different from the avoidance strategy they pursued when they were unsuccessful. They were proactive in the classroom by consistently being there, by positioning themselves where they would be least distracted and by asking questions until understanding occurred. They were proactive in their study habits by diligently and consistently doing their homework and by doing more than mandated when the need for comprehension arose. As previously mentioned, the students were proactive in finding and availing themselves of learning resources such as tutors, the online math program, and the college math lab.

Classroom behavior. The researcher kept a journal of all her classroom observations of the students. All but two of the students were observed twice. Scheduling conflicts prohibited the researcher from being able to observe them more than once. As the researcher observed and talked with these students, she noted that they were all very different. Because of the age differences, they were at different stages in life. They had different personalities. Some were shy. Some were outgoing. Some were blunt. Some were diplomatic. When the researcher observed these students in class, the differences melted away.

The researcher noted in her journal that as she went from class to class, it seemed like she was observing the same student because they exhibited the same types of behavior. It was as if they were all following a common formula for success. All the students selected a particular place in the classroom to sit. All of the students took extensive notes. All of the students focused on the discussion and answered the instructors' questions not addressed to specific students aloud. All the students freely asked questions when they needed clarification or when they did not understand or when they were curious how the concept applied.

When the researcher entered the classroom to observe the students, the first thing she did was to deliberately look at where the students chose to sit in the classroom. Table 3 gives a summary of their locations in the classroom. The students sat in the same place in both observations. Most of the students sat close to the front, many of them very close

Table 3

Seat Position in Class

Student	Seat position in class
Amy	Second row center
Ken	Third row center
Pete	Third row center
Kim	Fifth row center
Sam	Second row center
Tim	Front row two seats left of center
John	Front row center
Mike	Third row center
Ed	Second row center
Jeff	Fourth row center
Terri	Front row center
Lisa	Second row two seats right of center
Sue	Front row three seats right of center
Mary	Front row three seats left of center

to center front. Some of the classes had a larger enrollment than others. The largest class had 30 students and the smallest had 10. In the classes with smaller enrollment, the front row and sometimes the second and even the third row were often vacant. In that case, the students were on the first row closest to the teacher without any students in between. This was the case with Ken, Pete, Ed, Sam, and Lisa. Jeff, Mike, and Amy had just one student in front of each of them. Kim placed herself at the very back, but it was in the center of the classroom. Kim's teacher suggested she may have been further back because she wanted to sit by her friend, but she still chose to be in the center. These observations were made after the student interviews were conducted. Although not specifically asked about her classroom placement, Terri responded that one of her learning strategies was the right seat position because it helped to prevent distractions.

> Also, I sit front row and center in the class. I think it helps you to focus more because you are not watching what everybody around you is doing. You just see that person, the teacher, and I think that helped me too. It makes a difference because then you are not distracted by everything behind you. (Terri)

The researcher observed that some of the other students sitting towards the back and sides of the classroom tended to shift their focus from the classroom discussion to talking with their neighbor or texting on their cell phones. Noting that several students in his class were continually texting, Pete specifically mentioned in his interview that one of his learning strategies was to not text anyone while in class.

Many of the students specifically mentioned in their interviews that when they were in class, a crucial factor in their successful learning was to “pay attention” or to “focus.” Ed mentioned that he “buckled down and paid more attention in class.” Ken said he had learned “how to focus” and that has helped him to do well. As mentioned, Terri thought her classroom seating position helped her “to focus more,” because distractions were minimized. Tim said that “paying attention when someone is instructing” was very important to his success. His mind set had become, “I have to pay attention. I have to focus.” Pete knew that the only way to understand is to pay attention. He said simply, “If I focus, then I can follow along.”

Evidence of students’ focusing was apparent in the way they took notes in class. As the researcher observed the students, she noticed that all of the students had notebooks open and were taking notes as the teachers presented the mathematical concepts. They were looking at the white board and copying what the teachers had written and they were also writing additional notes about the teachers’ verbal comments that were not written on the board. When questions were asked, they wrote down the teachers' responses. The researcher noted that this process of continual note-taking kept the students engaged.

Students had to be paying attention to answer the teachers' questions. In many of the classes, the teachers used a question-answer format to teach a concept. They asked a question directed to the whole class and students responded verbally aloud. Many times the teachers asked a question equivalent to "What comes next?" Example of student responses included: "Do parentheses first." "Add six to both sides." "Set it equal to zero."

Students also exhibited their engagement in the way they asked questions. When students did not understand a concept being explained, they stopped the teacher with a question. Some examples of questions the students asked are: "Can you repeat that one more time?" "Can you explain that again?" "How did you get that?" "Why is that?" "Why did you put a negative three in instead of a positive three?" "Do you have to break years into months?" "When you take the square root of both sides, why do you have to do plus and minus?" When a concept was not understood, the students did not hesitate in asking questions until they did understand.

Students also used questions to make sure that they were grasping the concept correctly. "Do all basic exponential functions go through the point (0,1)?" "So in composition of functions, you really work from the inside out?" "Could you go over example three in the book? I want to make sure I'm understanding it right." "Can you always treat ten to the negative 7 as one over ten to the 7^{th}?" "Does S stand for sample space?" Students gave the teachers feedback when they understood. "OK. I get it." "Got it!" "That makes sense." "Oh, OK."

The researcher observed that these students extended their thinking beyond the example being shown by the teachers. For example, in a probability discussion, Sue asked, “Does this come into play in other situations besides cards? I’m trying to think of a real life application. Does this work with ‘Deal or No Deal’?”

The teachers also relied on the successful students to help them in their explanations. When Mike’s teacher did not understand another student’s question, Mike explained to the teacher what the student meant, and then the teacher was able to successfully answer him. When a student could not follow the teacher’s presentation of a concept, Lisa’s teacher asked, “Who can help to explain this?” She then explained the concept correctly to the student. Kim’s teacher asked the students in the class how they could tell if they had a one-to-one function from the graph. When no one answered, he said, “Come on Kim. Let’s hear it!” She responded correctly, “The horizontal line test.” Kim’s teacher also had the students work in groups. The researcher observed that Kim explained how to work some problems to the others in the group and answered their questions when they did not understand. Terri caught a mistake her teacher had made on the board and corrected him right away. It saved the teacher from the embarrassment of working through the whole problem and getting a wrong answer and it saved the students from confusion. The reliance shown by the teachers added to the students’ confidence and their feeling of success.

Study habits. When students were asked what learning strategies have helped them be successful, the most common answer was doing the homework consistently. Students mentioned that doing the homework as soon as possible after class helped solidify concepts for them. To understand some concepts, many of them said they did more problems than assigned. If they still did not comprehend, they got help right away. The students saw the purpose of homework as a steppingstone to their understanding.

Ed stated that the most important learning strategy was to “do the homework right when it’s assigned,” and if he started missing “the questions on the homework, to sit down with the teacher ...and get one-on-one help.” Lisa also mentioned that her first learning strategy was “keeping up on the homework and asking for help when I need it.” Pete set aside a specific time every day to do his math homework. If he needed help, he either contacted his sister-in-law, who helped tutor him or went to the math lab. Terri also indicated that doing her homework daily was on her list of learning strategies. “I think staying on task, doing the work when it’s assigned. Don’t wait until the last minute, when it’s due. Probably just keeping up on it, looking over it,” and when help is necessary, “make time to talk to my teacher.”

Mary found that doing the homework before class reinforced her understanding and enabled her to have prepared questions for her teacher in class.

> I do the homework before class that we will be discussing and try to understand the concepts before I go to class. That way if I have any questions, he can answer them in class.

A strategy Sam and Jeff found effective was to do their homework immediately after class.

> What I tried to do was space my classes out to where I had—I did this for the first two semesters, but I wasn’t able to this semester—space it to where after math class, I had at least an hour to just go straight to the math lab and work on my math right after class, so obviously that’s the best thing because it’s already there in your head. You’ve already been thinking about it for the past hour. You might as well work on your homework that you’ve done, and it just kind of locks it in

> there and helps me out a lot better. That's what I did for the first 2 years. This year, I wasn't able to do that and I've noticed the difference. Going to do my math homework a couple of hours later, a day later—not a good idea. I don't recommend it. (Sam)

> Doing homework immediately after lecture. That is crucial! ...But, do homework immediately after because when you're sitting in the lecture, that's just auditory learning. You need to be doing something motor, at least for me, to really get it down. (Jeff)

Students pointed out the benefits of the "repetition" experienced in the homework. Amy, Jeff, and Sue stated that they did more problems than necessary to understand the concepts.

> Repetition—just doing it over and over and over again. Not necessarily the same problem, but problems like it. OK. Do this problem. Here's another like it. Do it. Then here's another. Do it. I do more problems than are assigned to study for tests so I make sure I understand the concepts. If there is a concept I'm not sure on, I will do more problems if I have to. (Amy)

> Well if you're not getting it, for me, you need to do more than just the assigned homework, if you're not understanding it. If you're really understanding it, sure just do the assigned homework, but if you're not, then do all of the homework. Do all of the chapter review. Do all of that. I kind of overkill it. (Jeff)

> I'd work all the time from the time I got home until late at night. I'd work really hard, going over it, reviewing for tests. And I'd always do all the homework. And M. doesn't even assign all the homework, but I do all of the odds, specifically just so I can see if I can get it and then I can check the answer to make sure I got it. (Sue)

Ken mentioned the continual practice provided by the homework made a difference for him. "Just a lot of practice with the stuff. Professor W. assigns a lot of homework. That really helps a lot." The practice and repetition the homework provided engrained the mathematical concepts in the students' minds.

Kim stressed the importance of doing homework and getting help when not comprehending. Kim realized that the purpose of homework was not to insure passing the class but to aid in understanding, a marked difference from her high-school thinking.

> Mostly, just actually doing my homework like consistently. Doing homework and getting help on problems that I don't understand, instead of just skipping over them and then thinking, "Oh, well that's just one thing. I can still pass, but not have to know that subject that I don't understand."

Sam contrasted his high school experience where he did the homework just to get it done and now realized that homework is necessary for comprehension.

> Instead of just doing it and getting it over with, just doing it and making sure I understood it. Now, I make sure I understand it while I'm doing it instead of doing it, looking in the back of the book, getting the wrong answer, and then just fixing it, because that's what it says in the back of the book. I make sure I get the right answer and understand why they got that answer instead.

Tim expressed his homework experience in high school as "going through the motions" and his method now as doing his "homework effectively." His homework strategy entailed doing the homework so he understood the concepts.

> How to do your homework effectively so it's not just going through motions. "OK, my teacher expects me to turn in problems one through thirty. I'll do one through thirty and that's it. And I'll never look back on the homework and never put more effort to it." But to actually do homework and learn and to pay attention, I think that's what's made a difference for me.

The students realized the importance homework plays in understanding and recognized that it might take extra time and effort and even sacrificing social or other opportunities. Sam remarked about the amount of time he has invested in learning mathematics. "Time is a big thing. I put time into it.... If I had put as much time into high school as I do now, I would have been valedictorian." John realized that learning mathematics requires work.

> Math is a lot of work. You have to do your homework. You have to study.... That's the good thing about math. If you put in the work, then you will get the grade. If you don't, you won't. It's as simple as that.

Sue commented on the amount of time and work she has spent in understanding mathematics.

> I work really hard, really hard. I spend a great deal of time in the math lab. And I double the time I spend—I spend that much time at home. And I'll ask questions in class, because if I don't understand what's happening, I have to either keep working at it until I figure out the reason or I, you know, I have to work hard for it. And I have to know it in my mind or it doesn't stay there.

Mike referred to his effort and work as "diligence." He was amazed at the people in his class who were not willing to make the effort required to understand.

> Diligence. I mean there is a lot of diligence involved with it.... There are a lot of people in there that could pass the class but they don't put the work in that's required to do it, and I think to myself, "Why am I doing so well? Why is it coming so easy for me?" And it's because I'm putting the time in. I'm actually trying to understand it than just taking it and redigesting it. And so, I think there's a lot of diligence that goes into it as well.

John noticed the same type of students in his math class.

> I look around at the kids in my math class. They don't do their homework. They get C's on every test. They're barely passing. At first, I found myself thinking, "What are they doing here? Why are they not working?" ...They're here to meet girls and boys and go on dates and have fun and they're only in math because they have to be.

Pete realized the importance of "dedicating time" to doing homework and was willing to give up being with his friends to get his homework done. "My actions are different now. Somebody will call me up to hang out and I'll say, I have to do my homework first. That's a big thing right there. I'm more committed to school now than I was before."

Many of the students stressed the importance of understanding a concept before moving onto a new one. They viewed it as strategic to their progress and their success. Kim said that she has become successful by "just doing my homework and making sure that I understand the concepts before I try to move on to something different."

Jeff felt that understanding was essential before trying to learn a new concept.

> But I think also the other thing is that when you don't understand something, I find a lot of students just say, "Oh, OK." And move on. You have to stop, even if it means you slow down or even if I don't get my homework done, it doesn't matter. There is no point in keeping going if I don't get this concept, if that makes sense. I would much rather get a lesser or lower grade on a homework assignment because I had to spend more time getting this concept understood and get a better grade on a test than to rush through and go to my solutions manual and just write a bunch of answers down and not truly understand what is going on. Don't move on until you understand it. Math builds on itself. You have to understand what you learn today so you can understand what's being taught tomorrow.

Those students who were involved in study groups also found them effective in aiding their mathematics understanding. Terri was involved in a study group the previous semester and ended up being the tutor for the group. She explained the benefits she gained from it.

> Actually last semester with intermediate algebra, I ended up helping do a study group. I was the tutor, which helped me, but it also helped them. You know when you are explaining it to others, it helps you learn more. So, we are doing it again this semester with a couple of kids from my class. So, that's definitely helping.

Sam has also been involved in the same study group for two semesters. One of the advantages has been teaching one another. When asked what learning strategies had helped him, Sam gave this response.

> Teaching other people. We kind of have a group of friends. There's a couple of us that went from beginning algebra all the way. We're still in the same class intermediate algebra. And a lot of times, they won't get it. I'll get it, and I'll explain it to them until they get it. That helps me because I teach it to them. And then if I don't get it, they explain it to me and I get it. So we kind of have a little circle going on. So, it helps me to teach obviously.

In the process of the interviews, several students alluded to how they prepare for exams. John said he spent time on sample exams his teacher made available to him. Kim also completed the chapter test available in her textbook.

> I know that in my current math class, we have chapter tests in the book. Doing those before I take the exams, I find it really helpful, because it reviews things from the beginning of the chapter that maybe I don't remember quite as well because it's been awhile.

Lisa shared her strategy for preparing for an exam.

> I've kind of come up with a system like when I study for tests, we get the review. And as I go through the review, everything that I feel confident in, I just check off. And I don't go back and review that again until right before the test. I don't muddy my brain with what I know. I just focus on what I don't know and slowly eliminate that. To have that structured approach has really been helpful.

All of the students had developed strategies that helped them learn, understand, and engrain the mathematical concepts in their minds. Doing homework consistently was a major strategy touted by all the students. Dedicating time and effort to doing the homework was important in being successful, because doing homework "effectively" meant increasing comprehension and understanding. If students still did not understand right away, they obtained help. They knew that they could not "move on" until they understood the concept.

In addition to homework, students developed strategies on how to prepare for exams. Some of the students were involved in study groups and tutoring one another. As mentioned previously, the students also used the learning resources available such as the math lab and outside tutors.

K-12 Changes

When students were asked what changes in their K-12 math learning experiences would have helped them be successful, many of the students stated that a change in attitude and in motivation would have made a difference. Those were personal changes that students themselves would have to make. There were, however, two changes in the learning environment that students felt would have helped them. First, students suggested that if they had been more closely monitored, their learning difficulties might have been diagnosed earlier, making it possible for them to overcome them and progress much sooner. Second, many of the students indicated that it would have been very helpful to have a math lab as a resource in their elementary and secondary education.

Monitoring. The term “monitoring” was actually used by some of the students in their description of how they wished that teachers would have recognized their learning difficulties and then given them the extra help to overcome them. Amy’s struggles began in elementary school, which is where she focuses her suggestions. “But I guess in elementary school, the ones that struggle and are the lowest, the teachers should put more time aside to help those students out.”

Tim also mentioned that if his teachers had expressed interest in helping him personally, it would have made a difference.

> Maybe they needed to be a little bit more personable and take more time, not just instructing in general, but instructing the individual and helping me out personally. “Look Tim. I can see that you’re falling asleep or that you’re showing up late. What do I have to do to get you to my math class on time?” or “What do I have to do so that you understand this concept?” Not just be, “Well, I taught it in class, so if you didn’t get it, go home and do the homework. Ask your mother or something.” Maybe if it would have been a little bit more personal, the instruction, then I think it would have been better for me.

John felt his teachers “could care less” about his progress in high school. He said he “only had one teacher who cared.” Mike also commented about the teachers’ interest in his learning.

> If I could have seen that they were just regular people like me and that they really were trying to teach me the things that were going to help me out and just given me the applications, I think that would have made a huge difference for me.

Sue stated that teachers who were "interested in her learning and not just trying to pass the class or pass the time" would have made a difference in K-12 education. The researcher noted that these students were actually expressing that in their view the teachers not monitoring them was an expression of their lack of caring. Some of the students realized that with such large classes, they knew that teachers could not reach everyone.

Lisa said that if she had been properly diagnosed when her difficulties began, she might have been able to develop tools to handle those difficulties.

> I think that if I had been monitored more carefully all the way through, starting in sixth grade, or when I started to flounder, I think that if I had been *monitored* and tested to see how I learn to see where my learning strengths were or where my learning weaknesses were. Because, first off, I would not have had the all-encompassing feeling that I was dumb. I would have had some reason—Oh, my processing skills are slower than average—so therefore I am going to need—I would have more tools.

Ed stated that if there had been someone who could have helped him see a concept he was missing in his K-12 experience, it would have helped his learning.

> I know the concept and I'm actually doing it right; I just have missed one little thing. I've made an assumption I shouldn't have or maybe I've missed one small concept that is integral to the entire problem. And to have somebody there who can see that would have helped. From kindergarten through high school, having somebody there or at least having access to somebody who could do that would have helped a lot.

Pete shared an experience of the elementary school monitoring and diagnosing of his speech problem. After it was diagnosed, he was sent to the speech counselor for extra instruction and practice. He suggested that type of monitoring for mathematics difficulties.

> In second grade, I remember—this has nothing to do with math, but you will see how it applies—I remember I had a problem with my S's. I couldn't say S. And then my teacher saw that, and she referred me to a counselor, to where I went to counseling every three days or something. I remember those counseling activities were fun. I liked them actually, and then if I had something like that with math, that would have been great. If there had been that kind of one-on-one help in math like I got for my S's. If my teachers would have—not that I'm blaming it on them because it's my fault that I didn't learn math; I don't know if I should even blame myself—but maybe if they would have noticed a little bit, they could have referred me to someone--kind of like my speech tutor did way back when with my S's.

Consistent monitoring of students would have helped students earlier to recognize and overcome their math learning difficulties. The perceived lack of monitoring translated to the students' minds the teachers' lack of caring. When questioned, very few of the students were aware of any monitoring in their behalf during their K-12 experience. Only one student mentioned being placed in a lower level math class, but none of the others mentioned any extra resource counseling to aid them with their difficulties. To express it simply, they wished they would have been "caught" and helped earlier.

Math lab. Many of the students felt the math lab was a very helpful resource in aiding them to be successful. They did not understand why such a resource was not available to them in their K-12 experience. They thought the math labs in K-12 could be patterned after the college math lab and that they would be a great help to struggling students there.

When asked about helpful K-12 changes, Amy suggested the creation of "a lab for so many hours just dedicated to the students like our math lab here." John did not understand why there are no math labs in K-12.

> I don’t understand why there’s no math labs, math tutoring help, in secondary education. It’s beyond me, because that’s the first time those kids have ever seen that before. Now everybody who is here has already done all this math before until you get to like calculus. So if anything, there should be a math lab just for that. But you can go into the math lab and study arithmetic review for the most simple things. I can’t think of a reason that there is not a math lab in every high school and every junior high, especially with like the “No Child Left Behind” thing and all that crap that the teachers have to teach to, to pass the test and get the numbers. It’s beyond me. I don’t understand it. But that would have been another huge help, if you could actually go to a place and do homework there with people who knew what they were doing, it would have been really good.

Sue also felt that a math lab would have been very helpful for her K-12 experience and for others as well, specifically her children.

> I think it would be helpful to have a math lab. Truly, I do. And when my daughter, she’s in precalculus at the high school, I can’t help her. I have no idea how to help her. And my oldest daughter can, because she’s taken a couple of calculus courses at BYU. She can help her, but I am always thinking, “Why isn’t there a math lab?” Because even the littlest kid in elementary school could easily benefit from the tutors. The tutors are very good and they are very patient and they let you figure it out one little step at a time and maybe give you little clues as you go along and that would be very beneficial, I think. So, a math lab from the very beginning of time!

The suggestion of a math lab demonstrates the students’ perception of the effectiveness of the math lab in their own mathematics learning. The students envisioned a math lab organized and arranged much like the one at their college with all its accompanying resources. Capable tutors, study group rooms, workshops on test anxiety and troublesome math concepts, computers with the online math program, and online white-board tutoring were some of math lab resources available to these students. These students were confident that a math lab would have helped them had it been available to them.

Common characteristics were exhibited by all the successful students interviewed. The students placed a value on education, realizing its importance in being able to achieve their vocational goals. All the students recognized the importance of understanding mathematics in order to pursue their goals in education. All but one had chosen a major and they were committed to their educational program, even if it involved successfully completing several mathematics courses. Each student was field independent and took a proactive role in achieving mathematical understanding.

When students were successful, they were all motivated to learn mathematics. They could see how math was applicable to them. Their attitude towards learning mathematics changed and they found a confidence that they could succeed. They developed strategies for learning mathematics. All the students mentioned that they had good teachers who provided a positive learning environment. The students were proactive in seeking out resources to help them learn and in developing effective learning strategies.

CHAPTER V

DISCUSSION

The purpose of this phenomenological study was to examine developmental students' unsuccessful and successful experiences of learning mathematics. To gather information about this phenomenon, fourteen developmental mathematics students at a 4-year college in the western United States were interviewed and observed in their classrooms. There were eight males and six females ranging in age from 19 to 51. Half were age 23 and below. The other half were 25 and above.

The students chosen to participate in the study possessed common characteristics of developmental mathematics students enumerated in the literature review chapter. In their unsuccessful experience, all of the participants lacked academic skills and had a poor attitude. Many had a lack of vision of what they would do after high school. Some had decided they would choose a career requiring no math. Most remembered no counseling or resource help.

Kinney (2001) suggested that students arrive underprepared because they either did not take the relevant courses in high school or if they did, they did not master the content. If they did master the content, they forgot what they mastered. Each of the students interviewed had one or more of those experiences. Some avoided taking any more mathematics courses than necessary to graduate from high school. Many of them barely passed their high school courses enabling them to graduate but did not master the content, and many had forgotten much of what they had once known.

It should be noted that the students' unsuccessful experiences occurred before they reached adulthood, ranging in the spectrum of early elementary school to high school. They did not have much control over their learning environment. They had few responsibilities. They depended on teachers to transmit knowledge to them. Head (1981) described their situation. “Prior to adolescence the child has few decisions to make of his own; his social class is that of his parents; his timetable is chosen by school; his beliefs come from parents and peers” (p. 339). They exhibited the characteristics of field dependent learners, which Brookfield (1986) described as “extrinsically oriented” and “responsive to external reinforcement” (p. 41). “Field dependents make greater use of mediators in learning and experience greater difficulty in learning material in the absence of an imposed structure for learning than do field independent learners” (Brookfield, p. 41).

The researcher noted in her journal that as students described their unsuccessful experiences in trying to learn mathematics, their frustration in not being able to control some aspects of their learning environment was evident as they spoke. For two of the students, the class size was too large, which essentially prevented the teacher from giving them the attention they needed. Several of the students felt that since their parents could not help them and their teachers “were not very good,” they saw no way to get the help they needed to understand. The researcher wrote, “The students seemed to express that they were trapped in their particular learning environment, which ironically prevented them from learning.” Because they were children or adolescents when their negative experiences occurred, they were of necessity field dependent and felt incapable of changing their learning situation. “It was as if they were crying for help but no one could hear their pleas."

The students' frustration soon gave way to a feeling of helplessness. Not knowing how to change their situation, they began to reluctantly accept it. Each unsuccessful experience stifled any motivation they might have had to learn. The resulting helplessness seemed common to all the students. One student expressed it as "it got to the point where I just was giving up and running away from it." The researcher noted that "giving up" trying to learn mathematics was shared by all the students in their unsuccessful periods.

The students' successful experiences happened in their adult years. In the process of time, changes have naturally occurred in their lives. These adult learners would be classified as field independent learners, who are "analytical, socially independent, inner-directed, individualistic, and possessed of a strong sense of self-identity" (Brookfield, 1986, p. 41). Adult learners were described by Malcolm Knowles in his theory of andragogy (Brookfield). They have demands on their time and family and vocational responsibilities. They are self-directed learners who come to class with many experiences. They want to learn and they want to see the applicability of what they are learning. They have a choice of choosing what they want to study and many times can choose particular learning environments. Table 4 summarizes some of the differences specified by Brookfield between pedagogy and andragogy.

As adults pursuing a college education, these students had control of choosing their major field. They had control in choosing their teachers and changing teachers if they felt they could not learn well with them. They were empowered to seek out learning

Table 4

Comparison of Andragogy and Pedagogy

Category	Andragogy	Pedagogy
Demands of learning	Learner must balance life responsibilities with the demands of learning.	Learner can devote more time to the demands of learning because responsibilities are minimal.
Role of instructor	Learners are autonomous and self-directed. Teachers guide the learners to their own knowledge rather than supplying them with facts.	Learners rely on the instructor to direct the learning. Fact based lecturing is often the mode of knowledge transmission.
Life experiences	Learners have a tremendous amount of life experiences. They need to connect the learning to their knowledge base. They must recognize the value of the learning.	Learners are building a knowledge base and must be shown how their life experiences connect with the present learning.
Purpose for learning	Learners are goal oriented and know for what purpose they are learning new information	Learners often see no reason for taking a particular course. They just know they have to learn the information.
Permanence of learning	Learning is self-initiated and tends to last a long time.	Learning is compulsory and tends to disappear shortly after instruction.

resources to aid them. They exercised their choice to ask questions in class that would aid their understanding. As the researcher interviewed the students about their successful experiences, she sensed a determination that was not present before. Being able to “have a say” in how they were learning seemed to fuel their motivation to learn. They chose to expend time and effort to learn believing that this time things would be different because now they had a voice and could express it and they knew it would be heard.

In the course of investigating the unsuccessful and successful experiences of the participants, five themes emerged in the analysis of the data: *turning point, attitude, motivation, learning environment,* and *learning strategies.* Each of these themes is discussed separately with some overlap. Attitude and motivation are closely linked together in the literature and in the results of this study.

Turning Point

As revealed in the interviews, each student came to a definite turning point in their learning of mathematics. The students could recall the grade level in which the learning difficulties began. In most cases, they could pinpoint the actual concepts that were troublesome. This turning point not only impacted the students' achievement, but it affected the students' beliefs about their own capabilities in determining success or failure. Attribution theory attempts to explain the cognitive processes a student undergoes in coming to those beliefs.

Driscoll (2005) explained the basic premise of attribution theory.

> The central assumption of attribution theory...is that the search for understanding is the (or a) basic "spring of action" (Weiner, 1979, p. 3). In other words, people attempt to understand the causes for their successes and failures, and their attributions about these causes determine their future actions. (p. 326)

There are three facets within attribution theory: "internal versus external, stable versus unstable, and controllable versus uncontrollable" (Driscoll, 2005, p. 326). Internal causes refer to characteristics within the individual such as ability, effort, or attitude. External causes are conditions outside the person such as assignment difficulty, help from others, teaching or classroom environment. Stability refers to how easily changed a factor may be. Ability is inclined to be more stable, but effort or attitude is more readily changed and tends to be unstable. Controllability is "the degree to which the individual has control over the causes of success or failure" (Driscoll, p. 326). A student determines the amount of time and effort expended to study for an exam. Exam preparation is controllable. The test difficulty is not controllable.

Motivation psychologists theorize that everyone has one of two basic internal orientations that Dweck (2006) called mindsets. The fixed mindset is the belief that an individual’s talents and abilities are completely fixed or stable. One either has them or one does not. A person’s failure is explained by lack of ability or talent. In the same way, a person’s success is touted by the presence of ability or talent. A person with a fixed mindset spends his life trying to look intelligent and talented (Dweck). “The growth mindset is based on the belief that your basic qualities are things you can cultivate through your efforts” (Dweck, p. 7). The growth mindset concedes that people may vary in talents, aptitudes, abilities and interests, but “everyone can change and grow through application and experience” (Dweck, p. 7). In other words, ability is viewed as unstable and malleable.

When attribution theory is applied to learning mathematics, there are two internal orientations for learners—mastery or performance (Driscoll, 2005; Middleton & Spanias, 1999; Turner et al., 1998). A student with a performance philosophy has a fixed mindset and believes that success is completely determined by ability. Since students tend to see ability as stable and uncontrollable, their success and failure are explained and in essence not changeable (Driscoll; Middleton & Spanias; Turner et al.). “Students who adopt ability-focused goals interpret success as a reflection of their scholastic ability and a comment on their self worth” (Turner et al., p. 759).

Performance-oriented students taking a math class maintain that their success is due to their ability, and they would say they failed because they lack the ability. Because they lack the ability, which in their view is stable, there is no point in trying. The next concept cannot be understood because the last one was not comprehended. Failure is inevitable. Students have put themselves in a state of "learned helplessness" (Middleton & Spanias, 1999). Students interviewed in this study evidenced this orientation in their unsuccessful experience. One student said she signed her name on the tests and handed them in without answering any questions. She felt like a failure because she did not feel capable of learning. Another student said math was "more than she could take." Other students expressed the futility of going to class because they knew they would not learn anything.

A student with a mastery orientation has a growth mindset and has the belief that the improvement of a skill or knowledge depends on working hard, trying to understand mathematical concepts, developing learning strategies, and collaborating with others (Middleton & Spanias, 1999). This view suggests that ability is malleable and is shaped by effort and attitude (Driscoll, 2005). Students with this orientation have "learning-focused" goals (Turner et al., 1998).

> Students who adopt learning-focused goals define success as developing new skills, understanding content, and making individual progress. They believe that increased effort will lead to understanding and academic success. Because mastery-oriented students want to develop new competencies, they regard errors as constructive rather than debilitating. They exploit mistakes as information about the need to reevaluate themselves, the task, or their strategies. (p. 759)

Beliefs about mathematics and how to learn it can influence whether a person is learning or performance focused (Middleton & Spanias, 1999). Mathematics may be considered as a fixed body of knowledge where students tend to develop strategies of memorizing facts and procedures with the goal of getting the correct answers.

Mathematics may also be viewed as a process where students begin to construct relationships between concepts and develop patterns of understanding, which become their own (Middleton & Spanias). The successful students in this study had gravitated to the latter view, which is a reflection of David Paul Ausubel's (Driscoll, 2005) theory of meaningful learning.

Ausubel's research was built on the premise that new learning takes place most effectively when it fits into schemes that already exist in student's minds. "Anchoring ideas are the specific, relevant ideas in the learner's cognitive structure that provide the entry points for new information to be connected" (Driscoll, 2005, p. 117). New information is connected to the anchoring ideas in three possible ways:

1. Derivative and correlative subsumption
2. Superordinate learning
3. Combinatorial learning (Driscoll)

In the first category, new ideas are subordinate to an anchoring idea that is already in memory. When new examples or experiences reinforce a previously learned concept, derivative subsumption occurs. When new ideas extend or modify a previously learned proposition, correlative subsumption happens. Superordinate learning refers to the subsuming of already learned ideas into a new inclusive concept (Driscoll, 2005). When the new idea does not specifically relate to a current anchor but is relevant to a broad spectrum of information, combinatorial learning occurs (Driscoll).

Ausubel developed label assimilation theory to explain the learning processes exhibited in subsumption, superordinate learning, and combinatorial learning. The process of retaining the information so that it was easily accessible to use at later times was also part of his assimilation theory (Driscoll, 2005). Speaking of retention and meaningful learning, Ausubel, Novak, and Hanesian (1978 as cited in Driscoll) stated, "The result of the interaction that takes place between the new material to be learned and the existing cognitive structure is an assimilation of old and new meanings to form a more highly differentiated cognitive structure" (p. 67-68, as cited in Driscoll, p. 123). For Ausubel, what the learner already knows is the single most important factor influencing learning (Driscoll).

Ausubel's ideas were extended to schema theory (Driscoll, 2005). "Schemata are packets of knowledge, and schema theory is a theory of how these packets are represented and how that representation facilitates the use of knowledge in particular ways" (Driscoll, p. 129). Schemata not only involve cognitive structure and the associated mental models but the learners' perceptions of the learning experience as well (Driscoll). As with Ausubel's theory, schema theory operates from the proposition that the most effective learning takes place by starting with what the learner knows and making meaningful connections with the new idea being introduced (Driscoll).

The successful students in this study confirmed this premise. Students mentioned that their placement in their math classes was accurate; that is, their placement course matched their present knowledge and skills. If they had been placed in a higher course level, they all agreed that they would not have been successful. The students were able to relate what they did know to new concepts being taught. As one student described why he thought he was successful now, he said, "One big thing is that I'm starting where I *can* start." He was starting from the concepts he knew and connecting them to the new ideas he was learning, and he was successfully making those connections.

In their successful experience, the students in this study exhibited the growth mindset or mastery orientation. They believed that if they put forth the effort and made sure they understood concepts, they would be successful. Many of them said that it was important not to move on until they understood the present concepts before them. They invested the necessary time and made use of the available resources that would bring them that understanding.

When students experienced a turning point to their successful experience, they mentioned internal and external causes for their change in orientation. The men in this study stated that they changed their goals in education due to present and future responsibilities to their families. The women wanted to pursue an educational field that they would enjoy and that would insure financial security. In examining career development theoretical models with respect to gender, Coogan and Chen (2007) concluded that motivation for educational goals do vary from males to females due to early gender-role emphasis and family responsibilities.

The students' goals definitely influenced their philosophy of how and why they would succeed or fail. "Goal orientation has been found to be a strong predictor of achievement" (Middleton & Spanias, 1999, p. 74). In this study, when unsuccessful, the students had a goal to try and pass their mathematics courses in elementary and secondary education, many of them believing their lack of ability explained their mathematics inadequacy and that their goal may not be achievable. The successful students had goals to pursue educational fields which would not only provide financial security, but ones in which they would be interested and ones they would enjoy. They knew they would need to understand what they were learning to successfully complete their goals. These types of goals fostered the mastery orientation exhibited by most of the students.

Goals and beliefs heavily influenced the students' turning points. "An individual's intrinsic motivation is mediated through the types of goal structures he or she has created" (Middleton & Spanias, 1999, p. 73). Goals and beliefs are therefore heavily tied to an individual's motivation, which is the next theme discussed.

Motivation

When students in this study were asked their opinions on why they were successful now when they had not been successful before, the most common reason given was motivation. Contrary to the researcher's assumption that learning environment would be the favored response, motivation was the number one answer. In their eyes, motivation was *essential* to their success.

At one time motivation was a prominent field of study in psychology (Driscoll, 2005). In the 1930s and 1940s, psychologists defined motivation as "what moved a resting organism to a state of activity" (Weiner, 1990, p. 617 as cited in Driscoll, p. 310). This definition supported the theories of learning proposed by the radical behaviorist, B. F. Skinner, who proposed that behavior could be learned by providing the right stimulus and reinforcement. The purposive behaviorist E. C. Tolman demonstrated that learning is possible without motivation. In his experiment, two groups of rats were allowed to explore a maze. One group had the stimulus of food; the other did not. Both were able to find the end of the maze. On a subsequent trial, food was put at the end of the maze. The group who had previously had no food motivation found the food as quickly as the "trained" rats. Tolman's experiment showed that learning could take place without clear motivation (Driscoll). Then psychologists contended that motivation was connected to the use of knowledge, not so much to its development.

Cognitive psychologists began to investigate motivation with respect to learning in the 1960s and 1970s. Finding that rewards for behavior did not consistently yield desired behavior, they began to concentrate on the "human's need for achievement" (Driscoll, 2005, p. 311) as the focus of their research. Achievement motivation or incentive motivation was defined "to be a fundamental tendency of humans to manipulate, dominate, or otherwise master their environment" (Driscoll, p. 311). Researchers found that external and internal orientations influenced motivation. Internally oriented students exhibited greater motivation than externally oriented students (Driscoll).

Because of its unmistakable connection to learning, motivation continues to be the subject of research. As motivation research has evolved, so has the definition of motivation. Originally, it was what moved someone from a resting state to activity. Now researchers have devised different definitions depending on their particular paradigmatic orientation. Hannula (2004, as cited in Sullivan, Tobias, & McDonough, 2006) stated that motivation was "the potential to direct behavior that is built into the emotion control mechanisms. This potential may be manifest in cognition, emotion and/or behavior" (p. 24 as cited in Sullivan et al., p. 82). Attitude, which is encompassed in the construct researchers call "affect," plays a significant role in this theory. The significance of emotion as characterized in the affective domain is discussed in the attitude section.

Other definitions emphasize belief and goal orientations and the associated cognitive processes as part of a person's motivation.

> Simply stated, motivations are reasons individuals have for behaving in a given manner in a given situation. They exist as part of one's goal structures, one's beliefs about what is important, and they determine whether or not one will engage in a given pursuit. (Middleton & Spanias, 1999, p. 66)

This view has already been discussed in connection with students' goals. During their unsuccessful experience, students had the goal of passing their math class, but because they had a fixed mindset, passing hinged on their ability, which they saw as lacking and unmalleable. Consistent failures reinforced students' beliefs that they lacked the ability to learn, sending them into a state of learned helplessness. "Past experiences, often times failures, in mathematics usually dictate student opinions concerning their perception of personal ability in mathematics" (Hall & Ponton, 2005, p. 30). Personal belief in the ability to organize and perform actions that produce outcomes is defined as self-efficacy (Hall & Ponton).

Bandura (1997, as cited in Driscoll, 2005) stated that self-efficacy beliefs

> influence the courses of action people choose to pursue, how much effort they put forth in given endeavors, how long they will persevere in the face of obstacles and failures, their resilience to adversity, whether their thought patterns are self-hindering or self-aiding, how much stress and depression they experience in coping with taxing environmental demands, and the level of accomplishments they realize. (p. 316)

When unsuccessful, the students believed that learning mathematics was beyond their capabilities. Consistent with Bandura's (1986) description of choice behavior in self-efficacy judgment, these students avoided mathematics learning tasks. When successful, the students were confident they could understand mathematics concepts and demonstrate their acquired skills. "The stronger their perceived self-efficacy, the more vigorous and persistent were their efforts" (Bandura, p. 394).

Research has verified the connection between students' mindset, motivation, and achievement. In a study involving third, sixth and eighth grade cohorts, Skaalvik and Valas (1999) found that "in the two oldest cohorts, motivation was affected by previous achievement" (p. 135). Klomegah's (2007) study of 103 undergraduate students at a North Carolina university ascertained that university students' high school grade point average and self-efficacy "were strongly correlated with academic performance" (p. 407). Most of the students interviewed had this fixed mindset about their failure by the time they were in high school, which supports what has been reported in the literature.

> By middle grades, many students begin to perceive mathematics to be a special domain in which smart students succeed and other students merely "get by" or fail. They begin to believe that success and failure are attributable to ability and that effort rarely results in a significant change in their success patterns. (Middleton & Spanias, 1999, p. 69)

As pointed out in the results, other influences affected their belief system as well. Several students mentioned they had no support system at home. Their parents could not help them. Underlying their belief structure may have been the thought that their parents also did not see the value of learning mathematics since they were lacking in skills. One student said his parents did not really see the value of education, not having gone any further than high school themselves, and therefore encouraged their children to start working after high school. Others indicated that they could not see the applicability of mathematics in their lives and therefore did not see how it would help them with their present goals. The importance of learning mathematics was tied to its applicability, which concurs with the findings of Schweinle and colleagues (2006) who concluded that the "importance of a task is more relevant to motivation than is its challenge" (p. 271). Glasser (1998, 2000) maintained that applicability is an integral part of education. "Education is not acquiring knowledge; it is best defined as *using* knowledge" (Glasser, 1998, p. 238).

Because these students' beliefs and goals did not support mathematics learning, the actual reason to learn came from an external source. In a structured-learning environment, there are two types of academic motivation—intrinsic and extrinsic. Middleton and Spanias (1999) described extrinsically motivated students as engaging "in academic tasks to obtain rewards (e.g., good grades, approval) or to avoid punishment (e.g., bad grades, disapproval)" (p. 66). Cangelosi (2000) stated that extrinsically motivated students do not engage in learning activities "because they recognize value in experiencing the activity" (p. 238), but because they want the expected reward or they want to avoid the corresponding punishment if they do not participate.

When students in this study reflected on their unsuccessful experience, they came to class because they "had to be there." They found it to be a "waste of time." When they found themselves incapable of being successful, they tried to avoid disapproval. It should be noted that students' goals in high school were "to get through it." Their goals were not constructed with a "vision of the future." Since they had a fixed mindset, they did not see the value of participating in the academic tasks.

When students were successful, students had established definite educational goals. Many of them had chosen majors that required much more mathematics than the minimum required for graduation. Consequently, learning for understanding became the underlying tenet of their motivation. As students found success in understanding, their motivation seemed to be enhanced, which supported the results in Miller's (2000) study of successful developmental mathematics students. As discussed earlier, their mindsets had changed to a growth orientation and thus they were mastery oriented. Their academic motivation was primarily intrinsic. Meece, Bleumenfeld, and Hoyle (1988, as cited in Middleton & Spanias, 1999, p. 73) asserted, "An individual's intrinsic motivation is mediated through the types of goal structures he or she has created."

Students who are intrinsically motivated "engage in learning 'for its own sake'.... Their motivations tend to focus on learning goals such as understanding and mastery of mathematical concepts" (Middleton & Spanias, 1999, p. 66). Intrinsically motivated students see the academic task "as directly beneficial. The learning activity itself is perceived to be valuable" (Cangelosi, 2000, p. 238). Five of the students mentioned that they could see the applicability of what they were learning to their field of study and to their everyday lives, indicating that their learning and understanding had become personally valuable. All the students recognized the importance of understanding for their educational goals.

Although the primary motivation for learning was intrinsic for these students, there were secondary external sources that also influenced them. Many of the men mentioned their families and the responsibilities of supporting them as extrinsic motivations for learning. Extrinsically motivated individuals want to obtain favorable judgments of their competence from their teachers, families, or peers (Middleton & Spanias, 1999). One student mentioned that his family had given him the encouragement to study at times when he wanted to do something else, but he hastened to add that he needed to be “motivated from within first“ for that extrinsic motivation to be effective.

In comparing the unsuccessful to the successful experience, all of the students experienced a change in motivation. Their goals changed. Their belief systems changed. Their mindset changed which spurred the change in motivation and this agrees with current research. “For a change in motivation to take place, there must be a desired goal and one’s beliefs (including efficacy beliefs) must support the change” (Hannula, 2006, p. 170).

Attitude

Closely linked with motivation is attitude, which has to do with a person’s emotion towards a person, place, event, or situation. Hannula (2006) suggested that there was a strong connection between attitude and motivation. “Emotions are the most direct link to motivation, being manifested either in positive (joy, relief, interest) or negative (anger, sadness, frustration) emotions depending on whether the situation is in line with motivation or not” (p. 167). The feeling one develops towards learning can significantly influence not only what one learns but how one learns (Gomez-Chacon, 2000; Klomegah, 2007; Malmivuori, 2006; McLeod, 1994; Middleton & Spanias, 1999; ‘Teynde, Corte, & Verschaffel, 2006; Turner et al., 1998). For students to be successful, they have to overcome their fears and believe they can succeed (Hammerman & Goldberg, 2003).

The emotional aspect of learning was recognized by Benjamin Bloom who theorized that humans’ learned capabilities could be categorized in three domains: cognitive, affective, and psychomotor. The term “affective” refers to the experience of emotion or feeling. On their web site, the Swiss National Center for Competence in Research (2008) defined the term “affect” as encompassing the constructs of motives, attitudes, moods, and emotions. In collaboration with David Krathwohl (Krathwohl et al., 1964), Bloom associated the cognitive and affective domains and developed a hierarchy or levels within those domains as discussed in Chapter II.

When considering the students’ unsuccessful experience, they experienced the first two levels of the affective domain. They received the mathematics instruction and were aware and perceived it and paid attention to it. At first they responded by trying to do the homework and take the tests, but when they received negative feedback, their response was a negative feeling. “Emotion reflects students’ appraisals of whether the environment poses harm, threat, or benefit to their goals” (Turner et al., 1998, p. 761). As mentioned in the results, the students all expressed dislike and even hatred towards learning mathematics. The fixed mindset of lacking the ability to learn mathematics reinforced cognitively what they were experiencing affectively, supporting Krathwohl’s (1964) assertion that the cognitve and affective domains were interrelated.

Turner et al. (1998) suggested, “Negative affect about failure might explain why some students for whom performance goals are important develop maladaptive beliefs, engage in counterproductive behaviors, and doubt their ability to succeed" (p. 761). The negative attitude combined with the fixed mindset was demonstrated in these students subsequent avoidance behavior. "Boekaerts (1993, 1995) and Skinner (1995) have argued that negative feelings during a learning activity tend to direct time and attention away from learning and toward behaviors that will restore well-being or protect self-worth" (as cited in Turner et al., 1998, p. 761). These students' subsequent avoidance of mathematics effectively halted their learning.

The students' successful experiences demonstrated a progression through all five levels of the affective domain. Students again were aware, perceived, and paid attention to the mathematics learning instruction. They responded with effort spurred on by the cognitive growth mindset. They received satisfaction in the understanding of what they were learning. They valued what they were learning, knowing its necessity in achieving their established goals. They began to see applicability of what they were learning in their present lives and for their future vocations. Those values generated an attitude of confidence to face the next math class and reinforced the value of continuing their education.

With their growth mindset, these students did not try to protect their self-worth. They asked for help when they did not understand and they were not afraid of making mistakes, seeing that finding the reasons for the mistakes helped them correct their thinking. They fit the pattern of mastery-oriented students as described by Turner et al. (1998).

> Students with learning goals are not focused on protecting self-worth. Errors are not interpreted as a sign of low ability and do not evoke negative affect. Instead, these students adopt an optimistic outlook that involves seeking more challenges, using more strategic and meaning-oriented strategies, and trusting in their ability to succeed (p. 761).

Their confidence not only reinforced their persistence to keep working to reach comprehension, but they gained the self-assurance that they could succeed in the subsequent course.

In both experiences the students' attitudes and emotions were inseparably linked to how students enacted their goals, demonstrating the interrelationship of the cognitive and affective domains and the integrated link between motivation and attitude. This agrees with the findings of Schweinle et al. (2006), who found that "affect is essential to student experience in mathematics lessons and skill is perceived in conjunction with affective variables" (p. 271). Turner et al. (1998) agreed. "Emotion could be crucial in directing the patterns of cognition, motivation, and self-regulation that students adopt in different learning situations" (p. 761).

Learning Environment

The students in this study viewed their learning environment as a key component in their success. Lizzio et al. (2002) found that "students' perceptions of their current learning environment were a stronger predictor of learning outcomes at university than prior achievement at school" (p. 27). In high school, these students were subject to the prescribed learning environment. In college, these students had the flexibility of being able to select resources, change some placement decisions, and even change teachers, if they felt it would help their learning. Having some measure of control over their learning environment strengthened their confidence and increased their motivation.

Class Size

Two students in this study mentioned that class size was a deterrent to their learning in their unsuccessful experience. As mentioned in Chapter II, an increasing body of research in elementary and secondary levels of education involving large samples with controlled experiments shows that lowering class size produces significant results and continued benefits to students (Finn, 1998; Finn & Achilles, 1999; Glass et al., 1986; Konstantopoulos, 2008; Molnar et al., 1998). Students' perceptions that large class size in their K-12 experience did have a detrimental effect on their learning are reinforced by these research findings.

The largest class size the students had in their successful experience on the college level was 30 students, which is small for most college general education courses. Most of the students in this study had an average class size of 20. Two classes had 30. One class had 10. All the rest ranged in between. The researcher noted that the smaller class size seemed to contribute to the students' freedom to ask frequent questions and get immediate feedback. The smaller class size contributed to an intimacy where students felt comfortable asking questions without fear or ridicule or intimidation.

Placement

In their unsuccessful experiences, students were unaware of any placement testing for their particular courses. One of the students was placed in a lower-level math class in high school but thought he did well on the standardized tests. When questioned, the other students had no knowledge of being placed in a course as a result of a diagnostic test while in elementary or high school. One of the students who enrolled in college right after high school remembered taking the college placement exam and then failing the course in which she was placed. Placement was at the very least inaccurate for some and essentially nonexistent for most of the students.

Correct placement into a mathematics course is essential for success (Duranczyk, 2007; Muller, 2002). The course must match the student's skill level. Some colleges and universities use ACT or SAT scores as placement, while others use a placement exam. Placement exams were used as a diagnostic to "place students into courses for which they are prepared and in which they are likely to succeed" (Jacobson, 2006a). Correct placement was viewed as very important to insure student success (Hartl, 1997; Hector & Hector, 1992; Jacobson; Roth, Crans, Carter, Ariet, & Resnick, 2001; Shelton & Brown, 2008). Hartl maintained that colleges had a responsibility to help students enroll in the courses that matched their incoming academic level.

> Colleges need to be able to identify entry-level skills and accommodate diversity. Colleges also need to identify the academic skill level required for success in initial and subsequent courses. Assessment of students' skills at enrollment needs to be improved so that students can be matched to courses that have appropriate entry-level requirements. (p. 20)

What is troubling is that placement exams do not always accurately place students in the course that matches their skill level (Cronin, 2000; Jacobson, 2006a). In a mixed method study of the effectiveness of a particular math placement exam, Cronin found that only 37% of students successfully passed the first course into which they were placed.

However, Pedersen's (2004) investigation of a different placement exam found it along with other demographic variables to be a significant predictor of successful completion, accounting for 36% of the variation.

The successful students in this study all took the college's placement exam. Six of the students interviewed expected to be placed in the course in which they tested. Four were surprised that they were not placed lower and the other four were surprised that they did not place higher. However, after the students had taken the course, all but two agreed that the placement matched their skill level. One of those felt she was still missing concepts that she would have mastered in a lower level course. She did choose to stay in the recommended course. She said she worked hard, spent extra time, got help so that she could master the concepts she was missing, and was successful. The other student placed herself in a lower course than in the one she had placed, because she wanted to make sure she had a secure mathematical foundation for her future goal of graduate school. She felt her self-imposed placement was accurate.

All of the students were successful in the courses in which they placed. Even though some of them disagreed with the placement at first, all but one student felt they were in the course that matched their academic skill level. All of them agreed later that if they had been placed in a higher-level course, they would not have been successful. Since they all successfully completed their courses, the diagnosed and in one case self-imposed placement would appear to be accurate. All the students interviewed expressed that getting into a course that matched their skill level was essential to their success.

Learning Resources

Computer-Assisted Learning

Computer-assisted learning programs have now become part of course management and are available with most textbooks (Burden, 2007, 2008). These programs have now progressed far enough that they center on the user and his wants and his needs. The Microsoft design team described the theoretical focus of a learner-centered approach.

> User experience and interface design in the context of creating software represents an approach that puts the user, rather than the system, at the center of the process. This philosophy, called user-centered design, incorporates user concerns and advocacy from the beginning of the design process and dictates the needs of the user should be foremost in any design decisions. (Microsoft Developer Network, 2008)

Because of their capabilities for creating homework problems, giving instant feedback with problems worked out step-by-step, providing alternate examples, and supplying teaching videos, they provide students with extra aids to do their homework that they would not have from regularly assigned homework in the text. Many programs also include the complete text on the web. Teachers have the option of using these programs in their classes.

Several colleges and universities have reported significant benefits from integrating computer-assisted learning programs into their course structure. The University of Alabama redesigned their intermediate algebra program implementing a computer-assisted learning program and found that their pass rates increased by 50% (Speckler, 2007). Upon implementing computer-assisted learning into their college algebra program, Louisiana State University saw their drop rates go from 15% to 9% (Speckler). Georgia State University incorporated the program into their completely redesigned precalculus curriculum and had a 23.3% higher pass rate (Speckler). The remedial algebra program at University of Wisconsin-Stout was also revamped with the computer program added. A longitudinal study over 4 years showed a decline in failure/withdrawal rates of 11% (Speckler). In a mixed method study, Zerr (2007) examined the effectiveness of an online homework system on students in first-semester calculus. There was an improvement in overall student performance and student surveys indicated that there was a high level of satisfaction with computer-assisted learning.

Some of the previously mentioned studies involved programs that had been redesigned, where many changes had been made with the computer-assisted learning being one of them. Other studies comparing computer-assisted learning with traditional "book" homework found no significant differences in achievement, but students did show an increased positive attitude. Taylor's (2006) study investigated the effects of a computerized-algebra program on achievement of university freshman. The experimental group utilized the computer program. The control group did not. The experimental group performed just as well as the control group and the experimental group exhibited a decrease in anxiety and an increase in positive attitude. Jacobson (2006b) found that computer-assisted learning students performed no better than the control group, but student evaluations of the program were strongly positive.

Three students in this study mentioned using the computer-assisted learning program in their courses. One of the students interviewed stated that this program was the difference between him being unsuccessful and successful. The program provided the immediate feedback and explanations he needed to understand. This web-based program permitted him the flexibility to do homework any time and have it graded right away, giving him the necessary instructional feedback needed to gain a correct understanding of the concepts. In essence, the computer program acted as a tutor. Schofield, Eurich-Fulcer, and Britt (1994) compared such programs to tutors providing an additional resource for the students and giving the students control over the kind and amount of help they received.

Tutors

Another resource the students found was tutors both inside and outside of the math lab. Six of the students mentioned that they asked family members or friends to help them when needed. Merrill, Reisor, Merrill, and Landes (1995) maintained that "individualized instruction significantly improves students' pedagogical and motivational outcomes" (p. 315). Carman (1976) conducted a long-term study tracking freshman from Santa Barbara City. The treatment groups were given tutoring as an integral part of the course. Significantly fewer students in the tutored groups withdrew from the course and student attitudes were significantly more positive. After following them for 2 more years, Carmen found that they maintained the increased positive attitude and exhibited a pattern of increased persistence. Bar-Eli, Bar-Eli, Tenenbaum, and Forlin (1998) conducted three case studies involving seventh-grade tutors teaching third-grade tutees. Their results indicated that when tutors were prepared to teach, the tutees were better able to handle tasks given in class. The tutees became better achievers.

Merrill et al. (1995) described the methods successful tutors utilize:

> This discourse analysis suggests that tutors are successful because they take a very active role in leading the problem solving by offering confirmatory feedback and additional guidance while students are on profitable paths and error feedback after mistakes. However, tutors carefully structure their feedback to allow students to perform as much of the work as possible while the tutor ensures that problem solving stays on track. These results suggest the types of strategies tutors employ to facilitate guided learning by doing. (p. 315)

In the course of the interviews, students revealed that the tutors they had were patient and guided them through a problem one step at a time, giving them a suggestion when they needed help to get to the next step, reinforcing the findings of Merrill and colleagues.

Math Lab

The college math lab was the resource mentioned most often by students as most helpful in learning mathematics. Nine of the students used the math lab as part of their learning strategies. This particular math lab had designated study tables for each level course. Students could put a flag up when they needed to ask a question and a tutor would come to their assistance. In addition, group study rooms were available as well as one-on-one tutoring. There were computers having the online math-learning program where students could get a tutor's assistance with the program if needed. Online white board tutoring was also available through math lab personnel. The math lab is heavily advertised in each class at the beginning of the semester to make students aware of the resource.

Most of the students utilized the tutors in the math lab to aid them when they encountered difficulty in doing their homework or to gain clarification if they did not understand a concept discussed in class. The students expressed that going to the math lab as soon as possible after class to do their homework helped reinforce what they had just learned. They mentioned that the tutors were patient and helpful, giving them hints to the next step in working a problem when needed. Some went with a friend or their study group to the math lab to study and obtained help when necessary.

Math labs at other colleges and universities have different titles such as math learning center, math student service center, or mathematics support center, but they perform essentially the same functions as this college's math lab. Studies investigating the effectiveness of math labs have verified that students are "very satisfied with the time they spend there and the help they receive from the peer tutors, often claiming passing or better grades as a result" (Halcrow, 2004, p. iii). In surveying first-generation and non-first-generation college students about college resources available to them, Thompson (2007) found that "students that used academic support programs provided by the university believed they benefited from the programs they utilized. Both groups indicated that they believed the math lab provided the most benefit" (p. iii), which agreed with what the students said in this study. The results of Muller's (2002) study demonstrated that academic support centers are an essential part of facilitating student success. Students have also indicated that math student service centers were key to their success in subsequent courses (Duranczyk, 2008). In addition, Cress (2003) found that math lab users "persisted to subsequent courses at consistently higher rates than nonusers" and "that successful completion of both initial and sequential courses was related to" (p. iii) the students' use of math learning centers.

Teachers

Teachers and the classroom environment they provide were seen as an important component in the students' learning. "Students' mathematics learning and their dispositions towards mathematics are indeed influenced—for better or for worse—by the teaching they experience at school.... In other words, teachers *do* matter" (Goos, 2006, p. 8). Glasser (1998) emphasized the importance of a good teacher. "A good experience with a good teacher is the key to learning anything well" (Glasser, p. 248). An excellent teacher is one who helps "their students learn in ways that made a sustained, substantial, and positive influence on how those students think, act, and feel" (Bain, 2004, p. 5). Teachers of the students in this study varied in personality and teaching style, but they all exhibited a personal interest in each student, a willingness to help them learn outside of class, a comfortable classroom atmosphere, and clear, organized teaching presentations.

In their unsuccessful time, six of the students mentioned that they did not have "good" teachers. During their successful experience, all the students felt their teachers were good for them. Highly effective teachers often display an openness with students and share with students their own experiences in their learning journey. They express an interest in their students and encourage them to be candid and reflective about what they are learning (Bain, 2004). In her study of successful developmental mathematics students, Duranczyk (2008) found that teachers whom the students perceived as caring had a great impact on them. The researcher noted in her classroom observations that the teachers knew all their students' names. The casual atmosphere allowed students to express themselves freely. Students in this study expressed that they felt their teachers cared that they learned. One student even stated that his teacher was more than his teacher now; he felt she was his friend.

Research has shown that effective teachers will encourage students to learn outside of class (Bain, 2004). In their unsuccessful time, only two students mentioned seeking help outside of class. When the students were successful, all of them mentioned that they felt comfortable asking their teachers for help and many of them met with their teachers in their offices. Two students mentioned that they often walked with their teachers back to their offices after class, where they not only talked about what they had just learned in class, but considered other topics as well.

Studies have shown that teachers who provide a comfortable, non-intimidating atmosphere where students feel free to ask questions positively influenced the way students perceive their classroom atmosphere (Bain, 2004; Kealoha, 2006; Middleton & Spanias, 1999). Effective teachers encourage students to think aloud and they create a nonthreatening environment in which their students can do so (Bain). Dosemagen (2004) found that a comfortable classroom climate contributed to the development of understanding.

Reflecting upon their unsuccessful experience, two of the students said they were embarrassed in front of the class for not being able to successfully work a problem. They expressed fear of being called on to perform mathematical computations in front of the class. Another student said he felt like his math teachers acted like they were “gods.” He felt intimidated. It was apparent that these students did not feel the atmosphere was comfortable.

The researcher observed all the successful students in the classroom. Every student asked questions about homework problems, about concepts being discussed, or about how these concepts would apply to other contexts. Some of the students even helped answer other students' questions. All the teachers used a question and answer technique in presenting concepts. With this method, teachers were not only able to assess the students' familiarity and knowledge of the concepts discussed, but they were able to actively engage students in learning. Many of the students answered the questions aloud. If answers were incorrect, the teachers used the incorrect answer to guide the students to the correct answers. There was no negative feedback for incorrect answers, but positive feedback for students tackling a difficult problem. In short, the teachers' questions encouraged the students' to ask questions.

Excellent teachers use questions to take students from where they are to where they need to be.

> Questions help us construct knowledge.... Some cognitive scientists think that questions are so important that we cannot learn until the right one has been asked: if memory does not ask the question, it will not know where to index the answer. The more questions we ask, the more ways we can index a thought in memory. Better indexing produces greater flexibility, easier recall, and richer understanding. (Bain, 2004, p. 31)

In mathematics, facts are not only stored away, but patterns and procedures are identified. Memory maps of those procedures called schemata are stored in the brain for recall in solving similar problems (Driscoll, 2005). Questions can encourage students to tune the schemata to applicable experiences or even restructure schemata to new situations (Driscoll).

In their prior unsuccessful experience, students professed a fixed mindset. They believed that their success or failure depended on their ability. Their consistent failures sent them into a state of learned helplessness. Middleton and Spanias (1999) asserted that learned helplessness occurs when the educational environment places a high value on ability and lower value on effort. Any motivation they might have had was extrinsic where they tried to perform for some type of reward or to avoid punishment. They had a performance orientation.

Their successful experience revealed characteristics directly opposite to those of the unsuccessful period. Students had a growth mindset, believing that their abilities were malleable. They believed that with effort and work and collaboration with others, they could learn. For the goals they had established, they knew they would have to learn for understanding. Therefore, their motivation was intrinsic. Mastering the task, which was evidence of their understanding, was reward enough for them. They were mastery oriented.

"Good teachers know how to give students what they need" (Glasser, 1998, p. 251). Teachers who can more correctly evaluate what motivates a student will construct learning activities matching the student's motivational orientation. "Teachers who are better able to predict their students' motivational constructs seem to be better able to fine-tune their instruction to meet the motivational needs of their students" (Middleton & Spanias, 1999, p. 76). In a study of effective math teachers, Russell (1996) found that these teachers believed that all students can learn and will learn if the instruction matches their skill level.

Sullivan and colleagues (2006) found that most of the eighth-grade participants in their study had a performance orientation. Other research has also indicated that many students begin developing a performance orientation in the early grades (Middleton & Spanias, 1999; Stipek et al., 1998a). Turner and colleagues (1998) found that students "in upper elementary mathematics classes are concerned enough about doing well that they react strongly to making errors. Their fears prompt beliefs and behaviors that detract from learning rather than enhance it" (p. 769). Students are led to focus on ability. Teachers who focus on speed and accuracy inadvertently encourage students to blame their ability for their performance (Turner et al.).

Since performance-oriented students are bolstered by extrinsic rewards, motivation decreases when the reward is removed. Bain (2004) referred to a study conducted by Deci (1970 as cited in Bain) in which two groups of students were given a block-construction puzzle. The first group never received a reward for solving the puzzle and never lost interest in trying to solve it. The other group received a monetary reward at first, but it was later withdrawn. The second group lost interest when the reward was taken away. "They have consistently found that most extrinsic motivators damage intrinsic motivation" (Bain, p. 33). Deci concluded that if people think they are being manipulated by an external reward, they lose their motivation to perform the task.

Glasser (1998) maintained that many students who are coerced to acquire knowledge detect it, then resist it, and eventually rebel. The fun in learning is lost. Glasser's Choice Theory asserts that fun is one of the five basic human needs (Glasser, 1998, 2000). "Fun is the generic reward for learning" (Glasser, p. 41). Students learned best when they enjoy what they are being taught and are taught by someone they enjoy learning from. They work best when they enjoy the work or the challenge and find that what they are doing is not drudgery. Learning is to be enjoyed (Glasser).

Classroom contexts can influence students' orientation (Middleton & Spanias, 1998; Nicholls, Cobb, Wood, Yackel, & Patashnik, 1990; Stipek et al., 1998a; Turner et al., 1998). A study by Nicholls et al. indicated that "that teaching practices can have a considerable influence on orientations" (p. 119). Stipek et al. demonstrated that teachers could be trained to encourage intrinsic motivation with a mastery orientation. Their study involved three groups of teachers. The first two groups participated in professional development programs. The first group was trained intensively in methods and strategies promoting intrinsic motivation, and considerable emphasis was given to assessing student motivation. The second group was primarily trained through a teacher workshop, which gave general instructions on promoting and assessing intrinsic motivation. The third group had no training at all. "The teachers in the intensive intervention ...made more accurate judgments of students' motivation" (p. 319) than the second group. The last group exhibited some negative effects on student motivation.

A second report of this study focused on the motivational objectives of the teachers who had experienced the training. Teachers were advised to facilitate students'

> (a) focus on learning and understanding mathematics concepts as well as on getting right answers; (b) self-confidence as mathematics learners; (c) willingness to take risks and approach challenging tasks; (d) enjoyment in engaging in mathematics activities; and (e) related positive feelings. (Stipek et al., 1998b, p. 466)

These goals focus on increasing understanding and developing skills and were clearly directed towards a mastery orientation. The instructional practices of the teachers trained in the intervention positively affected the students' intrinsic motivation and conceptual learning. The positive motivation was associated with increased skills (Stipek et al., 1998b).

In his investigation of the "best college teachers," Bain (2004) gave a description of effective educators.

> In general, the people we investigated tried to avoid extrinsic motivators and to foster intrinsic ones, moving students toward learning goals and a mastery orientation. They gave students as much control over their own education as possible and displayed both a strong interest in their learning and a faith in their abilities. They offered nonjudgmental feedback on students' work, stressed opportunities to improve, constantly looked for ways to stimulate advancement, and avoided dividing their students into the sheep and the goats. Rather than pitting people against each other, they encouraged cooperation and collaboration. In general, they avoided grading on the curve, and instead gave everyone the opportunity to achieve the highest standard and grades. (p. 35)

Based on the classroom observations of the students in this study, the researcher observed that their teachers practiced many of the methods Bain mentioned. They focused on the learning of concepts and mastery of skills. They provided a non-threatening atmosphere where students felt comfortable asking questions and were not embarrassed if they made a mistake. The teachers expressed confidence in the students' abilities to learn concepts and recognized them for their effort with comments like, "You thought through that problem step by step and got the right answer and because you know the process, you will be able to apply it to other problems," or "You are learning to analyze word problems really well," or "You have worked hard to understand factoring techniques and it has paid off." Some of the teachers encouraged group work outside of class and many of the teachers encouraged collaboration in class. All of the students expressed that they felt their teachers cared about them and their learning. None of the teachers graded on the curve. All of the teachers gave the students a clear guideline of what they would learn and how it would be evaluated, which was according to their mastery of the concepts.

The researcher also noticed that although all the students commented that their teachers gave them “lots of homework,” the students recognized the benefit of all that practice in understanding the concepts and solidifying it in their stored knowledge. Even though there was a lot required of the students, they felt the homework tasks were not overwhelming and were appropriate for what they were learning. They also felt the exams reflected the concepts they had learned. The students considered their teachers’ assignments and exams as promoting their understanding, which were both their goals. The teachers definitely designed intrinsically motivated activities for these intrinsically motivated students and, as evidenced by their success, matched them well.

In an effort to describe the experiences of intrinsically motivated people, Csikszentmihalyi developed flow theory (Schweinle et al., 2006).

> According to flow theory, an activity is rewarding in relation to whether individuals find it attractive or challenging and whether they believe that they have the skills to accomplish it. Optimal experience, or flow, occurs when a person perceives the challenges in a certain situation and his or her skills as balanced and above average. When challenges and skills are unbalanced, such as when challenges outpace skills, an activity is not necessarily rewarding, and could evoke anxiety. (p. 272)

The quality of the experience can evoke different responses. The reactions are described with their corresponding challenge level of the task and student skill level: “(a) involved and strong with high challenges and skills, (b) apathetic with low challenges and skills, (c) anxious with high challenges and low skills, and (d) boring or uninvolved with low challenges and high skills" (Schweinle et al., 2006, p. 272). Students in this study were in the first category.

Their teachers had designed learning activities that matched the students' skills but with enough challenge to keep them involved, giving optimal flow. To achieve optimal flow, teachers have to plan structured learning activities, allow enough time for students to complete them, and break up larger more complex tasks into smaller units (Schweinle et al., 2006). Most of the teachers observed had structured learning activities. One teacher would give students a chance to work in assigned groups on "Quick Checks," which involved more difficult problems than discussed in the lecture. He would walk around giving clues to those groups needing help. Another teacher would explain a concept and then say, "OK. Here's one for you to do!" She put a more difficult problem on the board and walked around the classroom reviewing the students' work and answering individual questions. It appeared this was a regular occurrence in the classroom because students seemed to expect it. These activities gave students a chance to evaluate if they understood the concept discussed, to experience a higher degree of challenge, and to have immediate feedback about their learning.

The students mentioned that their teachers gave them regular and consistent feedback. "Feedback is most useful when it is (a) immediate, (b) links success with effort, and (c) provides information about improvement and mastery" (Schweinle et al., 2006, p. 273). The researcher noted in her classroom observations that the comfortable classroom atmosphere allowed students to ask questions giving them immediate feedback, which allowed them to know if they were understanding correctly. The students also indicated that their teachers graded their exams quickly, another indication that teachers were providing immediate feedback. Teachers promoted the position that effort will yield rewards of understanding. Most all of the students had the mindset, “If you do the work, you’ll make the grade!” They knew their success depended to a large degree on their consistent and persistent effort.

The classroom observations of these students occurred towards the end of the semester. The researcher noted that several teachers reminded their students of how far they have come. “Look at where you were at the beginning of the semester,“ or “Look at how much you know now compared to when you came into this class” were typical of teachers’ urgings for students to remember how much they have progressed. The interviews revealed students’ reflections of how much they have learned and how much more they are able to do mathematically. One student said she felt her “brain open up in ways it had never done before.” This practice of reflecting on “how far you have come” seemed to strengthen motivation and confidence. This concurs with the findings of Hall and Ponton’s (2005) study, which suggested that teaching methodologies for developmental mathematics students should “not only develop mathematics capability but also a self-awareness of increased capability” (p. 26).

The teachers observed in this study practiced a student-centered instruction, viewing themselves as facilitators in helping students to construct their knowledge. A predominant theoretical perspective in the mathematics educational research community today is constructivism (Bain, 2004; Kieren, 2000; Lerman, 1996, 2000; Middleton & Spanias, 1999; Muis, 2004; Pugalee, 2001; Weinstein, 2004). “Constructivist theory rests on the assumption that knowledge is constructed by learners as they attempt to make sense of their experiences. Learners, therefore, are not empty vessels waiting to be filled, but rather active organisms seeking meaning" (Driscoll, 2005, p. 387).

Constructivist learning environments foster learning activities that develop critical thinking skills, multiple perspectives and modes of presentation, social interaction with peers and teachers, student ownership in learning, and a self-awareness of the knowledge construction (Driscoll, 2005). The teachers observed in this study encouraged critical thinking with their question and answer techniques. The presented concepts were demonstrated in different applications. Group work provided interactions with peers. Teachers working individually with students in class and out of class provided interaction with students. Students realized that their effort was critical to their learning. Teachers encouraged students to remember and reflect on what they had previously learned to understand what they were presently learning. The students were also encouraged to remember their progress in learning. Their teachers were helping them construct their own learning.

Learning Strategies

When students were unsuccessful, they unanimously chose an avoidance strategy to cope with their failures, which research indicates is a typical tactic (Middleton & Spanias, 1999; Turner et al, 1998). "Individuals who perceive mathematics as difficult and their ability to do mathematics as poor generally avoid mathematics, if possible. Such students are termed math anxious" (Middleton & Spanias, p. 77). Turner et al. suggested that avoidance deflects the students' attention from attempts at learning to preserve self-worth and restore well-being.

Typical symptoms of avoidance are "preference for easy tasks, rushing to complete work rather than thinking about it, giving up easily, avoiding seeking help when needed, and failing to correct errors and mistakes" (Turner et al., 1998). Students in this study exhibited one or more of these coping techniques. One student mentioned that when she took a test, she just signed her name and handed it in. She gave up. Another said she "skipped over" the homework involving concepts she did not understand. Another student said he would not do his homework until his parents made him. Another said he just did not do his homework. Several said they did the minimum to get by. Another student said she took the same teacher every year in high school, because all she had to do to pass was hand in the homework, which was not graded. She knew it was not right, but she knew it was the way to pass. All the students avoided taking any more math classes than required.

Classroom Behavior

The successful students possessing a growth mindset had incorporated learning strategies in the classroom and developed consistent study habits outside of class to achieve their mastery goal of understanding. To these students, class attendance was essential in succeeding. Most of the teachers did not monitor attendance, but these students knew that being in class was a top priority. Research has verified the importance of attendance (Faro-Schroeder, 1995; Jacobson, 2005). Faro-Schroeder found that attendance was the best predictor of the final grade in developmental mathematics.

All but two of the students were observed twice. Of those students, the researcher noted that in both observations, the students chose to sit in the same seats. Six of the students were on the front row. Even though five of the students were not on the front row, there were no students sitting in front of them, making these students the closest to their teacher on their particular row. Three students had one person sitting in front of them. One sat at center back where she could be near her friend. One student mentioned that her seat position was one of her learning strategies. Sitting center front freed her from distractions going on behind her and allowed her to focus on the teacher and the discussion. Only one research report was found that examined seating position in a Christian education classroom (McFarland, 1993). McFarland suggested that students tend to choose a particular area because of its influence on their learning environment, which seems to support the student's reason for selecting her seat.

Every student took extensive notes when they were in class. Taking accurate and complete notes required the students' full attention. They used them as an aid in doing their homework, studying for exams, and to clarify their understanding of concepts. Research has shown that there is a positive relationship between taking notes and student performance (Eades & Moore, 2007; Sumowski, 2007). Sumowski summarized studies researching the impact of notetaking.

> Fisher and Harris…found that undergraduates who recorded and reviewed lecture notes produced greater free recall and multiple-choice performance than those who did not record notes and/or did not review their notes. In addition, Kiewra and colleagues…found that lecture note quality was related to performance on comprehensive course exams. Text notetaking is also related to positive performance on outcome measures…. For instance, Rickards and Friedman found that undergraduates who took and reviewed text notes produced greater free and cued recall than those who either did not take notes and/or did not review their

> notes. Finally, Bretzing and Kulhavy found that information in text notes had a significantly greater probability of being recalled than information that was not recorded in notes, with probabilities of .58 and .15, respectively. (p. 2)

As the researcher reviewed the students’ notes, she observed that the notes were accurate and comprehensive. The students were careful to accurately record what was written on the board. They also wrote down pertinent comments in the discussion which contributed to their understanding. Eggert (2001) found that accuracy of class notes was a good predictor variable in performance. Although note taking alone cannot account for successful achievement, it is one of the components that does contribute to student success (Eades & Moore, 2007).

As mentioned previously, the researcher observed that the teachers used a question and answer technique to engage the students and stimulate learning. These questions not only elicited responses, but were reciprocated by the students’ own questions. These students exhibited the posture of “ask until you understand.” Questioning by the students then became a learning strategy for the students.

Research has shown that students’ questions play a significant role in meaningful learning, in motivation, and in guiding teachers’ explanations (Chin, Brown, & Bruce, 2002; De Jesus, Almeida, & Watts, 2004; Willis, 2007). De Jesus and colleagues suggested four main reasons student questions impact learning:

1. “Creating a culture of inquiry” (p. 532). As teachers acknowledge student questions, they reinforce their importance as a natural component in learning mathematics.

2. “Heighten conceptual understanding” (p. 532). Questions can lead to

understanding. As students ask questions, they expose how they are thinking, which gives the teacher an opportunity to reinforce accurate perceptions and correct misconceptions. Questions also help students retain what they are learning.

3. “Driving classroom interactions” (p. 532). Questions can provoke teachers’ own thinking and foster discussions of interest to both students and teachers.

4. “Promoting autonomous inquiry-based learning” (p. 532). This questioning provides students with the training to reflectively ask themselves questions in other areas of interest and in other domains.

Behaviors observed in the classroom evidenced all four of these areas. Teachers observed in this study helped create a culture of inquiry by their question-answer approach in class. Teachers allowed the flexibility of letting students’ questions guide the discussion and pursue the students’ curiosity and interest as it added to the learning of the subject. Students adopted questions as a strategy to develop conceptual understanding and clear up any misconceptions. As students progressed in the art of questioning in their developmental mathematics classes, they trained themselves to assimilate this method of inquiry into other areas. One student saw her probability lesson as being applicable to “Deal or No Deal” and confirmed that by asking her teacher about it. This method of questioning was used inside or outside of class.

Study Habits

The learning strategy most commonly mentioned by students as aiding them in being successful was homework. Homework is defined as learning tasks to be completed outside of the normal class period (Cooper, 1989; Pease, 2006). Accurate homework completion is recognized as essential for successful achievement in mathematics (Brophy, 1986; Cooper; Corno, 2000; Keith, Diamond-Hallam, & Fine, 2004; Pease).

When learning takes place, certain processes have to be activated (Driscoll, 2005). Gagne described nine events of instruction associated with these processes. Driscoll (p. 373) summarized the internal processes and corresponding instructional events and actions in Table 5. For effective learning to take place, the learner must go through all nine internal processes (Driscoll; Pease, 2006). Earle (1992, as cited in Pease) maintained that six of Gagne's events of instruction can be satisfied with homework. "Appropriately designed homework assignments can stimulate recall of prerequisite learning, present stimulus material, elicit performance, provide feedback about performance correctness, assess performance and promote retention and transfer" (Pease, p. 15).

Table 5

Gagne's Nine Events of Instruction

Internal process	Instructional event	Action
Reception	1. Gaining Attention	Use abrupt stimulus change.
Expectancy	2. Informing learners of the objective	Tell learners what they will be able to do after learning.
Retrieval to working memory	3. Stimulating recall of prior learning	Ask for recall of previously learned knowledge or skills
Selective perception	4. Presenting the content	Display the content with distinctive features.
Semantic encoding	5. Providing "learning guidance"	Suggest a meaningful organization.
Responding	6. Eliciting performance	Ask learner to perform.
Reinforcement	7. Providing feedback	Give informative feedback.
Retrieval and reinforcement	8. Assessing performance	Require additional learner performance with feedback.
Retrieval and generalization	9. Enhancing retention and transfer	Provide varied practice and spaced reviews.

Students in this study realized that doing their homework would promote their learning. The homework required them to perform by having them do problems reflecting the instruction they had just been given. They could check their answers in the back of the book or if they used the computer-assisted learning program, they got instant feedback. The feedback reinforced what they had just learned. Several students made a point of doing their homework immediately after class. One of those students summarized the benefits of doing his homework that way. “You’ve already been thinking about it for the past hour. You might as well work on your homework that you’ve done, and it just kind of *locks* it in there and helps me out a lot better.”

There are added benefits of doing homework as well. Students recognized that their effort yielded results. All the students interviewed expressed that their success was dependent upon devoting time and effort into understanding, which translated into “work.” Students’ comments included the following: “Math is a lot of work.” “I’m putting the time in. I’m actually trying to understand it.” “If you put in the work, then you will get the grade.” Research agrees with the students’ expressions that time spent on homework is positively related to academic achievement (Miranda, 1999; Riley, 2007).

A comment coming from many of the students was that they were assigned a lot of homework, but they realized that they were reaping the rewards of reinforced understanding by doing it. Some students mentioned that they did more than the assigned homework when they felt that they had not fully grasped the concepts. None of the students complained about the homework being too overwhelming. Middleton and Spanias (1999) stated that teachers have the challenge of choosing homework exercises that will provide for reinforced learning and understanding yet also choosing problems that will be challenging but not too difficult for their level. “Tasks must allow for a high degree of success given appropriate effort by the student” (p. 80).

The students also expressed satisfaction that their diligence was rewarded. As Corno (2000) pointed out, “a student also experiences a certain satisfaction with homework completed—satisfaction for good effort invested, but more importantly, a sense of oneself as a student” (p. 545).

The training in doing homework teaches students self-discipline, independence, and responsibility that extends to other academic pursuits (Cooper, 1989; Corno, 2000; Pease, 2006) and to life-long learning. Corno suggested that this training could begin in elementary school and enables students to become life-long learners.

> Children who do additional academic work outside school are likely to become acclimated to academic rigor. In the best of circumstances, students develop an aptitude for academic work through the extra practice and reinforcement of homework. Their inclination to engage in future academic work depends to some extent on their reinforcement history with homework. When children experience flow in doing homework, they persist long enough to become able learners and ultimately reach academic expertise (p. 530).

Transformation

By analyzing the interviews and observing the behavior of students in this study, the researcher reflected upon the transformation that occurred in their lives. It began with a change in beliefs and orientation and then students making conscious decisions to approach their educational experience differently than before. What they experienced was consistent with transformative learning theory (Franz, 2007; Grabove, 1997; Imel, 1998) first introduced by Jack Mezirow in 1978 (Imel).

> As described by Mezirow (1997), transformative learning occurs when individuals change their frames of reference by critically reflecting on their assumptions and beliefs and consciously making and implementing plans that bring about new ways of defining their worlds. (Imel, p. 2)

When students changed their fixed mindset to a growth mindset, it caused them to reevaluate their capabilities and their possibilities. Those reflections yielded a change in their educational plans and their educational strategies. Merriam's (2004) description of the process of change in transformative learning theory summarizes succinctly what the students experienced.

> In transformational learning, one's values, beliefs, and assumptions compose the lens through which personal experience is mediated and made sense of. When this meaning system is found to be inadequate in accommodating some life experience, through transformational learning it can be replaced with a new perspective, one that is "more inclusive, discriminating, open, emotionally capable of change, and reflective"; in other words, more developed. (Mezirow, 2000, p. 7, as cited in Merriam, p. 61)

> Mezirow (2000) broke this change down into a ten-step process:
>
> 1. Experience a disorienting dilemma
> 2. Undergo self-examination
> 3. Conduct a deep assessment of personal role assumptions and alienation created by new roles
> 4. Share and analyze personal discontent and similar experiences with others
> 5. Explore options for new ways of acting
> 6. Build competence and self-confidence in new roles
> 7. Plan a course of action
> 8. Acquire knowledge and skills for action
> 9. Try new roles and assess feedback
> 10. Reintegrate into society with a new perspective (as cited in Franz, 2007)

Students in this study seemed to follow the 10 steps quite closely. They had a very unsuccessful experience in learning mathematics. When they began to contemplate what vocation they wanted to pursue and realized that a college education was necessary for their chosen goal, they made a conscious decision to come back to school. With their previous fixed mindset, they believed that they did not have the ability to learn mathematics. That assumption changed. Spurred on by their educational goal, their mindset changed to one of growth. They believed that with effort, persistence, and hard work, their ability could expand. As they put this belief into action, they began to see the rewards. As they consistently attended class, asked questions, did homework and took advantage of available resources, they performed well on assessments. Not only were there outward evidences of their transformation, but there were inward changes as well. The students were able to successfully connect new ideas to the anchoring ideas they already understood. They knew they were understanding. Confidence in their abilities increased. A natural by-product was an enjoyment of learning mathematics they had never tasted before. Their attitudes changed. They not only had a new perspective about learning mathematics, but they had a new perspective about themselves.

K-12 Changes

Two changes in K-12 education were suggested by students in this study—close monitoring and a math lab. They felt that if they had those two advantages, they might have been more successful in mathematics in their earlier education.

Monitoring

When students did experience difficulties, they used the strategy of avoidance to cope with their learning situation. They avoided participating in class, avoided asking for help, avoided doing homework, and avoided taking any more math classes than required.

Every one of them admitted to this strategy. Yet, reflecting back on their unsuccessful experiences, the students mentioned that they wished their teachers would have noticed their struggling and worked with them to find their points of difficulty and help them overcome them. The researcher found a paradox in this yearning for monitoring. The students did not want to seek help because they wanted to avoid others' recognition of needing help; therefore they avoided seeking it. Yet looking back, they wished the teachers would have recognized their need and helped them.

One student mentioned that all her friends thought she was a "straight A student." Yet she was struggling in her math class. She did not want them to know of her difficulties. When she was asked about what changes in her K-12 experience would have helped her be more successful, she immediately answered, "I think that if I had been monitored more carefully all the way through...when I started to flounder, that would have made a difference." Admitting that he had also avoided seeking help, another student stated that he also wished he would have been monitored much like the school monitored his speech problem, giving him extra resource help for his acknowledged difficulty.

Other students expressed the same wish of monitoring. One student said he would have liked his teacher to ask him why he was having trouble with his homework. Another said he wondered why his teacher did not ask him what could be done to help him. Given the students' pattern of avoidance, the researcher noted that students may not have reacted positively to such offerings of help at that time. Researchers, however, do suggest that teachers should "spend time closely monitoring the progress of individuals, and interact with them one on one" (Sullivan et al., 2006, p. 95).

With the inherent accountability of *No Child Left Behind*, educators have begun monitoring student progress more closely. Progress monitoring has been practiced in special education for several decades. Now educators have recommended extending progress monitoring to all students through curriculum-based measurement (CBM). Ysseldyke, Algozzine, and Thurlow (2000, as cited in Fore, Boon, Lawson, & Martin, 2007, p. 324) explained that "CBM is characterized by standardized, direct, and frequent measures of skills based in the content of the particular curriculum being used."

There are two approaches in constructing the measures—curriculum sampling and robust indicators (Foegen, Jiban, & Deno, 2007). Curriculum sampling involves constructing problems representative of what is taught in the year's curriculum. Teachers have an advantage of getting diagnostic feedback on specific skills and concepts a student is lacking. Teachers can then design effective remedial tasks to aid students in overcoming the deficiency. Curriculum sampling is limited to a particular curriculum. A different measure must be constructed for each year level and since curriculums vary, different measures would have to be constructed for different curriculums in different school districts.

Robust indicators are constructed according to the expected proficiency for a particular level. Core competence is not dependent on specific curriculums. It can be used for different grade levels and could possibly be generalized across school districts. It is useful for tracking a student's growth over multiple years. Feedback for teachers is much more general, making it more difficult to construct individualized learning activities

(Foegen et al., 2007).

Technology-enhanced continuous progress monitoring systems for mathematics have been developed to aid teachers in managing and differentiating instruction according to the results of CBM. When teachers implemented the systems as intended, “students gained significantly more than those for whom implementation was limited or nil” (Ysseldyke & Bolt, 2007, p. 253).

Progress monitoring using CBM has been practiced in elementary grades and has been found to be reliable and valid (Foegen et al., 2007). In conducting an analysis of research studies of CBM’s reliability and validity on the elementary and secondary level, Foegen and colleagues found no studies addressing mathematics CBM for high school. Further research into progress monitoring systems on the secondary level needs to be done.

Math Lab

Nine of the students in this study regularly used the college math lab resources as an aid in learning mathematics. They mentioned that access to a math lab would have helped them when they were experiencing difficulties. Reflecting upon how much the math lab had helped him, one student stated,

> I don’t understand why there’s no math labs and math tutoring help in secondary education. It’s beyond me, because that’s the first time those kids have ever seen that before.... I can’t think of a reason that there is not a math lab in every high school and every junior high.... That would have been another huge help. If you could actually go to a place and do homework with people who knew what they were doing, it would have been really good.

Another student echoed the same thoughts.

> I think it would have been helpful to have a math lab.... Because even the littlest kid in elementary school could easily benefit from the tutors.... So, a math lab from the very beginning of time!

Research has shown that some schools have adopted math labs into their learning structures (Cobb, 1998; George, 2006; Johnson, 2002; McLaughlin, 2000). Johnson examined the 11-year progress of an elementary school serving a large population of transient, low-income, non-traditional families. The school had undergone some organizational and curriculum changes, one of which was the establishment of a math lab. As a result of the changes, there was a significant growth in student learning.

McLaughlin (2000) investigated the effect of a math lab resource on at-risk tenth grade students at a large high school. The treatment group was given an elective hour of math lab. The control group did not receive any additional help. An academic skills test was given to both groups and they were tracked through graduation. Test scores and graduation rates were slightly higher for students in the experimental group. They were significantly higher for Hispanic females.

George’s (2006) study examined the effectiveness of two high schools’ intervention programs, which included a math lab. Tutors were integral to the program. Based on test scores and teacher and tutor surveys, the programs were shown to be effective. These studies seem to validate students’ observations that math labs in elementary and secondary education would aid in mathematics’ learning and success.

Conclusions

The lived experiences of students who had previously experienced difficulty in learning mathematics and who at the time of this study were successful were examined in this study. To progress from the unsuccessful period to the successful time, the students underwent significant changes. It was the object of this study to describe the students' transformations using their own voices.

The unsuccessful experience had a marked beginning. Students could recall the time period where they started experiencing difficulty and in many cases the actual concepts that gave them trouble. If students themselves knew when they started having trouble and what concepts were giving them trouble, educators should also be able to recognize a student's turning point.

As students experienced failure, they began to view themselves as incapable of learning mathematics. They developed a dislike for learning mathematics and the negative attitude began to manifest itself in their actions. Since they viewed their ability as unchangeable, they were in a state of learned helplessness where failure was inevitable. Being not yet adults, these students had no vision of the future. They did not see mathematics as being useful or applicable to their life situation at the moment. Therefore, they lacked the motivation to even try to learn.

Because students were children or adolescents during their unsuccessful experience, they were field dependent. Most of the students felt their learning environment contributed to their failures. Some felt they were lost in large classes and others had poor teachers, ones they perceived as not caring whether they learned or not. They did not feel they had much control over their circumstance; so to cope, they developed a strategy of avoidance. They avoided participating in class, avoided doing homework, avoided studying, avoided asking for help, and avoided taking any more math classes than necessary.

The successful experience also had a turning point where the students made a conscious choice to learn mathematics. Students had educational goals requiring them to take mathematics courses. They believed that their ability was malleable and that if they put forth the effort, they could learn. Because of their goals and their growth mindset, they were intrinsically motivated. They wanted to learn for understanding, knowing it would be needed in furthering their education and for life's experiences. As one student said, "Math is everywhere!"

All of the students were adults when they experienced success. As they experienced success, their attitude changed. Most of the students admitted to enjoying learning mathematics and all of them expressed confidence in being successful in subsequent math courses. The students were placed in the appropriate math class and had patient, caring, capable teachers. They were field independent learners. The students felt they had some control over their learning. They were proactive in positioning themselves in the classroom to minimize distractions. They were proactive in asking questions until they understood. They were proactive in doing homework consistently. They were proactive in using available resources including the college's math lab and tutors. The students knew if they put in the time and effort and necessary work to achieve understanding, they would be successful and they were.

The researcher was surprised at some of the results. She expected students to cite learning environment as the reason for their unsuccessful experiences. Motivation was the number one reason students gave as the difference between their being unsuccessful and successful. Although the students may not have been able to identify that their type of motivation was different between the two experiences, they knew that it had changed. With the fixed mindset, the students were extrinsically motivated. When they started having difficulties, it sent them directly to their learned-helpless state. There was no way out of that state without a change in mindset. The students' belief changed to one that held that ability could grow with students' initiative and effort. That outlook set the stage for a successful experience. In fact, that mindset was *essential* for the students' success.

The other variables added to the equation of success were the right placement, good learning resources, and capable teachers. Students recognized them as helping them to be successful, but had the students not made the effort to learn for mastery—that is to learn for understanding—those variables may not have been enough to turn the tide of failure to success. That effort was demonstrated in their classroom behavior and in their study habits. Motivation and effort were the building blocks for their success.

A principle characteristic of this group of students was that they were previously unsuccessful and are now successful. It was their belief that if they would have had the right motivation previously, they would have been successful in their previous math classes. As mentioned, these students were adults and had control over the choice of teacher and learning resources, a choice they did not have in their unsuccessful experience. The researcher sensed that this empowerment along with the growth mindset fueled the students' motivation to be successful. If these students still had no control over their learning environment, they may not have been successful as adults.

An important result of the study is the students' suggestions of what would have helped them be more successful in their K-12 experience. The researcher did not expect the response of establishing math labs in the schools. The students felt strongly that the resource of the math lab should have been available to them on the elementary and secondary level. Having a place separate from the classroom where students could go whenever they needed help would have been a resource these students said they would have used. Educators and policymakers are encouraged to investigate the feasibility of establishing math labs in the public school system.

Another suggestion that the researcher did not expect was the paradox of monitoring. Students did everything they could to avoid being monitored in their K-12 experience. For the most part, they were successful. But now looking back, they wish they would have been closely monitored and helped right away. Researchers, educators, and policymakers have the challenge of finding ways of closely monitoring those who do not want to be discovered as having mathematics learning difficulties. Both these suggestions deserve the attention of researchers. If research determines that either of them do improve student success, they will be a means of reducing the number of developmental mathematics students in colleges and universities.

Implications for Further Research

The results of this study have provided knowledge about developmental math students' perceptions of their math experiences, attitudes, and learning strategies. This project has also contributed to an understanding of what experiences have occurred to motivate the students to try and acquire the math skills they have not been able to acquire in the past and the learning strategies the students have developed to do so. As Weinsten (2004) stressed, “there is much to learn, both for the sake of “pure” learning and the sake of pragmatic applications, from listening to their voices and hearing their stories” (p. 231).

It is hoped that an understanding of the students’ past learning experiences will lead to the development of strategies to identify students experiencing learning difficulties earlier. If students experiencing math learning difficulties can be recognized earlier, they may receive the attention and instruction necessary to overcome those difficulties and be able to advance with other students at their age level. It is also hoped that the results of this project will foster the development of additional resources to aid students struggling in mathematics learning.

Students can then progress in their mathematical learning and begin their postsecondary education in college-level mathematics courses. This would lead to a reduction of developmental math students nationwide, a reduction in costs to higher education, and open up greater educational avenues for all students.

This study covered a span of ages from 19 to 51. Eight men and six women were interviewed. The sample was adequate for age and gender. However, since the western college where this study was conducted has a predominantly Caucasian population, all the participants except one Hispanic were Caucasian. Because of that limitation, some aspects may not be generalizable. Further studies with a more diverse population would need to be conducted to determine if the results are common to other ethnic groups.

This sample was also limited to successful students who labeled the common ingredient of motivation as directly contributing to their success. Students who are still experiencing learning difficulties were purposely not selected. Had these unsuccessful students been interviewed, their responses may have been different than the participants in this study. Further research investigating the challenges of unsuccessful students should be undertaken.

Further research on when and how students' formation of their mindset occurs needs to be conducted. Diagnostic measures of distinguishing students' mindsets also need to be developed. Further studies also need to investigate the influence that the learning environment has on perpetuating a particular mindset. A related topic of research would be the investigation of a student's self-awareness of increased capability and its impact on learning.

Perhaps a less important topic for research but one of interest is the relation of student achievement to the student's seat selection in class. For the most part, students in this study placed themselves fairly close to the teacher, allowing fewer distractions. No conclusive studies were found relating these two variables.

Another topic for research is effective monitoring of high school students' progress. Students suggested monitoring as one of the strategies that would have helped them be more successful in their elementary and secondary experience. As mentioned, no evidence of research regarding high school monitoring using a curriculum based measure was found.

Through investigating the lived experiences of developmental mathematics students in successful and unsuccessful periods, this study has revealed the students' realization of the importance of motivation and attitude in learning. The impact of the learning environment was acknowledged by students as well. Also unveiled in this study was the students' ability to create learning strategies that enabled them to be successful. It is hoped that the results of this study will inspire the development of learning strategies and activities to capture the curiosity of the intrinsically motivated. To love learning for its own sake is what every teacher wishes to inspire in each student. Through their lived experiences, these students have shown us their path to that goal.

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APPENDICES

Appendix A

Demographic Survey of Developmental Mathematics Students

Demographic Survey of Developmental Mathematics Students

and Preliminary Survey of Students' Perceptions

1. Math course presently enrolled in: ______________________________

2. Gender: ____Female ______Male

3. Age: _____ years

4. Race/ethnicity: _________________

5. Did you take any college-level math courses before this one?
   If so, what courses?

6. Before this course, when was your last math course? __________________

7. What was your last math course? ___________________________

8. Have you had any problems with math in the past?
   (If yes) Can you identify these problems?

9. How would you describe your attitude towards mathematics in the past?

10. How would you describe your attitude towards mathematics now?

Appendix B

Observation Protocol

Observation Protocol

Name __________________________

Course ________________________

Date ___________________________

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 C

Interview Protocol

Interview Protocol

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 questions will be asked:

1. What are some of your earliest recollections of learning mathematics?

    Probe: What other experiences do you remember?

    Probe: What do you remember about being tested in math? (Did you receive the results of the test?)

    Probe: What specific difficulties do you remember? Do you remember specific concepts that were difficult?

2. What did you do to cope with these difficulties?
3. What attitudes do you recall having toward math in the past?
4. Talk about your placement in developmental mathematics courses in college.

    Probe: Was the placement expected or a surprise?

    Probe: Was it a good placement? Why or why not?

5. You are now very successful in your present math course. Why do you

think you are successful now when you were not successful before?

Probe: What experiences and learning strategies have helped you?

Probe: How would you describe your present attitude toward learning mathematics?

6. Knowing what you know now, what changes in your K-12 math learning experience would have helped you be more successful then?
7. What else would you like to say about the process of shifting from an unsuccessful math student to a successful math student?

Appendix D

Informed Consent

Informed Consent

Introduction/ Purpose	Laurel Howard, a doctoral candidate at Utah State University and a faculty member of the Developmental Mathematics at UVSC, is conducting a research study to determine the perceptions of mathematics students in unsuccessful and successful learning.
Procedure	If you agree to be in this study, the researcher will interview you with open-ended questions about your perceptions and experiences in learning mathematics using an audio recorder. The interview will be approximately 60 minutes in length. A follow-up interview may be necessary to provide you an opportunity to clarify or affirm the information obtained in the interview.
Risks	There are minimal risks involved in this study.
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.
Voluntary participation & right to withdraw	Participation in this study is entirely voluntary. You may withdraw at any time, or refuse to participate without consequence.
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 student researcher and the principal investigator, (b) all coding documents will be stored in double-locked filing cabinets, (c) confidential assessment data from instructors will be kept from coding documents in a separate locked filing cabinet, (d) names of persons identified in the research will be given pseudonyms as it is anticipated that some statements will be quoted, (e) information collected will not be released to any person at UVSC, (f) written records will be shredded within 12 months of completing the study and audio records will be destroyed within 6 months of completion of the project.

IRB Approval	The Institutional Review Board (IRB) for the protection of human subjects at Utah State University and the Institutional Review Board for the protection of human Subjects at Utah Valley State College will review and approve this research project prior to its implementation.
Reporting of Results	The results of this study will be reported in a doctoral dissertation at Utah State University. Other articles may be published in educational journals. It is anticipated that the dissertation will be available by April 2008 through Dissertation Abstracts International.
Documentation of explanations provided	Laurel Howard has explained this study to you and answered your questions to your satisfaction. If you have other questions, you may reach Laurel Howard at 801-863-6311 or howardla@uvsc.edu.

Signature of principal investigator: ______________________________

Dr. Gary Straquadine
435-797-3521

Signature of student researcher: ______________________________

Laurel Howard
801-863-6311

Signature of subject: ______________________________

By signing above, I agree to participate

____

Phone Number

____

E-Mail Address

____

Date

Appendix E

Study Information for Instructors

For the Proposed Study
Perceptions of Developmental Students of their Unsuccessful and Successful Mathematics Learning Experiences

Researcher: Laurel Howard, Assistant Professor
Developmental Mathematics
Utah Valley State College
Orem, UT 84058
(801) 863-6311
howardla@uvsc.edu

For the proposed study, I would like to interview developmental mathematics students who are presently very successful in your current math class and who have had trouble learning mathematics in the past. The only stipulation is that these students do not have a diagnosed learning disability.

The research literature is very limited in giving students themselves a voice in what happened to them and what they are experiencing now. This study would fill that gap. Based on the findings, it may be possible to develop identifying criteria of students who are struggling in elementary or secondary school and construct a learning environment to help them.

This will take very little of your time. Here is what I would need from you:

1. During the sixth or seventh week of the semester, select two very successful students in each math course you teach. (By then, I think you would know who is successful and will continue being successful.)
2. Ask them if they would be willing to participate in this study.
3. When you find two willing volunteers, fill in their name, phone, and email address on a form I will give you.
4. Tell them I will contact them.
5. With their permission, send me copies of their assessment scores in your class.

The students will be expected to:

1. Come for an interview at midsemester. This interview could last an hour.
2. Sign an informed consent form, which gives written details of the study, and which says that they have volunteered to help with the study and that they can withdraw at any time.
3. Read over the final report for accuracy of their statements.

With your permission, I would also like to observe these students three times in your class and write down my observations of them.

I will contact you individually about the study to answer any questions. If you do not feel you can help in this study, I understand. If you can help me, it will be greatly appreciated.

Appendix F

Bracketing Interview

Bracketing Interview of Laurel Howard

By Jeff Maxfield

Jeff: What are some of your earliest recollections of learning mathematics?

Laurel: I remember learning them in the car that is learning math facts in the car with my dad before I was even in Kindergarten.

Jeff: Him quizzing you?

Laurel: Yah. Instead of singing songs along the way or pointing out things outside, he'd ask me math facts. So, I've always liked math.

Jeff: Is that because, I'm going to probe here a little bit, is that because of a connection with your father or have you always liked math?

Laurel: I think I've always liked it because it came easy to me.

Jeff: OK, what other early experiences do you remember?

Laurel: I remember going through school and learning my math facts when I was in third and fourth grade and learning how to divide and doing all of those things all along the way. I remember not being put in an advanced math class in junior high because they didn't check my test scores. I remember being bored.

Jeff: You know, everybody has some anxieties, especially when testing. What do you remember about being tested in math? Did you ever find out what your results were?

Laurel: I never did. Not what the school tested me in.

Jeff: You never found out the results of the standardized testing.

Laurel: I never did. I don't know what it even entailed.

Jeff: OK. Do you find yourself remembering any difficulties you might have had?

Laurel: I never experienced difficulties until I was in grad. school getting my Master's Degree.

Jeff: Things were a little more complex.

Laurel: Yah.

Jeff: What did you do to cope with those difficulties?

Laurel: I studied with other students and tried to understand it like they understood it. I went to the teacher sometimes and asked for explanations. Sometimes I realized after talking to some of the other students it wasn't as bad as I thought.

Jeff: Did you ever have an experience where you weren't as bright as some of the other students in the class?

Laurel: Oh yah.

Jeff: How did that impact you?

Laurel: Oh, I think I have an appreciation for my students because I did not catch on right away. And I needed more explanation. It's frustrating when you don't get the explanation and I try really hard when I'm teaching to watch for students that aren't getting it.

Jeff: What kind of, I'm going to probe a little deeper about frustration, what kind of frustration did you have when you don't get that feedback?

Laurel: It's almost a hopelessness, like I don't think I can learn it without some outside help. And then when you don't get the outside help, then you really are hopeless. You want to give up. Or you try to think of some other way to get past it. It's hard. It's really hard. I can see where a lot of developmental math students have had experiences where they have felt the same way for a long time.

Jeff: I want to go back and talk about learning from peers. Did you find any difficulty in learning from peers, either they taught you the wrong way or they got you thinking in the wrong direction, or conversely really helped you with the way they thought?

Laurel: I've had both. I've had where they have really caused a light-bulb moment for me. Sometimes, I say " Oh, That's how it is!" I've had where somebody's explained it to me and it doesn't quite gel and I've asked the instructor and we were both off. I've had both experiences.

Jeff: Does that have any impact on your feeling towards math or is this just one of those things that usually happens?

Laurel: I think it's one of those things that happens. It happens in other things too. I've had a physics class like that.

Jeff: OK What attitudes do you recall having towards mathematics in the past?

Laurel: I have always liked it. I've always liked it all the way through school, and even when I was in grad school when I had some difficult classes, I still liked it. I'd get frustrated, but I still liked it.

Jeff: But the frustration would not get in the way of your continuing on?

Laurel: No.

Jeff: You had no fear of failure.

Laurel: Oh, I did. That's why I kept searching for ways to understand it. I think fear of failure drove me, like it is in this doctoral program. That's what's driving me.

Jeff: I understand that. Talk about developmental math courses in college. How do you feel about them in particular. I know you are not placed in one; you probably never were, but how do you feel about them? Are they necessary? Are they unnecessary?

Laurel: They are necessary right now. I wish in a way they weren't. I wish students were able to get all they needed in their junior high and high school education because if they have to come to college and take developmental math, they are never going to be able to take a major or complete a major that requires a lot of math. They just can't and maybe they would like to, but they can't. So, it kind of limits their choices.

Jeff: Let me probe that just a little bit. Why do you think there are so many students in developmental mathematics?

Laurel: Well, for the traditional students, I think that somewhere along the way, they had a stopping point. Math is a unique subject in that it builds on itself. Concepts build on each other. What you understand today helps you understand tomorrow. And if you don't understand what you learned today, you won't understand tomorrow.

Jeff: There's kind of a linear aspect to it?

Laurel: Yes! And so somewhere along the line, they had a stopping point where they didn't understand something and nobody picked it up. Not their teacher or them. And students are very good at hiding that they don't know something. They don't want the others in the class to know that they don't know something so they hide it. They become dependent on the calculator or switching classes or take a correspondence course and graduate. I've had one student do that. They have somebody help them do their correspondence course. That's sad to me. This fear of failure, the fear of being labeled by the rest of the class.

Jeff: You mentioned a stopping point somewhere. Do you think there could be a starting point where they could start learning again?

Laurel: Yah. I've had students where that has happened to them. One girl stopped in fifth grade. She had a stopping point in fifth grade and ended up graduating from high school with a correspondence course, because that's the only way she could graduate. And she came into my class which was the lowest level math class she could take and got straight A's in my class. She got straight A's in the next class. I tracked her. She got straight A's in the next class, and she came back to my intermediate algebra class and got straight A's in my class. She was bright. She hit a stopping point. She thought she was dumb. And from then on, she gave up.

Jeff: So could someone who is in developmental math go on and take on a science career?

Laurel: Right. Right.

Jeff: OK. So, I just identified one of your biases for you, if you'll listen back at this, because you said that they can't really go on, so . . .

Laurel: That's true.

Jeff: I'm helping you out here identify your biases.

Laurel: Yah.

Jeff: You were pretty successful in math. When you haven't been in the past, is it teacher-centered? Or is it curriculum-based? Or is it

Laurel: I hate to do this because I am a teacher, but I would say that a lot of the blame goes to the teacher.

Jeff: On their inability to teach or on their curriculum structure or how they've put the course together.

Laurel: I think more on their inability to teach. I've had a lot of people who are very good people and are very good mathematicians, but are not good teachers. They just can't get the ideas across. I'm the kind of the student who has always put out the effort to try to learn. I know some students are lazy. There's another bias. But I haven't done it that way. So, I think a lot of it is the teacher.

Jeff: OK. What would be your present attitude right now regarding mathematics, in particular, this program of developmental mathematics?

Laurel: I think it's a good program. It meets the needs of the kids who are coming in from high school. It also meets the needs of the non-traditional students. This is the only program that meets their needs. They graduated from high school 20 years ago. They can't go back to high school. We can't penalize them from not learning it then, because back then it was not developmental math. It was a college-level course. And so I think it's beneficial for all of the students. It's sad that we have to have it for the traditional students but it's important that we have it for the non-traditional students for sure, because there is no other place for them.

Jeff: They can't go back to a high school teacher and get tutoring and

Laurel: Right! So, it's important that they have a place to go.

Jeff: Knowing what you know now, what changes would you make in the K-12 program?

Laurel: If there would be some way that we could do it, I would like to see some type of diagnostic of kids every year, so you could figure out what they did not understand. And catch them right then. Then get them into even if it's a lower course level than what they're taking. Get them into something. Get them some help, so that they can get the understanding they need so they can catch up. I think they could. When students are in overcrowded classrooms, I think it is a difficult thing to find the kids having trouble or even diagnose them.

Jeff: OK. Anything else you'd like to add about taking an unsuccessful math student to success?

Laurel: I think it can be done with most students. I do think that there are some that have diagnosed learning disabilities and some with undiagnosed learning disabilities that they'll never learn their math facts or that they'll be able to do some of the math things because they don't have the ability, but I think for a lot of them, they could.

Jeff: As a teacher of college-level students, what is your view of them if they tend to not care or can't care about math?

Laurel: Oh, I have quite a few that don't and I don't blame them because they've failed so many times in school that they don't want to try any more. But I really try hard to give them the enthusiasm that they can be successful, and provide a comfortable atmosphere where they feel they can ask questions and not feel funny in front of the class or feel embarrassed for asking such a question. That's my number one thing to do is make sure that everyone feels comfortable asking questions and you know if my classes were a little smaller, that would help, but that's OK. They're not.

Jeff: Would a TA help or a grad assistant help in some way or not?

Laurel: Maybe. I hadn't thought about that but what I try to do is learn each of their names the first couple weeks and make sure I get to know them a little bit. I try to talk to them before class starts and if I can get to that point where I'm friendly enough where they feel like I am not any threat to them. If they feel like I am a facilitator to their learning, that makes all the difference, I think of them wanting to learn and them feeling like they have a chance. They have to feel like they have a chance to learn it.

Jeff: Anything else you want to add before we close this up?

Laurel: Not that I can think of.

Jeff: It's not a terrible process, but I think you've identified a few areas that you need to bracket of the experience so that you don't shape it through your lens.

Laurel: Yah.

Jeff: And that's the key.

Laurel: Tell me some things you saw.

Jeff: Well, I think you have I don't want to call it pollyanic, but you have an anybody can do it if they get the right teaching and stuff attitude. That may not be how they feel or it may not be the truth for them. So, I would be careful to not "halo" effect the student. I kind of got that feeling from you. The other thing is a strong bias came out of my interview to against instructors of the past. You know like I had a real hard time with certain instructors, particularly those who tried to indoctrinate rather than educate. I'm more of a Socratic method probably. They are more of tell me what to learn and I'll learn it rather than I'm the one with all the knowledge. This is what you will learn kind of experience. I think a little bias towards that came out. Those are the two main ones that I saw.

Appendix G

Letter of Verification

August, 2008

Laurel Howard, a Doctoral Candidate at Utah State University, requested that I read the transcripts of interviews she has collected as data for her dissertation. I was also asked to review her analysis of these gathered data.

Laurel's analysis contains accurate quotations of the study participants. While reading these transcripts and Laurel's analysis, the themes she identified were apparent from participant responses. Each student identified his/her difficulties encountered regarding mathematics in early educational experiences. While the ages when the difficulty appeared are different for each of the study participants, the reported causes or reasons were consistent and presented accurately. Each student reported an avoidance of math when possible with acceptance/expectation of lower grades. Each student also reported in their Developmental Math Program experience he/she began to have an understanding about the applicability of math to their chosen field of study and an enhanced ability to understand and use math concepts.

Laurel has used complete and accurate quotations from the study participants to demonstrate emergence of overarching themes and related subthemes. Her explanations are documented by the statements of the study participants, allowing the participants' voices to verify her analysis of student experiences.

Based upon the review of the gathered data , I believe Laurel's analysis and presentation of the emergent themes is consistent with the students' reported experiences. The analysis is thorough, clearly presented, and well documented.

R. Jeffery Maxfield, Ed.D.
Assistant Dean/Emergency Services Program
Utah Valley University

CURRICULUM VITAE

LAUREL HOWARD

Utah Valley University
Developmental Mathematics Department
LA 217d
800 W. University Parkway
Orem, Utah

EDUCATION

Doctor of Education	Utah State University, Logan, Utah Curriculum and Instruction
Master of Science 1973	Brigham Young University, Provo, Utah Mathematics—emphasis Algebraic Topology
Bachelor of Science 1971	Brigham Young University, Provo, Utah Major—Mathematics Minor—German Utah Secondary Teaching Certificate Honors: Graduated Magna Cum Laude Honors Program Voted Most Outstanding Student Teacher

TEACHING EXPERIENCE

9/03-Present	Utah Valley State College, Orem, Utah Associate Professor, Developmental Math Department MAT 800 *Arithmetic Review* MAT 990 *Beginning Algebra* MAT 1010 *Intermediate Algebra*
9/98-9/03	Brigham Young University, Provo, Utah Instructor of Mathematics Course Coordinator for *College Algebra & Trigonometry* MATH 110 *College Algebra & Trigonometry (Traditional & Computer-based)* MATH 305 *Mathematics for Elementary Education Majors*

MATH 306 *Mathematics for Elementary Education Majors*

9/97-6/98 Salt Lake Community College, Salt Lake City, Utah
Instructor of Mathematics
Mathematics for Elementary Teachers
Intermediate Algebra

9/80-7/97 Mesa Community College, Mesa, Arizona
Instructor of Mathematics
Developed Basic Skills Math self-paced computer-Assisted learning program
Self-paced Basic Skills Math
Beginning Algebra
Intermediate Algebra
College Algebra
Science & Engineering Calculus (Traditional & Harvard Reform)
Brief Calculus

8/78-5/82 Arizona State University, Tempe, Arizona
Instructor of Mathematics
Intermediate Algebra
College Algebra

1/75-4/78 Brigham Young University, Provo, Utah
1/73-4/73 Instructor of Mathematics
Director of Modular *College Algebra & Trigonometry Program*
Wrote sample tests for text.
College Algebra & Trigonometry
Mathematics for Elementary Education Majors

PRESENTATIONS

MAA Conference “College Algebra Online Course”
BYU-Idaho, Rexburg, Idaho April 2001

American Mathematical Association of Two Year Colleges
“Does Class Size Impact Student Achievement?”
Cincinnati, Ohio November, 2006

International Conference on Research in Access and Developmental Education

"Developmental Students' Perceptions of Unsuccessful and Successful Mathematics Learning"
San Juan, Puerto Rico, September, 2008

Conference Participation

National College Teachers of Mathematics
Orlando, Florida November, 1995

American Mathematical Association of Two Year Colleges
Salt Lake City, Utah November, 2003
Orlando, Florida November, 2004
San Diego, California November, 2005
Cincinnati, Ohio November, 2006

Southwest Association for Developmental Education
Salt Lake City, Utah October, 2007

International Conference on Research in Access and Developmental Education
San Juan, Puerto Rico, September, 2008

Professional Publication Subscriptions

The AMATYC Review 2003-present

Professional Organizations

AMATYC-American Mathematical Association of Two Year Colleges
SWADE-Southwest Association for Developmental Education

Leadership

Utah Valley State College
Chair, Faculty Search Committee, Summer, 2007
Member, DTRP Committee 2005-present
Member, Faculty Excellence Award Committee Spring 2005
Member, Academic Policy Committee 2004-present
Member, Academic Standards Committee 2005-present
Member, Personnel and Elections Committee 2007-present
Member, UVSC Faculty Excellence Award Night Committee Spring 2004

Brigham Young University
Member, General Education Committee

Mesa Community College
Member, Basic Skills Committee for English, Reading, & Math 1994-1997
Member, Hiring Committee Spring 1995

AWARDS

School of General Academics, Faculty Excellence Nominee, Spring 2008
School of General Academics, Faculty Excellence Nominee, Spring 2007
School of General Academics, Faculty Excellence Nominee, Spring 2006
School of General Academics, Faculty Excellence Nominee, Spring 2004