DISSERTATION

A COMMUNITY COLLEGE BASIC ARITHMETIC COURSE:
PREDICTIVE FACTORS FOR SUCCESS

Submitted by

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY GAYLE LYNN KRZEMIEN ENTITLED A COMMUNITY COLLEGE BASIC ARITHMETIC COURSE: PREDICTIVE FACTORS FOR SUCCESS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATION AND HUMAN RESOURCE STUDIES.

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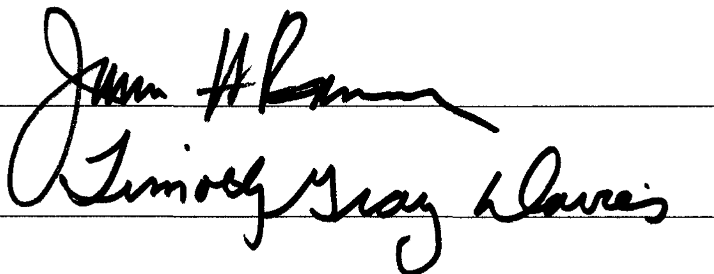

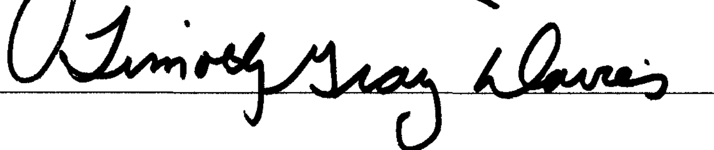

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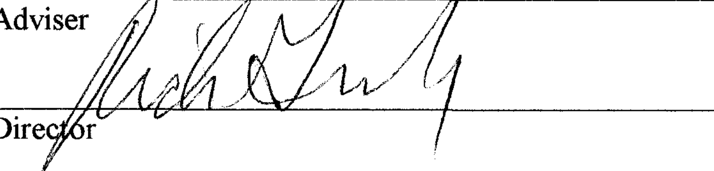

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ABSTRACT OF DISSERTATION

A COMMUNITY COLLEGE BASIC ARITHMETIC COURSE: PREDICTIVE FACTORS FOR SUCCESS

Despite the increased availability of technology to aid students' learning, more rather than fewer students who are under-prepared in basic mathematical skills are entering the community college. Clearly, curricular trends in K-12 mathematics have not produced a generation of high school graduates who are more capable in their computational skills than their counterparts of the previous generations. It is incumbent upon those who teach developmental math in the community colleges, as well as those whose courses and programs these students eventually enter, to determine what makes for a successful academic experience in this critical gatekeeper course.

This study examined the gain scores of students from a pretest-posttest administration of the ASSET Numerical Skills Test in both a computer-mediated setting and a traditional lecture-discussion setting for an entry-level arithmetic course at a community college. Besides the effect of presentation method on gain score, a number of additional independent variables were examined to see if individually or in some combination these variables were better predictors of success. Qualitative data was gathered from several settings to focus on the experiential side of the course from the students' perspectives as well as through observations by the teachers of the sections involved in the study.

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The results of the analysis revealed that presentation method was the only independent variable that produced a significant effect on gain score. The fact that the other independent variables did not produce a significant effect would suggest that the greatest determining factor of student success is the classroom experience, not factors such as age, gender, number of hours working per week or previous experience using a computer. The qualitative data provided an experiential context for the quantitative outcomes and suggested that individual success might also be related to specific student characteristics.

Future studies might include a larger selection of class sections that would cover a broader spectrum of the overall community college student population. Attempts might be made to identify those students who are best suited to a computer-based setting and examine their gain scores in comparison to those of students in a traditional class.

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DEDICATION

For Wayne and Scott, my sons, who have given me the greatest joy of my life.

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CHAPTER I - INTRODUCTION

Deanna is a typical basic arithmetic student in her first semester at a community college. Her placement test score placed her in MAT 036, General Skills in Mathematics. She feels that this is somewhat a waste of her time, and a bit of an embarrassment as, in her words, "I've had this stuff since I was in grade school. Why do I have to take it again?" When asked about her previous experiences in math class, Deanna replied, "Tragedy!" She went on to explain that she never felt comfortable in math class; all the facts seemed to swim before her in an ocean of unrelated rules. "Sometimes," she explained, "I would get an answer right, but I was never really sure why, so I couldn't tell if I would get the next one right. Mostly, I just learned how to work the mechanics to find the right answer, not why the mechanics worked." Although she is resigned to having to take this class, Deanna feels that there is nothing new to be offered and that she will just have to endure the semester.

The Developmental Math Student

Deanna's experience is not unlike that of many incoming community college students today. Currently, there are three dominant groups who enroll in developmental math courses. The first is comprised of adults who are returning to school after a number of years, many who did not have an adequate high school math experience or who, through lack of reinforcement, have forgotten some of their basic arithmetic skills. The second group is comprised of those who are recently out of high school. Phillip Mackey, Vice President of Student Services at Carl Sandburg College in Galesburg, Illinois,

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(personal communication, October 16, 1998) indicated that a trend he has observed over the past several years is that more and more recent high school graduates are being admitted who need one or more developmental-level courses. The third group is an increasing population of students who, throughout their K-12 years, have had a predominantly special education experience. As such, according to Judy Kort (personal communication December 9, 1998), they often have received a high school diploma in the sense that they have completed the objectives on their Individual Education Program (IEP), but this conveys little concrete evidence of what skills they actually have, or have not, acquired.

Instructional Issues

As Horn (1997) reported, "...the current movement toward collaborative learning in American college classrooms (is traced) not to radical politics nor to research, but to a 'desperate response' to the particularly large numbers of under-prepared students entering colleges all over the country during the early 1970s" (p. 26). Some of them are adult learners who simply need a refresher course. Many of these students, however, display a lack of ability to sustain focus for more than a short time, an attitude of waiting to be "entertained" as well as a general lack of preparation for active participation in academic work. Large numbers of students recently out of high school have developed extensive dependence on the use of calculators for basic arithmetic operations. In this manner they have been able to find correct answers, but as they lack a command of underlying processes, they cannot extend their thinking to abstract settings. Often this manifests itself in answers that are illogical, but because obtained from a calculator, are deemed correct. An example is finding the selling price of a $450 television with 6.4% sales tax.

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One student wrote $2880. She clearly did not pay attention to proper placement of the decimal point to find the tax ($28.80) nor did she add the tax amount to the price of the item. Such errors are common.

Students who are of the opinion that learning (math) is more difficult for them often have the idea that "good" students do not have to work hard to achieve academically (Yaworski, 1998). Many at-risk students bring a sense of helplessness and uncontrollable failure with them to the classroom. The degree to which students involve themselves in learning tasks is influenced by their perceptions of internal and external factors that control their behavior. Students who believe that teachers or the conditions of their lives control what happens to them may assume a "why try?" attitude (Roueche & Roueche, 1993). Breaking this cycle is one key to moving students beyond their deficiencies in basic skills to being in charge of their academic pursuits. The following illustrates how one young woman humorously captured this feeling that an individual's potential for excelling in mathematics is predetermined.

> On the eighth day, God created mathematics. He took stainless steel, and he rolled it out thin, and he made it into a fence, forty cubits high, and infinite cubits long. And on this fence, in fair capitals, he did print rules, theorems, axioms and pointed reminders. "Invert and multiply." "The square on the hypotenuse is three decibels louder than one hand clapping." "Always do what's in the parentheses first." And when he was finished, he said, "On one side of this fence will reside those who are good at math. And on the other will remain those who are bad at math, and woe unto them, for they shall weep and gnash their teeth" (Buerk, 1985, p. 59).

Aside from attitudinal barriers, a significant deficit exhibited by the current population of those enrolled in basic arithmetic classes is their inability to function as students. We need to know not only what content to present to these students, but also what conditions foster the development of student-like behaviors. What makes enrollees

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become students? What makes them want to be successful? These questions must be answered for instructors to structure appropriate learning environments. Recent research (e.g., Bell 1998), reports from two decades ago (e.g., Eldersveld 1983), have suggested that there are multiple interactive factors that affect student success. In structuring a developmental arithmetic course, it is essential to keep in mind three areas of activity that are most directly related to student success: a) student contact with faculty and peers, b) student classroom experience, and c) student learning behaviors (Tinto, 1987). All of these should be positive for an optimal learning experience to take place. Furthermore, in mathematics there is a tendency to focus primarily on content presentation issues, as noted by Rupnow and Bogenschild (1998), "(I)f indeed there is reportedly a relationship between the affective and cognitive domains, could it then be possible that greater satisfaction with the learning setting has a favorable impact upon achievement?" (p. 28). It is critical to pay closer attention to what atmosphere is created in the math classroom.

As noted by Tinto (1987), interaction with peers is directly related to student success, yet most math classes are structured to promote students working in isolation. If Horn's (1997) suggestion that there are few true lone wolves among the most successful students is true, then the challenge is to make math classrooms environments within which students begin to form those supportive peer relationships that will transform them as learners.

Research Problem and Questions

The research problem of this study was to investigate the students' experience in a basic arithmetic course, MAT 036, at a community college. The quantitative portion of

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the study examined the effect of various factors on achievement gain scores from the pretest to the posttest on the ASSET Numerical Skills Test.

Independent Variables

Presentation method, dichotomous: Control Group
Experimental/Academic Systems Group

Age of student, normal

Gender of student, dichotomous: Male
Female

Number of years since last educational experience (taking a class), normal

Number of hours student is working per week, normal

Required to take any math courses beyond MAT 036, dichotomous: Yes
No

Previous experience using a computer, dichotomous: Yes
No

Computer ownership, dichotomous: Yes
No

Computer access at work, dichotomous: Yes
No

Comfort level using computers, normal

Weekly amount of computer use, normal

Dependent Variable

Gain score from pretest and posttest of the ASSET Numerical Skills Test, normal

Research Questions

This research study used a quasi-experimental, pretest-posttest nonequivalent comparison control group design. Since the research problem was to investigate the effect

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of various factors on achievement gain score in a basic arithmetic course at a community college, the following research questions were posed.

1. Is there a difference between presentation methods in regard to achievement gain score?
2. Is there an association between age and achievement gain score?
3. Is there a difference between genders in regard to achievement gain score?
4. Is there an association between number of years since the last educational experience (taking a class) and achievement gain score?
5. Is there an association between number of hours working per week and achievement gain score?
6. Is there a difference between students who do and do not need a math course beyond MAT 036 in regard to achievement gain score?
7. Is there a difference between students who have and have not had previous experience using a computer in regard to achievement gain score?
8. Is there a difference between students who do and do not own a computer in regard to achievement gain score?
9. Is there a difference between students who do and do not have access to a computer at work in regard to achievement gain score?
10. Is there an association between comfort level working with computers and achievement gain score?
11. Is there an association between amount of weekly computer use and achievement gain score?

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12. Is there a combination of variables that predicts achievement gain score better than any predictor variable alone?

A minor addition to the quantitative portion of the study was to examine gain score and retention for the two dominant presentation methods – lecture-discussion and Academic Systems – and a group-support presentation method. This portion of the study posed the following research questions.

13. Is there a difference between presentation methods in regard to achievement gain score?
14. Is there a difference between presentation methods in regard to retention?

Two additional quantitative research questions derived from the student responses to the writing prompt, "What has math been like for you and what do you expect to get out of this class?"

15. Is there a difference between students who have had positive past experiences with math and students who have had negative past experiences in regard to achievement gain score?
16. Is there a difference between student expectations for the course in regard to achievement gain score?

The qualitative portion of the study focused on investigating the experiential side of the MAT 036 course from the students' perspectives as well as through observations by faculty (including the researcher), posing the following research questions.

1. What is the classroom experience that is observed in the sections using the different presentation methods?

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2. What are the dominant themes that emerge from interviews with the faculty using the different presentation methods?
3. What are the dominant themes that emerge regarding students' reporting of their experiences in classes that use the different presentation methods?
4. From a faculty perspective, what are the dominant themes that emerge regarding the perceived differences between the presentation methods?

Definitions

Lecture-Discussion Presentation Method

The lecture-discussion presentation method is commonly thought of as the traditional manner of teaching. The majority of class time was spent with the teacher presenting material in a coherent and sequenced format, eliciting questions and input from students during the process. The teacher typically explained a mathematical process at the board so that students could see the process unfolding piece-by-piece. During this presentation, vocabulary and alternative approaches were integrated into the discussion and students could stop the teacher to ask questions during the process. Although some group work or students working problems in front of the class may have been included, this method predominantly relied on a teacher-directed experience. A standard textbook with comprehensive examples and practice problems as well as homework problems was used in these classes.

Academic Systems Presentation Method

The Academic Systems presentation method used a mediated-learning computer software approach. Students were guided through concept development on the computer, and they had options to choose from which provided enhanced and varied explanations of

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the material. They then worked problems on the computer related to each of the major concepts. Two major differences from the lecture-discussion method were, first, that windows of information were often presented as a block rather than the piece-by-piece evolution characteristic of a teacher demonstrating at the board, second, although the Academic Systems method did provide alternative explanations and vocabulary development, these options depended on student initiated access by clicking on the appropriate icon on the screen. This method, while often presenting material in short blocks of content, did contain a "Go On" button so students could control when the next piece was displayed. Short lecture embellishments were also incorporated into the classroom experience to expand on concepts that were not addressed or were addressed minimally in the computer software. Students' homework was in a separate textbook that contained examples as well as a substantial bank of problems.

Group-Support Presentation Method

This method was a modification of the lecture-discussion presentation method and used the same textbook. However, there were several additional components to this method that differed from a traditionally structured class. Students were required to respond to a journal prompt on each chapter syllabus and then to two additional journal questions that were posed by the teacher based on their previous responses or on current content. The purpose of this activity was two-fold: 1) it gave the teacher insight into the students' experience in the class and 2) it challenged the students to write about the mathematical processes that they were using in their homework. Students also took a group test the day prior to each chapter test and the final. For groups in which all participants scored at least 80 percent on the individual test, three bonus points were

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added to their test score (Rupnow & Bogenschild, 1998). Additionally, students made one or two group presentations during the semester to introduce new content or to review previous content.

Another difference in this method was that the teacher incorporated several group activities into the classroom setting that deviated from a traditional presentation. In the chapter on fractions, she provided several packages of food items for students to have a hands-on experience with giving away various portions (1/6, 2/3, 3/4, etc.) of the items to classmates and had the class participate in a "pizza fractions" activity where uncut pizzas were ordered for class and the students worked out several mixed number subtraction problems using the pizzas. Later in the semester, the teacher used the video *Donald Duck in Mathemagic Land* in a class session to illustrate that mathematics is part of every facet of life.

Delimitations

The data for this study were taken from an institutional program evaluation effort at a community college that used the daytime class offerings (between 8:00 a.m. and 3:50 p.m.) on the largest campus of this multi-campus college. It is possible that there may have been significant differences in those students who attended night classes or attended one of the other campuses in the same city.

Limitations

This was a field study, not a research design where students would have been randomly assigned to each class section. The computer-based classes were identified in the semester class schedule; however, what frequently determines students' choice of section is whether it meets their scheduling needs. The fact that there is no reason to think

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that the students in one section differed markedly from those in another implies that this limitation should not have had a negative impact on the study's outcomes. The four sections that participated in the classroom feedback sessions may have shown higher gains due to more buy-in from students feeling empowered (Timpson, 1998). The experience of students in the group-support method may have derived more from the particular teaching style of the teacher, who was the researcher, than from the components that differentiated it from the traditional lecture-discussion method.

Significance

The conditions that create independent students who are motivated to learn out of those who enroll for classes are still unclear. Although much research has been done on how college affects students, the majority of the studies focus on four-year colleges (Depree, 1998). With a course such as MAT 036 serving as a port-of-entry for so many community college students, it is critical that educators gain an understanding of the experience of students taking such courses. Although many adult learners need only brush up their skills, "(f)rom a student standpoint, the major change of the last 10-15 years is the weakened academic ability of recent high school graduates. Arithmetic was a minor portion of most developmental education math programs in 1985. It is now a common entry course for many students in the community college" (Hackworth, 2000).

In 1995, the Colorado Community College and Occupational Education System office (now called Colorado Community College System) profiled students enrolled in remedial coursework in System community colleges. That study established its first, system-wide demographic profile of Basic Skill Education (BSE) students. The baseline year was academic year 1993-1994. A study done in academic year 1997-1998 updated

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that effort and added more detailed information. The updated study concluded "younger students (under twenty-two years old) comprised a higher proportion of BSE enrollments in 1997-1998 than their older counterparts. In 1993-1994, younger students comprised 32.1 percent of BSE headcount, compared to 42.9 percent in 1997-1998" (Zhou & Voorhees, 1999).

Despite the increased availability of technology to aid students' learning, it seems that from interviews with community college math faculty, more rather than fewer students who are under-prepared in basic mathematical skills are entering the community college. Clearly, curricular trends in K-12 mathematics have not produced a generation of high school graduates who are more capable in their computational skills than their counterparts of the previous generations. It is incumbent upon those who teach developmental math in the community colleges, as well as those whose courses and programs these students eventually enter, to determine what makes for a successful academic experience in this critical gatekeeper course.

As the data collected for this study were related to a program evaluation effort, the institution was seeking to determine if there was a clear indication that students gain more from one method or the other to assist in decision making about future class presentation methods. If there was no significant difference, and achievement appeared to be more related to individual student learning style preferences, then that information would support the institution continuing to offer a choice in presentation methods. It would also highlight the importance of appropriate initial advising of students to place them in a section where their chance of success is maximized.

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The current and future world order is not and will not be based on acquisition of a fixed body of information, but, as noted by DePree (1998), will be characterized by, "the shift from an industrial society to an information-processing society (that) has transformed the field of mathematics education" (p. 2). Students who cannot use appropriate mathematical processes to solve new problems will not be prepared to meet some of the challenges that lie ahead.

Researcher's Perspective

The researcher's interest stems from the fact that she has taught developmental math at the institution where the study was conducted for the past 14 years. During that time, she has experienced both the frustrations of students who are struggling to gain a command of basic arithmetic skills to which they have been exposed for years, and her own frustrations of how to present such material in a manner that captures their interest and motivation. This course is, in the view of the researcher, the most difficult of math courses to teach, not from the standpoint of content complexity but rather because it is difficult to motivate students to take their deficiencies seriously. Many of these students begin their tenure at the community college with considerable preconceptions about mathematics, frequently negative. They lack a history of positive and successful experiences in math, yet they rebel against the need to build a solid computational and conceptual foundation. Along with their skill deficiencies, they bring many misconceptions wih them.

With respect to the research study, the researcher was the only faculty member currently using the group-support method; thus, she had a vested interest in exploring

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whether the components she used to modify the traditional lecture-discussion method made a significant difference in the students' classroom experience.

The problem that presented itself was not to determine which of these methods was best for teaching basic arithmetic to adults, but rather what components of each contribute to creating successful experiences for students previously unsuccessful in mathematics. Out of those components, perhaps a blueprint for constructing one or more methods that provide for maximum achievement could be derived.

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CHAPTER II – LITERATURE REVIEW

Overview

The literature on developmental mathematics instruction covers a wide spectrum. It addresses outcomes of various instructional methods as well as considerable breadth on a number of active, attribute and extraneous variables. For this study, the literature review begins with a brief background on the community college and who the developmental students are. It then addresses developmental mathematics instruction and why literacy in math is of vital interest for today's population of students. Following that is a discussion of various presentation methods that have been and are being used in developmental math courses at the community college, along with research on the effects of several variables on the developmental math experience. Concluding this section is an exploration of the literature on the incorporation of calculators, computers and technology into developmental mathematics courses.

The Community College Background

The community college, as it is known today, grew out of the juniorcollege of the late 1800s with the first public junior college established in 1901. One part of the mission of early junior colleges was to provide for the first two years of the baccalaureate degree. In the 1950s and 1960s, the term *junior college* was most often applied to the lower-division branches of private universities and to two-year colleges that were independent or church supported. *Community college* referred to the comprehensive, publicly supported institutions. By the 1970s, the term *community college* was usually applied to

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both types of institutions. The community colleges experienced rapid expansion during the 1960s that was fueled by high birthrates in the 1940s and returning soldiers taking advantage of their military education benefits. The profile of students enrolling during this period produced significant changes in the student body. No more were the students a fairly homogeneous group that were completing the first two years of a four-year degree. Instead, students of increasing diversity, many of whom were not being served by traditional higher education, began to reshape the composition of those in the community college classrooms (Cohen & Brawer, 1996). Developmental education became a part of many community colleges' programs to meet the needs of students who, although motivated to seek higher education, lacked the pre-requisite skills in basic areas such as reading, English and mathematics.

The Developmental Student

With its open-door policy as the hallmark of the community college, supporting the egalitarian premise that all citizens are entitled to educational opportunity beyond high school, came the charge to provide for the remedial/developmental needs of those students not prepared for college-level coursework (Buchanan, 1992). Although the terms remedial and developmental are often used interchangeably, "developmental education" evolved as the preferred term in the 1970s (Baker, 1994; Blaszczynski, 1997). As noted in Baker,

> The term developmental, at least in the context of the postsecondary developmental education movement, focused on the student's potential rather than the student's deficit. Since the goal of developmental education is a fully developed and fully functioning person, focusing on academic skills alone is insufficient if students are to make the transition to all-around effective students and involved citizens (Baker, 1994).

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Roueche and Roueche (1993) have spent over twenty-five years researching and working with at-risk students in community colleges. They stress that it is not enough for community colleges to have open-door policies if those doors in effect become revolving doors that quickly exit the under-prepared student. Instead, the non-academic needs of developmental students must be addressed with equal commitment as their academic needs. Many such students bring a sense of helplessness and uncontrollable failure with them from past experiences. Frequently, they see their success or failure in the academic arena as externally controlled, "...that teachers 'give' grades, that trying will not result in better grades" (p. 127). It is essential that what is offered in the developmental classroom, along with the content, are the tools to enable the individual to experience the transformation from enrollee to student.

The profile of today's community college student is exceedingly diverse, not only in terms of academic background, but in every imaginable aspect including age, gender, socioeconomic status, ethnic background, aspiration, attitude towards higher education and motivation, to name a few. According to Pascarella and Terenzini (1991), "There can be little doubt that the growth of the community college sector has significantly expanded traditionally disadvantaged groups' access to postsecondary education" (p. 640).

However, the traditionally disadvantaged bring with them a host of characteristics that create a complex picture. There is no single answer to the question of how to provide the means for their success. Instead, it is incumbent upon those who teach developmental courses to acquire a repertoire of techniques that can address deficits that may be widely shared among developmental students as well as characteristics unique to specific

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individuals (Blaszczynski, 1997; Buchanan, 1992; Caston, 1995; Cook, 1997). Based on Roueche and Roueche's (1993) assessment,

> Students are leaving high school no better prepared than they were in the mid-1960s. In fact, evidence indicates that despite higher grade point averages, these students' skills and competencies are at the lowest levels in American history. Moreover, we are not talking only about literacy, or unprepared or underprepared students as viewed from their mastery or their attainment of cognitive skills; we are looking at a new generation of adult learners characterized by economic, social, personal, and academic insecurities. They are older adults, with family and other financial responsibilities that require part-time, or often full-time, jobs in addition to coursework requirements; they are first-generation learners with unclear notions of their college roles and their goals; they are members of minority and foreign-born groups; they have poor self-images and doubt their abilities to be successful; and they have limited world experiences that further narrow the perspectives they can bring to options in their lives (p. 246).

Given the fact that only about 50 percent of remedial students successfully complete preparatory courses, the critical question for our society is what happens to the other 50 percent (Roueche & Roueche, 1999). Indeed, the need for developmental education is not diminishing but rather is on the increase.

Yaworski's (1998) case study comparison of two students with a history of learning disabilities was not focused on analyzing data and reporting results, but on studying distinctly different college performance histories for those students. The value of this study is in the questions posed at its end. Those questions suggest that developmental educators need to examine what strategies learning disabled students use that promote academic success and incorporate the promotion of those strategies into their support services for students.

According to Judy Kort (personal communication, December 9, 1998), a segment of these students come poised to assimilate the material being presented; many do not. The conditions that create students out of those who enroll for classes are still unclear.

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Although much research has been done on how college affects students, the majority of the studies focus on four-year colleges (DePree, 1998). It is essential that those who are committed to working with developmental students at the community college recognize that it is every bit as much their charge to develop intellectual skills as it is their colleagues' who teach the college-level courses. According to Gaff, Ratcliff and Associates (1997),

> Faculty who have worked extensively with intellectual skills have discovered that these skills cannot be taught across the curriculum, even within a single major, unless they are articulated in developmental stages. It is not enough to specify the highest level of skill appropriate to a particular program and use it as a target for student achievement throughout that program. This becomes an exit standard. We need to visualize how students develop as thinkers, communicators, and ethical decision makers and specify how they grow in sophistication as they learn more and continue to apply those skills from course to course (p. 180).

The Colorado Community College and Occupational Education System, CCCOES (now referred to as the Colorado Community College System, CCCS) established the first, system-wide demographic profile of Basic Skill Education (BSE) students by collecting substantial data during the 1993-94 academic year. That report was updated using data from the academic year 1997-98 (Zhou & Voorhees, 1999). The later data confirmed the position held by Roeuche and Roeuche (1993) that despite current attention to assessment and accountability, younger students are not coming to the community colleges better prepared than their predecessors. In 1993-94, younger students (under twenty-two years old) comprised 32.1 percent of BSE headcount while they comprised 42.9 percent in 1997-98. Compounding the issue of additional younger students is the fact that more of them (64.3 percent) had earned a high school diploma in 1997-98 than in 1993-94 (58.4 percent), the implication being that high school is producing less well-prepared graduates. Female enrollment in BSE classes was slightly

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higher than their proportion in CCCOES but remained fairly consistent between the dates of the two studies. Recent longitudinal data from a six-year study (Van Etten, 1997) matched BSE and non-BSE students who enrolled in CCCOES colleges in the fall of 1998. The following outcomes resulted.

1. After completing the BSE courses, the BSE students perform as well as non-BSE students in subsequent college-level math and English courses.
2. BSE students have the same high persistence rate at community college as non-BSE students.
3. BSE students transfer to four-year institutions at rates that are equal to non-BSE students.
4. After leaving the community college, BSE students have comparable GPAs at four-year institutions to non-BSE students.
5. The persistence of BSE students at four-year institutions is as high or higher than non-BSE students (p. 7).

The data from the Van Etten study (1997) support that students who begin their college experience needing remediation in basic skills demonstrate their ability to perform at comparable rates to non-BSE students. However, as the preparedness of incoming students at the community college continues to show deficits in reading, English and math skills, it is essential that strong developmental programs continue to be available to maintain the success of those students once they have mastered their basic skills.

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Mathematics and the Developmental Student

With the increasing diversity of educational backgrounds in community college student populations, the need for successful developmental math courses is essential. According to Woodhams (1998), 56 percent of the students in remedial classes are entering freshmen, most over twenty-two years-of-age and more than a quarter of whom are over the age of thirty. Many students who enroll in developmental math courses have, for the most part, not had a consistent experience of success in mathematics (Senfeld, 1995; Tully, 1993). According to Chickering's first vector, achieving competence, the student's sense of competence is central to his or her growth (Pascarella & Terenzini, 1991). As noted by Pascarella and Terenzini (1991), coupled with the need for a sense of competence, it is imperative that students develop competencies and skills that allow them to

> ...process and utilize new information; communicate effectively; reason objectively and draw objective conclusions from various types of data; evaluate new ideas and techniques efficiently; become more objective about beliefs, attitudes, and values; evaluate arguments and claims critically; and make reasonable decisions in the face of imperfect information (pp. 114-115).

In many ways, mathematics curriculum is not impacted in the same way as other disciplines by current events, new developments in higher mathematics or advances in other fields (Seese, 1994). So, it would seem, that providing for a strong, developmental math foundation would be a fairly straightforward task. Yet the direction that our society has taken in recent years has served to exacerbate the problem of students who are under-prepared in mathematics.

> The study of Mathematics, which tends to be very non-forgiving, does not mix well with the current student mentality of entitlement, the tendency to point fingers of blame, and a low level of commitment to educational pursuits. Surveys show that fewer students than ever report that their parents think it is important to

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> do homework. American students taking a Mathematics test recently scored poorly, but as they left the test they reported that they felt good about their performances. Calculators have been relied on at all levels of the K-12 curriculum. A shortage of qualified Mathematics teachers has caused a low level of preparation for elementary school teachers (Seese, 1994, p. 5).

In early research, Friedlander (1979) commented on the increasing need for pre-college mathematics instruction. The preconceptions that developmental students brought to the classroom with them in the 1970s were not substantially different from that of subsequent years (Senfeld, 1995; Tully, 1993). Lowe (1982) went so far as to suggest that by merely asking students how they feel about math would enlighten instructors early in the semester as to which students were likely to experience math anxiety. Many of these students combine skill deficits with poor self-image, unsuccessful learning experiences and a dislike for mathematics. Often, basic algebra students come to class with misperceptions that can be barriers to success. The population that has significant learning disabilities often arrives with a stigmatized feeling from high school experiences, believing that good students do not have to exert much effort to be successful (Yaworski, 1998). Such students often have imitated mathematical processes in the past but have not really understood them. They are likely to view math as "an ocean full of meaningless facts and procedures to be memorized" (Wright). It is assumed by many that those needing developmental math courses are foreign students. They are surprised to learn that most are students who have graduated from North American high schools, speak English and still don't know their basic multiplication facts (Blaszczynski, 1997).

Boggs' study (1997) supports the findings of Zhou and Voorhees (1999) by providing evidence that developmental mathematics programs can be created that will

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allow students to enter subsequent college-level math courses and perform as well as their counterparts who did not require remediation. Colleges and universities must not only look at the success rates of their developmental math students in developmental courses but must additionally research whether those programs allow students to achieve goals which would not have been possible without the appropriate intervention curriculum. Boggs recommends that further studies examine which practices are effective and which are ineffective in developmental mathematics courses to determine key characteristics of those that are deemed effective. His recommendations are supported by Rives (1992) as well as Buchanan (1992). Buchanan (1992) reported that not only is the general consensus that remedial math education is not successful but that there is not substantial research on what is effective. Furthermore, although the developmental student population has an overrepresentation of nontraditional students, many of whom are first-generation learners, members of minority and foreign-born groups and have limited options to bring to this new experience (Roueche & Roueche, 1993), the reasons why they are present and what changes need to be made to meet their needs are not clear.

Need for Math Literacy

According to Seese (1994), "the number of entering college students expecting to major in Mathematics is only one-sixth of what it was in the 1960's" (p. 6). Given that many of the new and lucrative fields that have emerged over the past decade depend on a substantial command of mathematics, it is imperative that community colleges encourage students to pursue their math background beyond the bare minimum requirements if they are to have full access to the spectrum of opportunities available when they graduate (Bisse, 1994).

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Students who are not inclined or encouraged to pursue mathematics as either a supporting discipline for a career choice or as a career choice in itself limit the options that are open to them (Sells, 1980; Seese, 1994; Blaszczynski, 1997). Starkey (1990) reports that based on her study at a large, urban Southern California Community College, students tend to make decisions that affect their educational goals and career plans based on their self-concepts of their own abilities. Thus, it is of importance that students' concepts of themselves as math competent be developed if they are not to be denied access to many challenging and rewarding career fields.

Bisse (1994) cites the fact that technological and economic changes demand that educated citizens and workers need a better grasp of technology and a strong mathematics foundation. Bisse (1994) cited that the National Science Foundation noted two-year colleges are critical links in the pipeline that will provide the scientists and engineers of the future.

Presentation Methods and Dimensions

Many different approaches to developmental math have been adopted over the years to address the multivariate needs of these students. In 1990 a Title III grant made research of the Math 310 (Arithmetic) course at San Jose City College possible (Budros & Kangas, 1992). This particular study used three different models: a traditional three-unit classroom; a structured lab that offered variable units at a fixed time with one full-time instructor; and a learning skills center that utilized a multi-subject, learning center-based approach that offered variable units by arrangement. Persistence was defined as enrolling and succeeding in a course the following semester, competence as achievement that allowed students to progress to beginning algebra, and success as achieving a grade

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of C or better. The study determined that students in the structured lab persisted at a 55 percent rate, while the learning skills center and classroom had 38 percent and 31 percent persistence rates, respectively. The structured lab had the highest combination of success and persistence at 92 percent and 55 percent. The classroom had the highest combination of success and competency at 64 percent each but had relatively low persistence. The learning skills center had a high success rate, 74 percent, but low competency and persistence, 28 percent and 38 percent. The classroom student had a 64 percent rate of competency compared to 46 percent for the structured lab and 28 percent for the learning skills center. When the three methodologies were ranked on success, competence and persistence, the structured lab ranked first in success and persistence while the classroom ranked first in competence.

Rhodes (1999) conducted a study on two campuses of a metropolitan community college that explored the effects of the use of laboratory activities on students' attitudes and retention in a preparatory mathematics course. One campus used puzzles that were commercially produced, group activities, experiments and data collection activities. The other campus used a packet of activities produced by the faculty that included skill worksheets and some group activities. Her findings included that retention was increased by the inclusion of the one-hour lab; however, no differences were found in either retention or student attitudes between the students who used the different types of laboratory materials.

The recommendations made by Friedlander (1979) over twenty years ago suggested early support of instructional methods for developmental mathematics courses that did not rely solely on traditional lecture format. A case is made for incorporating a

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broad spectrum of techniques to address the needs of these students. In concert with the observations of Roeuche and Roeuche (1993) and Hackworth (2000), faculty at that time felt that their students were less well prepared than students from ten years prior. Cornell and Others (1996) noted that not only has there been an increasing need for remedial education, but their data also show that many students do not succeed in these entry-level courses.

Despite the technological advances over the past two decades, both Friedlander (1979) and Hackworth (2000) make the same observation that the majority of developmental mathematics classes are still presented using a traditional lecture-discussion approach. Hackworth (2000) further asserts that as community colleges have basically cornered the market on arithmetic, they have not been particularly noted for instituting changes in how that content is presented.

> We remain tied by tradition to many practices, such as group instruction, calendars, and contact hours, which are only indirectly related to learning. They were administrative solutions to problems of the past and are now impediments to improvements in our *instructional* systems (p. 20).

If those systems of the past could be shown to be consistently successful today, then there would be support for their maintenance. However, Hackworth (2000) noted that the program he worked in twenty years ago had a success rate near 90 percent whereas most Florida developmental education math courses are currently operating at about a 50 percent success rate.

DePree (1998) studied the impact of small-group work on adult preparatory algebra students' confidence in mathematical ability and achievement in algebra. As she noted, the National Research Council has reported that evidence from many sources points to the fact that although lecture is the method most frequently used in American

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classrooms, it is not the most effective means by which to promote mathematical understanding. Reform movements emphasize active learning strategies rather than passive participation. The results of her study were significant with respect to confidence in mathematical ability for a number of groups of students who have been historically underrepresented in mathematics, specifically Hispanic-American, Native-American, and female students. Her data supported the hypothesis that students in the cooperative, small-group class format had significantly higher course completion rates than those in a traditionally delivered class. Although there was no significant difference in achievement levels based on the two teaching methods, this was considered a positive result in that initially, some faculty had expressed concern that an insufficient amount of course work would be covered if small groups were used and those students would suffer academically.

Two case studies from New Zealand were used to explore the role of active learning strategies in developing mathematical knowledge in the constructivist sense in a study by Anthony (Bushaw, 1997). Learning strategies of the two students studied, Gareth and Adam, were analyzed in an effort to determine which active learning behaviors were effective. The study determined that it is insufficient to simply provide active opportunities for students but that appropriate strategies must be encouraged. Although Gareth participated actively, his strategies relied predominantly on rote learning and trying to anticipate what the teacher desired as a response. Adam, on the other hand, made a sincere effort to confront and assimilate mathematical ideas. This difference in striving for real understanding versus searching for the right answer is a critical dimension of deep learning.

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Rupnow and Bogenschild (1998) conducted a study at four private liberal arts colleges in different regions of the United States that measured the difference in achievement of classes of beginning algebra students who work in cooperative groups and classes which work individually. Although the study used only a small number of participating colleges, it is of note that in each school, the cooperative section had a higher mean than those that encouraged individual work. Although not considered as a formal aspect of the study, a participating teacher observed that the cooperative approach appeared to help lower achieving students, attendance in the cooperative class was higher and those students seemed to exhibit a more positive attitude.

Having students work in small groups may increase the contact that students have with their peers as they work collaboratively throughout the semester. Furthermore, if group work is a major focus of the class, the instructor has an opportunity for more direct contact with students than in a traditional lecture format. Allowing students to participate in collaborative activities can promote learning of a deeper nature.

Behaviors associated with a small-group experience support increased cognitive gains as well as modeling real-life work situations (Bisse, 1994). By working with peers, students become aware that good thinking is not instantaneous (Wright). By overtly stressing the significance of interconnectedness to college success, developmental educators can make a significant difference in the future choices of their students (Horn, 1997).

Bell (1998) examined the placement of successful, under-prepared students in developmental mathematics courses. This study did not address the manner in which the developmental math course was taught, but rather its purpose was to examine the

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placement test instrument used at a community college. The study found that there were no significant correlations between departmental pretest score and the follow-up course grade; however, there was a statistically significant positive correlation between course grade and follow-up grade. This finding supports efforts to make students' initial developmental math experience as successful as possible. As posited by Gonzalez-Rodriguez and Sjostrom (1998), "(o)ne of the best ways to scaffold learner cognition is by encouraging active, meaningful learning" (p. 2). A positive classroom experience fosters increased academic achievement.

A dimension of developmental math tied to the 1989 Standards published by the National Council of Teachers of Mathematics and the Mathematics Association of America that was addressed in a study by Blaszczynski (1997) was the importance of writing to communicate about mathematics. She emphasized that critical reflection is an essential element of a solid framework for math teaching. Students view mathematics differently when they write about it. It frees them to think about and reflect upon their processes rather than merely focusing on their outcomes. Of the faculty interviewed in the California State University (CSU) system and the community colleges, only 16 percent of the CSU math faculty and 11 percent of the community college math faculty report using writing.

In contrast to much of the literature, Nichols' (1996) study of community college math courses determined that, other than for Native American students, the lecture pedagogy was found to be nearly twice as effective as a math multi-course learning lab approach. Caston's (1995) study, which included matched pairs of classes in business, humanities, science/math and social science – one taught primarily with a lecture format

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and the other using a repertoire of methods – supported the lecture format with significant findings for attendance among re-entry, native English speakers, white, and female students. The findings for final grades, though not significant, favored lecture overall. However, students under age twenty-five, those with English as a second language, African American, Hispanic and male students received higher grades in classes taught using a repertoire of methodologies. Findings for course completion also slightly favored the repertoire group. In response to the affective dimension, Norwood's (1988) study supports that more structured methods of teaching a developmental arithmetic course at the main campus of the Community College of Philadelphia tends to reduce math anxiety when compared to less structured models.

Variables Affecting the Developmental Mathematics Experience

Age of the developmental student can be considered in more than one context. One is in terms of its effect on the predictive validity of placement tests with nontraditional-age students. Frequently, it has been found that when older students score lower on initial placement testing instruments, it cannot be concluded that they will also score lower grades once enrolled in a course (Refsland, 1992). Suggested was that other variables be considered during initial placement of older, more mature students.

With respect to retention, a study was conducted using the enrollees in developmental mathematics courses at an urban community college in the southwestern United States (Umoh, Eddy & Spaulding, 1994). It was determined that age, gender, and parental education did not have a statistically significant relationship with retention in the developmental mathematics classes that were studied. In terms of gender enrollment, males and females were balanced in the younger age group (eighteen to twenty-four), but females exceeded males in the more mature group (twenty-five and older). An interesting

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observation made was that developmental education students differ from their more typical college or university counterparts. Grade point average or academic achievement were not the driving forces behind whether they were retained. Instead, retention in developmental education mathematics appeared to be more dependent on the individual student's intent to continue with his or her studies, irrespective of grades. Furthermore, the majority of these students reported that they did not enjoy their developmental mathematics classes, nor were they intellectually stimulated by the material covered. However, most rated their attendance patterns as being very high. It was posited that perhaps students remain, whether they like the class or not, because it is a requirement for eventual college-level work, a means to an end.

In early research, Eldersveld (1983) studied factors related to success and failure in developmental mathematics in the community college, using students from eight community colleges in Northern Illinois. The independent variables he used were: (1) instructional method, (2) cognitive style, (3) numerical skills, (4) age, (5) sex, (6) self-assessment of knowledge of mathematics, (7) self-assessment of attitude toward mathematics, (8) self-assessment of mathematical ability, and (9) reason for taking developmental mathematics. Traditional instruction was defined to be lecture-discussion based with the pace being set by the instructor; nontraditional instruction was defined to be where students set their own pace for learning and testing. Two factors of particular interest from this study were instructional method and self-assessment of attitude. Eldersveld found that the success rate in the traditional group was 72 percent while that of the nontraditional group was 58 percent. He also found that successful students had a

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more positive attitude than those who were unsuccessful, however, self-assessment of attitude toward mathematics was not a discriminator in the traditional group.

To improve placement procedures for nontraditional-aged students, Zeidner (1987) suggested that length of time away from the classroom and the maturity of the older student be taken into account. Rives (1992), in her study of college mathematics students at three campuses of two universities reported that women have less preparation, less positive attitudes toward math, and have had a longer period of time since their last math course. In her research, she discovered that gender differences are more related to sex-role identity than ability. Many times female students have not been encouraged to pursue mathematics or fields requiring extensive math background. Rives recommends that efforts be made to encourage more female students to attempt the challenge of math and math-related fields.

A somewhat puzzling discovery was made by Rives in this same study. She determined that the relation between length of time since last mathematics course and success is direct and inverse. This would indicate that students with more time since their last mathematics course tend to be more successful. Given this outcome, Rivas recommended further study on length of time since last mathematics course and subsequent success rate.

Providing a psychologically safe environment is of vital importance for the developmental math student. "[T]esting ideas is the heart of learning and being wrong is a natural part of the process" (Hackworth, 2000, p. 21). Many such students bring with them the notion that math is always black and white; there is no room for speculation. Consequently, many are afraid to offer their thoughts on the solution to a problem in the

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mistaken notion that if the answer is not right (i.e., wrong), then their contribution is meaningless and often embarrassing.

According to Fennema and Sherman in DePree (1998), affective factors have an impact on the amount of effort students are willing to expend to learn mathematics. "People often cannot recall specific content in mathematics, but they can remember the way that they felt about mathematics or the way they perceive a specific mathematics course" (DePree, 1998). In 1993 Bershinsky's study at Laramie County Community College supported that there is a strong relationship between students' feelings about school, self and math and the outcomes of their experience in remedial math classes. As recommended by Eldersveld (1983), attempts should be made to improve students' attitudes toward mathematics as part of an overall effort to improve achievement. Furthermore, it is important that students develop confidence in their mathematical ability as this can have an impact on future choices in education or job-related goals.

Harper (1995) studied affective variables that contribute to the success and persistence of re-entry, nontraditional-aged female students at Harrisburg Area Community College. Many such women have stressful memories of previous math classes. In addition, such women often believe that education is for the young and, as returning, nontraditional-aged students, they are "out of step" with the traditional schooling cycle. Confounding the issue of what makes for successful experiences with re-entry women at the community college level is that the majority of the research has been done at four-year institutions, not two-year. The community college student is a much more accurate mirror of the population of the community that the college serves and thus, research aimed at those specific students is needed. Women have often been socially

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influenced to believe that math is a male domain and are therefore predisposed to assume that they will not have a substantial chance for success in this field. Although this predisposition was not born out by Harper's (1995) study (math was not determined to be stereotyped as a male domain), it is unclear whether this was due to the language in the instrument used rather than a substantial change in societal attitudes. In summary, Harper (1995) concluded that the nontraditional-aged female students exhibited greater success and motivation than traditional-aged students. [That success was attributed to hard work on the part of the student rather than ability.] The factor that showed the highest correlation to success was confidence as a learner of mathematics, thus, if a student believes she can be successful, she will persist until that goal is attained.

Senfeld (1995) explored possible relationships among math anxiety, acceptance of misconceptions about mathematics and the tolerance of ambiguity in General College Mathematics classes at Miami-Dade Community College/North campus. The study looked at whether gender, age, language, race, and ethnicity affected these variables differentially. Several of her recommendations include finding ways to raise the self-concept of students who enter with a poor self-image as a math student, address misconceptions that students bring with them to the classroom and bolster the self-concept of females with regard to mathematics. The study did not demonstrate a significant difference in math anxiety based on gender; however, it did note that a relationship does exist between self-concept and math anxiety.

Buchanan's (1992) study determined that math attitudes accounted for as much as 28 percent of the variance in the grades of the remedial students and 16 percent of the college-level students. Although the amount of variance decreased as the groups

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increased, it was still large enough to be considered as a predictor. Rives (1992) study supports that success and achievement in mathematics are related to affective as well as cognitive processes. Brown's (1986) study at an urban community college, however, showed that there was no significance in feelings about school, self and mathematics as factors in students' persistence and success. She did caution that perhaps this relationship should be reexamined with a less homogeneous student population. Her study involved predominantly disadvantaged black developmental arithmetic students at the Community College of Baltimore.

Calculator/Computer/Technology Use in Developmental Mathematics Courses

Although there are opposing schools of thought on when calculators should be integrated into the mathematics curriculum, "...most Calculus Reform proposals suggest using technology as a tool to enable students to look at more complex applications, to use Mathematical modeling techniques, and to avoid doing computations 'by hand'" (Seese, 1994, p. 6). Given this charge, the developmental mathematics faculty member is torn between the fundamental notion that students of mathematics should be able to do basic arithmetic functions without technological aids and responding to the ever-increasing demands that students use various forms of technology. This poses a perplexing dilemma for those who choose to integrate computer-assisted instruction into developmental mathematics courses. Is the technology to be used only for concept development, or is it to also be used for actual computation? This is not an easy question to answer as complete dependence on calculator-derived outcomes does not develop the much-needed process acquisition that the typical developmental math student is lacking. One advantage that the use of computers in the developmental mathematics classroom offers to students

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is an alternative to the traditional situation which, for many of them, failed to be fruitful (Seese, 1994; Tully, 1993). Indeed, developmental educators must resist the tendency to teach as they were taught since the majority of their students have already been exposed to those practices without success.

Keup (1998) discusses two specific computer-aided instruction systems used in remedial education at two-year colleges that show positive results. The INVEST system, used in the Nova Scotia Community College System in Canada, produced greater gains for remedial math students than traditional teaching approaches. Contrary to what many claim, that computer-aided instruction depersonalizes the learning process, this system incorporated a computerized journal into the curriculum. One file is private, for students to write in daily, the other is for the establishment of an ongoing dialog between student and teacher. Project SYNERGY was developed through Miami-Dade Community College in Miami, Florida. An advantage of this system, over the traditional classroom lecture format, is that it allows the teacher to personalize each student's curriculum based on computerized placement tests. There are two observations that have meaning for faculty considering using computer-aided instruction in developmental math courses. One is that the teacher is often thrust into the role of a system manager more than that of a learning facilitator. Attention must be paid to balancing the technical demands of computer-aided instruction and the personal needs of students. The other is that collaborative learning must be an integral part of the student's experience. If it is not a built-in component to the system being used, then the instructor needs to incorporate this dimension.

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In an attempt to determine characteristics of remedial math students that might lead to more effective educational practices, Buchanan (1992) determined that there is no cure-all to be found and that there is much disagreement among educators about the usefulness of computers in developmental math courses. In 1989, a study was conducted in California to examine basic mathematics programs in the community colleges and to produce specific program recommendations for the math curriculum at Saddleback College (Sworder, 1989). Of the 105 associate degree granting institutions surveyed, computer-aided instruction was used by forty-three colleges. A conclusion of the study was that, due to the diversity of the student population, a wide variety of styles, including computer-aided instruction, must be available to students. This recommendation has applicability beyond the California system as community colleges across the country experience increased diversity in their students.

Yet despite recommendations such as Sworder's, and in support of Buchanan's observation of disagreement, Blaszczynski's 1997 study of the California State University (CSU) system and its community colleges revealed that few faculty at either type of institution used computers as an instructional method. When used, it was primarily limited to out-of-class experiences for tutorial purposes and drill.

Both Bershinsky (1993) and Tully (1993) recommend the use of computer-aided instruction to allow students to progress at their own pace. Hackworth (2000) maintains that, although the incorporation of computers into developmental mathematics instruction is desirable, it is most often used in class or group instruction settings. Rather than capitalizing on the potential for individualization, many computer-aided instruction simply substitutes an electronic alternative to lecture.

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Summary

Far from providing a comprehensive roadmap for navigating the complex terrain of developmental mathematics, the literature raises as many questions as it seeks to address. There is no clear path to follow, no course charted. What is clear is that our four-year schools and workforce are increasingly dependent on community colleges providing well-prepared graduates. Given the increased opportunities in technical fields requiring math competence, we must continue to investigate the phenomena that surround the experiences of our community college developmental math students, with all their diversity, to gain insights that can be translated into sound, effective educational practices. These practices must then be scrutinized to insure that they lead to the development of a solid foundation upon which more complex skills can be built.

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CHAPTER III – METHOD

Research Design

This study was a QUANT + qual design, being quantitative dominant with the qualitative portion of the study as simultaneous and complementary (Tashakkori & Teddlie, 1998). The purpose of using a mixed methodology was to better understand the outcomes of using the two presentation methods. The terms presentation method and delivery method will be used interchangeably in the discussion of this study. The quantitative portions occurred at the beginning and end of the semester with the pretest and the posttest and the administration of an information sheet that included a short writing exercise. The qualitative portions were interwoven throughout and following the semester.

The dominant quantitative portion of this study was a quasi-experimental, pretest-posttest nonequivalent comparison control group design (see Figure 1). It was quasi-experimental as students were not randomly assigned to the two different presentation methods used. The delivery methods were coded as traditional lecture-discussion (C) and Academic Systems (E). Students were not assigned to groups; they enrolled in whichever class they chose. The reasons why they selected one class and not the other were not known. The class schedule indicates the time of day for each class as well as which were sections using a computer based approach. The main independent variable, delivery format, was active and had two levels.

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Several other independent variables were considered, data about which were gathered using an information sheet at the beginning of the semester (see Appendix A). These variables were: age, gender, number of years since last educational experience, number of hours working per week, requirement to take math courses beyond MAT 036, previous experience using a computer, computer ownership, computer access at work, computer use comfort level and computer use on a weekly basis. Additionally, the information sheet asked students to respond in writing to the prompt, "What has math been like for you and what do you expect to get out of this class?" The student responses were coded and analyzed as independent variables that may have an effect on the dependent variable. The dependent variable was gain score taken from the pretest and posttest scores on the ASSET Numerical Skills Test.

Assignment	Group	Pretest	IV	Posttest	Classification
NR	E:	O	X	O	*Mixed
NR	C:	O	~X	O	

*The purpose of this portion of the study was not to compare pretest or posttest scores between groups but rather to focus on the differences, if any, in gain scores. Thus, as the pretest-posttest scores were eventually converted to gain scores, the repeated measures dimension was eliminated making the final analysis strictly between groups.

Figure 3.1. Quasi-Experimental, pretest-posttest, nonequivalent comparison control group design

Two minor quantitative additions were a comparison of gain score and retention in the experimental group, the control group, and a third method, called group-support. Only one section of the group-support method was taught during the semester; therefore, it was not included in the dominant part of the quantitative piece. However, the examination of this presentation method may add breadth to the study.

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The qualitative portion of the study was composed of four separate gatherings of data throughout and following the semester. Data were gathered during the semester from in-class observations, faculty interviews and classroom feedback sessions. Data were also gathered from a post-semester faculty discussion session in which faculty who had experience using both the lecture-discussion method and the Academic Systems method participated. As the researcher took part in the study as a teacher of one of the sections of MAT 036, her observations were included with the other faculty members' data.

The strength of this design was in the fact that it examined gain scores for the two presentation methods and also what might be used as predictive factors for success, including students' past experiences and expectations. The qualitative dimension allowed an opportunity to examine insights to be gained from the students' own reporting of their experiences during the semester the study was conducted, as well as input from the faculty members who teach using the two methods.

Participants and Site

The theoretical population for this study was all community college students taking an introductory-level basic arithmetic course. The actual participants were those students enrolled in seven sections of MAT 036, General Skills in Mathematics, at a community college in a medium-sized western U.S. city. For any participants under eighteen years of age, a parental consent form was obtained. Various faculty taught the sections used for the study; one instructor taught two sections of the course.

For the dominant part of the quantitative portion of the study, two sections used the Academic Systems computer-based presentation method and four sections used a traditional lecture-discussion method. For the minor quantitative portion, a third

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presentation method, identified as group-support and taught by the researcher, was added. It was initially expected that there could have been up to thirty students per class, or a potential total of 240 participants, although generally enrollments are not quite that large and, with attrition, the number of students remaining in each class at the end of the semester would more likely have been twenty or fewer. Table 3.1 shows the actual number of students present for the pretest and for the posttest in each of the sections.

Table 3.1

Number of Students Present for Pretest and Posttest in the Seven Class Sections

Section	Number Present for Pretest	Number Present for Posttest
1	19	12
2	16	9
3	12	8
4	16	9
5	8	6
6	16	12
7	16	9

It should be noted that there were other students enrolled in most classes that took the pretest and the posttest, but only those consenting to be in the study are reflected in Table 3.1.

For the qualitative portion of the study, all sections were observed by the researcher; faculty who taught sections in the study were interviewed; four sections were selected to participate in a classroom feedback session, the two Academic Systems sections, one lecture-discussion section and the group-support section; and there was a faculty discussion session after the end of the semester. In-class observations provided two important dimensions to the qualitative portion. First, the researcher was able to note differences in the way each class session was structured and the activities in which

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students participated. Second, the researcher was able to note student behaviors in each of the methods and their reactions to the class atmosphere and structure.

As the campus at which the study was conducted draws students from various areas of the city, it can be assumed that there was a reasonable demographic spread among the students. At least among those needing this level of remediation, one limiting factor is that all the sections being used were from the daytime class offerings, between 8:00 a.m. and 3:50 p.m. It would be reasonable to assume that there may have been differences in those students who attended night classes, but that dimension was beyond the scope of the program evaluation effort that was undertaken at this institution.

Instruments

The Numerical Skills Test of the battery of ASSET tests was used for gathering the pretest and posttest scores for this study. ASSET was developed by ACT, with the most current test forms, B2 and C2, available since 1994. The ASSET Numerical Skills Test contains thirty-two items and is designed to be a paper-and-pencil instrument to be taken without the use of a calculator within a twenty-five-minute time limit. It was designed to assess basic numerical skills in the performance of operations with whole numbers, decimals, and fractions as well as basic problem-solving skills involving arithmetic (ASSET, 1994). It also includes some prealgebra items that comprise approximately 22 percent of the test. ASSET was designed as a guidance-oriented instrument to assess students' current skill levels and serve as an aid in course placement. It is a paper-and-pencil counterpart to the COMPASS test, a computer-based program, which the institution currently uses on campus for placement. As the entire semester consisted of the development of basic arithmetic skills, there should have been no

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significant carry-over effect, as the problems on the pretest and posttest closely resemble those worked throughout the semester's homework assignments.

ASSET is an appropriate instrument choice for this study for several reasons. First and foremost, in developmental math, the primary concern is that students are properly placed in their first math course and then, at the end of the semester, that they have mastered the skills needed to place into the next course in the math sequence. By using parallel forms of ASSET as pretest and posttest, it could be determined whether, at the beginning of the semester, students were in need of basic arithmetic skills as a foundation for algebra and, at the end of the semester, if they achieved a score on the posttest that would indicate a high probability of success in algebra. The gain score was used for statistical purposes of this study.

Historically, the department has administered a locally developed pretest to all MAT 036 students the first day of class to insure proper placement. The ASSET Numerical Skills Test is comparable in length and presentation to that which was currently used as the pretest, thus preserving the ecological validity of the experience. The test has been developed by ACT specifically to serve students entering community and technical colleges and therefore was an appropriate instrument for this population and purpose. Additionally, as it was not feasible to test all students in the classroom during their first class session using a computer-based program such as COMPASS, the paper-and-pencil instrument ASSET well suited the needs of this study.

In terms of instrument reliability, the Kuder-Richardson Formula 20 (KR-20) was used for estimates of internal consistency. The results were .86 for B2 and .85 for C2 (ASSET, 1994). Test-retest reliability was established by administering the same test

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form to a group of examinees at a two- to three-week interval. Form B had a correlation of .90 and Form C had a correlation of .82. Equivalent-forms reliability was established by using both same-session administrations of both forms and two-week interval administration. The same-session administration produced a reliability of .87 for the B2-C2 sequence and .88 for the C2-B2 sequence. The two-week interval administration produced a reliability of .86 for the B2-C2 sequence and .77 for the C2-B2 sequence.

The description of the tests and their development procedures supports extensive content validity, as the purpose of the tests is to assess basic skills in numerical computation and problem solving. Additionally, the *ASSET Technical Manual* provides extensive median estimated placement validity indices for selected cutoff scores. Using 1988 validity data, a correlation coefficient of .42 (.57 when adjusted for restriction of range) was obtained to relate tests scores and course grades for a fundamentals of arithmetic course using data from seven colleges

The demographic data for the independent variables were gathered from the information sheet, Appendix A. In conjunction with the students' written responses to the prompt, this information was used to analyze what, if any, of those factors can be used in a predictive manner regarding the success of a particular student in a MAT 036 class taught using one of the two presentation methods. The qualitative data were gathered from in-class observations, interviews with faculty, classroom feedback sessions and a faculty discussion session using observation protocols and guiding questions as appropriate (see Appendices B, C, D and E).

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Data Collection and Procedure

There were three parts to the quantitative portion of this study and four parts to the qualitative portion. At the beginning of the semester, Quant Part 1 was the pretest data from the ASSET Numerical Skills Test. For most students, this was administered in class on the first day of the semester as the pretest results were also used to determine if students had accurately been placed in MAT 036. For students who missed the first day of class or were moved down to MAT 036 from a higher-level course due to placement error, they were given the ASSET Numerical Skills Test in the Developmental Studies Math Lab within the first week of classes. Quant Part 2 consisted of students' responses to the information sheet, which was administered within the first week of classes. Quant Part 3 occurred near the end of the semester, approximately one-and-a-half to two weeks prior to taking the final exam for MAT 036. The alternate form of the ASSET Numerical Skills Test was given in class to all MAT 036 students. Any students absent on the day of the test took that alternate form in the math lab as they would have taken any missed test during the semester. The gain score from the pretest and posttest was used for analysis. Although the dates of the posttests varied somewhat due to different class schedules, students were tested at the same point in terms of content exposure. Students were provided with the scores from their pretest and posttest and given information regarding predictions for success in the next course.

Given that the data collected were part of an institutional program evaluation effort, faculty had recorded the pretest and posttest scores of their own students. For the purposes of this study, that data were kept confidential and coded by the researcher as X-X-XXX, with the first digit indicating the class section number (1-7), the second digit

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indicating the presentation method used (1 = lecture-discussion, 2 = Academic Systems, 3 = group-support) and the last set of three digits indicating the student ID number (1-107). This coding provided linkage between the data gathered from the information sheet, as described under Quant Part 2, and the outcome variable of gain score.

During the first week of the semester, the consent form for using pretest and posttest gain score data, data on the information sheet, the five-minute writing and data from potential classroom feedback sessions were distributed, signed and collected. Students under eighteen years of age took their consent form home for parental or guardian signature (see Appendix F). Quant Part 2 was then administered in class with one side of the page consisting of an information sheet with ten questions and the second side containing the writing prompt: "What has math been like for you and what do you expect to get out of this class?" (see Appendix A). This instrument provided the data for the independent variables that were analyzed with respect to gain score. The completed sheets were collected and placed in an envelope by the researcher at the end of class. The faculty member teaching that class did not see the data associated with names. As previously noted, the researcher kept all responses confidential, coding them as described to provide linkage to the outcome variable. The completed sheets from the researcher's section were collected by the department chair and placed in an envelope. The researcher did not have access to these data for coding until grades had been posted for the semester.

Qual Part 1 occurred during the eighth and ninth weeks of the fifteen-week semester, depending on scheduling with individual faculty members and consisted of in-class observations by the researcher. Prior to these observations, consent forms were obtained from faculty for participation in in-class observations, individual interviews and

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post-semester faculty feedback session (see Appendix G). Faculty names were kept confidential and not associated with data used in the final analysis for the study. The researcher used a protocol for recording observations, Appendix B, with substantial latitude to include specific dimensions of the class session that seemed pertinent as they emerged. In this setting, the researcher's role was that of a complete observer. She did not interact with the students or the instruction process but observed and took notes from the side (Creswell, 1998). In addition to observing her peers, the researcher included notes of her impressions and observations of her own section of MAT 036 that used the group-support method in the compilation of field notes according to the specified protocol. In this setting, the researcher assumed the role of a complete participant, somewhat in the sense of going native, as she was an integral and accepted part of that classroom experience (Creswell, 1998).

Qual Part 2 consisted of informal interviews with faculty during weeks eleven and twelve of the semester. Again, a general protocol with guiding questions was used, with substantial latitude to deviate from those questions as the interview proceeded (see Appendix C). As the researcher is a colleague of those to be interviewed and also taught a section of MAT 036, she periodically interjected some of her own observations and impressions about teaching this course. To provide for as natural and relaxed a setting as possible, the interviews took place in a private office and notes were recorded by hand as the researcher and interviewee conversed (Creswell, 1998). Each faculty member teaching a section of MAT 036 in the study was interviewed once and was provided a copy of the notes from the interview.

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Qual Part 3 occurred during the thirteenth through fifteenth weeks of the semester. Four sections of MAT 036 were selected – one lecture-discussion, two Academic Systems and the researcher's group-support presentation method – in which a classroom feedback session was held for approximately half an hour. For consistency of format and to maximize the qualitative information that the researcher gained from these sessions, all sessions were facilitated by the researcher. A general protocol of questions was developed, Appendix D, following the suggestions given in *Mid-Semester Student Feedback: The Classroom Meeting* from the Fall 1998 publication of the Center for Teaching & Learning at Colorado State University (Timpson, 1998). The protocol began with asking for what students appreciated about the class, then moved to how they would compare it to previous math classes, what concerns or recommendations they had (to be expressed using individual "I" statements) and finally ended with some questions about whether they would want to take another math class using the same presentation method and why or why not. Two additional questions were added to get student input on possible modifications of the MAT 036 course for the future. The researcher recorded the student input as it was given on the board so that responses were visible as the evolution of the feedback session unfolded to minimize redundancy of responses. She then copied those comments on paper after the sessions ended.

Qual Part 4 occurred after the semester had ended. It consisted of a discussion with faculty, some of whom did not participate in the study, but all of whom had taught using both the lecture-discussion and the Academic Systems presentation methods for MAT 036. As the faculty member who used the group-support presentation method, the researcher not only facilitated the discussion but occasionally participated as well. The

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major focus of the discussion was on what the perceived differences were between the two presentation methods, from a teaching perspective. Additionally, participants were asked to address what they saw as the relative strengths and weaknesses of each method. As before, a general protocol of guiding questions was used with the anticipation that the discussion would most likely diverge periodically (see Appendix E). Large sheets of paper were taped at the front of the room with the various protocol questions at the top. Each was divided into two columns, one for responses related to the lecture-discussion method and one for Academic Systems. After the session, all comments were then transcribed into document form. The transcript of the session was given to all participants.

The sequencing of the quantitative and qualitative portions of this study provided for a substantial interweaving of the two paradigms to add breadth and scope to the study. The timeline for the various parts of the data collection is shown in Table 3.2.

Table 3.2

Timeline for Data Collection

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Quant Pt 1																
Quant Pt 2																
								Qual Pt 1								
											Qual Pt 2					
														Qual Pt 3		
														Quant Pt 3		
																Qual Pt 4

Data Analysis – Quantitative Research Questions

The researcher did not have a clear bias as to which of the two delivery methods would produce the greatest achievement gain score as she had not personally used the

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Academic Systems presentation method. However, in terms of the qualitative data, she had a distinct and clear bias that the student reports of their experience in the classroom would be positive for the group-support method thatshe used during the study. However, it was unclear at the outset of the study whether there was a profile of students who much preferred to work with a computer-based presentation and have little instructor-directed presentation as would be customary in the traditional lecture-discussion method of teaching.

For the initial quantitative analysis, the gain score from the pretest to the posttest for the two presentation methods, lecture-discussion and Academic Systems, was compared to answer Research Question 1, "Is there a difference between presentation methods in regard to achievement gain score?" An independent samples *t* test was used as there was one independent variable with two levels, comparison was between groups and there was one normally distributed dependent variable. "The gain score analysis determines differences in the amount gained (or lost) among the … conditions. This is usually the information that one is interested in when implementing a study using the pretest-posttest design" (Gliner & Morgan, 1999, p. 299).

The additional independent variables, data for which were gathered from the information sheet, were each analyzed with respect to their relationship to gain score to answer Research Questions 2-11 and 15-16. The independent variables of gender, requirement to take math courses beyond MAT 036, previous experience using computers, computer ownership and access to a computer at work were each compared to gain score to look for possible differences between groups. The statistic used was an independent samples *t* test as, in each case, there was one independent variable with two

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levels, comparison was between groups and there was one normally distributed dependent variable.

The independent variables of age, number of years since last educational experience, number of hours working per week, computer use comfort level and weekly amount of computer use were each examined for possible associations with gain score. The statistic used to correlate the data was the Pearson correlation (r) as both variables were normal and other assumptions were not markedly violated.

The initial five-minute student writing was divided into two sub questions, "What has math been like for you? and "What do you expect to get out of this class?" The responses were transcribed and categorized for each sub question. After being linked to individual students, the independent variable of previous experience in math classes was analyzed with respect to gain score using an independent samples t test. As there was one independent variable with two levels, comparison was between groups and there was one normally distributed dependent variable. The independent variable of expectations for this class was analyzed with respect to gain score using a one-way ANOVA since there was one independent variable (expectations) with more than two levels (improved basic skills, preparation for future math classes and job-related reasons) and one normal dependent variable (achievement gain score) (Gliner & Morgan, 1999).

Research Question 12, "Is there a combination of variables that predicts achievement gain score better than any predictor variable alone?" combined the ten independent variables from the first side of the information sheet to see if any combination added to the differences observed due to presentation method. As one of the major goals of this study was to determine better ways to advise incoming students,

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multiple regression was an appropriate statistic to use "when the question is whether some combination of several independent variables predicts the dependent variables better than any one predictor alone" (Gliner & Morgan, 1999, p.70). In this case, there were several independent variables, some normal, some dichotomous and one normally distributed dependent variable.

As a minor addition to the quantitative analysis comparing presentation methods, a one-way ANOVA was used to compare the gain scores from the lecture-discussion sections, the Academic Systems sections and the one group-support section (Research Question 13). As this last section was taught by the researcher and was the only section using specific elements of presentation, it would be difficult to draw significant conclusions from comparisons of the gain scores as to the effectiveness of this method if applied on a broader basis. If any differences were noted, it would not be possible to determine whether they were due to presentation method in general or to the instructor's personal interaction with her class. However, the data were examined to augment the qualitative data that were gathered from the group-support method and to perhaps provide the basis for further questions beyond the scope of this study.

Retention was also examined, as a minor dependent variable, to determine if presentation method appeared to affect students remaining in the class until the end of the semester (Research Question 14). As attrition is a major concern for first-semester community college students, it was of value to determine what factors might contribute to retention. The statistic used for this analysis was the Pearson chi-square (X^2). According to Gliner and Morgan (1999), with nominal or categorical variables with a few levels on both variables, the use of chi-square is appropriate rather than the Pearson correlation (r).

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Data Analysis – Qualitative Research Questions

For the qualitative data, the framework for the analysis of all four data sets – in-class observations, faculty interviews, classroom feedback sessions and faculty discussion session – were componential analyses as numerous dimensions of contrast were compared for the contrast sets lecture-discussion and Academic Systems (Spradley, 1979). The data from each set were analyzed to see what themes emerged. The researcher included her own observations along with those of the other participants to gain insights into the total experience for students taking MAT 036. These results were organized into meaningful displays for clarity, using matrices showing the dimensions of contrast and the two contrast sets to illustrate the various levels of coding of the four sets of qualitative data (Miles & Huberman, 1994).

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CHAPTER IV – RESULTS

The interweaving of both quantitative and qualitative data collection was intended to provide a degree of triangulation to the study in the hope that the outcomes of each would support the conclusions of the other (Creswell, 1998). The main focus of the data analysis was to determine whether achievement gain score was significantly affected by whether the presentation method used for instruction was a traditional lecture-discussion approach or an approach using a computer-based program, Academic Systems. Several additional independent variables were also examined for their possible effect on gain score. During the semester, four sets of qualitative data were collected in various settings, the analysis of which was intended to produce a general theme pertaining to each of the two delivery methods. The overarching purpose was to learn something about the effectiveness of these two approaches with developmental level math students at the community college, usually in their first semester of attendance. The inclusion of a group-support method, a modification of the lecture-discussion approach, was a minor addition to provide added dimension but was not a significant focus of the study. The results of the study will be shared in terms of both quantitative and qualitative outcomes.

Quantitative Analysis

The purpose of the quantitative data analysis was to examine the effect of various factors on achievement gain scores from the pretest to the posttest on the ASSET Numerical Skills Test. The research questions pertaining to the quantitative data, as proposed in Chapter 1, are:

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17. Is there a difference between presentation methods in regard to achievement gain score?
18. Is there an association between age and achievement gain score?
19. Is there a difference between genders in regard to achievement gain score?
20. Is there an association between number of years since the last educational experience (taking a class) and achievement gain score?
21. Is there an association between number of hours working per week and achievement gain score?
22. Is there a difference between students who do and do not need a math course beyond MAT 036 in regard to achievement gain score?
23. Is there a difference between students who have and have not had previous experience using a computer in regard to achievement gain score?
24. Is there a difference between students who do and do not own a computer in regard to achievement gain score?
25. Is there a difference between students who do and do not have access to a computer at work in regard to achievement gain score?
26. Is there an association between comfort level working with computers and achievement gain score?
27. Is there an association between amount of weekly computer use and achievement gain score?
28. Is there a combination of variables that predicts achievement gain score better than any predictor variable alone?

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A minor addition to the quantitative portion of the study was to examine gain score and retention for the two dominant presentation methods – lecture-discussion and Academic Systems – and a group-support presentation method. This portion of the study poses the following research questions.

29. Is there a difference between presentation methods in regard to achievement gain score?
30. Is there a difference between presentation methods in regard to retention?

Two additional quantitative research questions derived from the student responses to the writing prompt, "What has math been like for you and what do you expect to get out of this class?"

31. Is there a difference between students who have had positive past experiences with math and students who have had negative past experiences in regard to achievement gain score?
32. Is there a difference between student expectations for the course in regard to achievement gain score?

There were 32 items on each pretest and posttest. The instructors used the first 18 items on the pretest to determine whether incoming students had adequate preparation to enroll in the next higher course. Although the intent was to have all students attempt the entire thirty-two items on the pretest, one of the instructors mistakenly directed his class to only complete the first eighteen items. Therefore, pretest and posttest scores were computed and compared separately for Q1-18 and Q1-32 to allow for this discrepancy in test administration.

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Although the results of each research question's analysis are provided individually, the overall outcome was that the only significant difference in achievement gain score occurred when comparing method of delivery. For each *t* test, Levene's Test for Assumption of Equality of Variances was performed and showed no significant difference. The assumption was therefore not violated and the unadjusted *t* value was used in each table. Tables 4.1 and 4.2 show the mean scores and standard deviations for the pretest and posttest along with the gain score for each method. Although gain score adjusts somewhat for difference in the pretest means, these tables are included at the beginning of the discussion to provide evidence that there were not markedly different results between the two groups at the outset of the study.

Table 4.1

Mean and Standard Deviation for Pretest, Posttest and Gain Score for the Lecture-Discussion and Academic Systems Presentation Methods on Q1-18

Presentation method	Pretest[a]		Posttest[b]		Gain score[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Lecture-discussion	8.24	3.23	13.46	3.09	4.83	3.24
Academic Systems	8.13	3.15	11.24	2.59	2.55	3.24

[a] *N* = 54 for lecture-discussion, *N* = 32 for Academic Systems
[b] *N* = 35 for lecture-discussion, *N* = 21 for Academic Systems
[c] *N* = 35 for lecture-discussion, *N* = 20 for Academic Systems

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Table 4.2

Mean and Standard Deviation for Pretest, Posttest and Gain Score for the Lecture-Discussion and Academic Systems Presentation Methods on Q1-32

Presentation method	Pretest[a]		Posttest[b]		Gain score[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Lecture-discussion	10.71	3.56	16.97	4.19	5.50	3.24
Academic Systems	11.00	3.69	14.33	4.25	3.20	4.19

[a] $N = 38$ for lecture-discussion, $N = 32$ for Academic Systems
[b] $N = 35$ for lecture-discussion, $N = 21$ for Academic Systems
[c] $N = 26$ for lecture-discussion, $N = 20$ for Academic Systems

To answer Research Question 1, the gain score *t* test was used. The gain score is the difference between the pretest and posttest scores. The mean gain score of the classes presented using a traditional lecture-discussion method was compared to the mean gain score of the classes using the Academic Systems method, a computer-based format for delivery of content. Table 4.3 shows the mean gain score on Q1-18 and Q1-32 of the pretest and posttest and the *t* test results. The mean gain score on Q1-18 was 4.83 for the lecture-discussion method and 2.55 for the Academic Systems method. The mean gain score on Q1-32 was 5.50 for the lecture-discussion method and 3.20 for the Academic Systems method. As shown in Table 4.3, students in the traditional lecture-discussion classes scored significantly higher gain scores than those in the Academic Systems classes.

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Table 4.3

Research Question 1 – Relationship of Presentation Method to Pretest-Posttest Gain Score on Q1-18 and Q1-32 Using t Test

Presentation Method	Q1-18 Gain score[a]				Q1-32 Gain score[b]			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
Lecture-discussion	4.83	3.24			5.50	3.24		
Academic Systems	2.55	3.24			3.20	4.19		
			2.51	.015			2.10	.041

[a] *N* for lecture-discussion = 35, *N* for Academic Systems = 20
[b] *N* for lecture-discussion = 26, *N* for Academic Systems = 20

Research Questions 2, 4, 5, 10, and 11 used the Pearson product moment correlation (r) to analyze for a relationship between gain score and the independent variables of age, number of years since the last educational experience, number of hours working per week, comfort level working with a computer and amount of weekly computer use as both variables in each case were normal and other assumptions were not markedly violated. Table 4.4 shows that none of these independent variables had a significant effect on gain score. In this analysis, for Q1-18 $N = 64$ and for Q1-32 $N = 55$. The only independent variable that approached significance was age. The r value of -.25 with $p = .062$ suggested a slight, but not significant, inverse relationship between the age of the students and their gain score on Q1-32. Thus, the younger students tended to have somewhat greater gain scores than their older classmates.

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Table 4.4

Research Questions 2, 4, 5, 10, and 11 – Relationship of Independent Variables to Achievement Gain Score on Q1-18 and Q1-32 Using Pearson Correlation (r)

Research Question	Q1-18		Q1-32	
	r	*p*	*r*	*p*
2. Is there an association between age and achievement gain score?	-.13	.290	-.25	.062
4. Is there an association between number of years since the last educational experience (taking a class) and achievement gain score?	.03	.796	-.07	.641
5. Is there an association between number of hours working per week and achievement gain score?	-.15	.256	.03	.817
10. Is there an association between comfort level working with computers and achievement gain score?	-.03	.820	-.20	.149
11. Is there an association between amount of weekly computer use and achievement gain score?	-.11	.400	-.20	.154

The analysis for Research Questions 3, 6, 7, 8, and 9 used the *t* test statistic as, in each case, there was one independent variable with two levels, comparison was between groups and there was one normally distributed dependent variable. Tables 4.5-4.9 show that none of the independent variables of gender, need for a math course beyond MAT 036, previous experience using a computer, computer ownership or access to a computer at work had a significant effect on gain score.

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Table 4.5

Research Question 3 - Relationship Between Gender and Achievement Gain Score on Q1-18 and Q1-32 Using t Test

	Q1-18 Gain score				Q1-32 Gain score			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
female[a]	4.55	3.17			5.28	3.44		
male [b]	3.07	3.65			4.20	5.31		
			1.53	.131			.88	.381

[a] $N = 49$ for Q 1-18; $N = 40$ for Q 1-32
[b] $N = 15$ for Q 1-18; $N = 15$ for Q 1-32

Table 4.6

Research Question 6 – Relationship Between Need for a Math Course Beyond MAT 036 and Achievement Gain Score on Q1-18 and Q1-32 Using t Test

	Q1-18 Gain score				Q1-32 Gain score			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
do need[a]	4.07	3.26			4.77	3.99		
do not need[b]	4.65	3.62			5.50	4.15		
			-.61	.544			-.61	.544

[a] $N = 46$ for Q 1-18; $N = 39$ for Q 1-32
[b] $N = 17$ for Q 1-18; $N = 16$ for Q 1-32

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Table 4.7

Research Question 7 – Relationship Between Students Who Have and Have Not Had Previous Experience Using a Computer and Achievement Gain Score on Q1-18 and Q1-32 Using t Test

	Q1-18 Gain score				Q1-32 Gain score			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
have[a]	4.14	3.34			4.76	3.56		
have not[b]	4.83	3.31			7.20	7.33		
			-.49	.629			-1.31	.197

[a]N = 58 for Q 1-18; N = 50 for Q 1-32
[b]N = 6 for Q 1-18; N = 5 for Q 1-32

Table 4.8

Research Question 8 – Relationship Between Students Who Do and Do Not Own a Computer and Achievement Gain Score on Q1-18 and Q1-32 Using t Test

	Q1-18 Gain score				Q1-32 Gain score			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
do[a]	4.12	3.34			4.63	4.15		
do not[b]	4.30	3.42			5.75	3.80		
			-.20	.841			-.93	.359

[a]*N* = 43 for Q 1-18; *N* = 38 for Q 1-32
[b]*N* = 20 for Q 1-18; *N* = 16 for Q 1-32

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Table 4.9

Research Question 9 – Relationship Between Students Who Do and Do Not Have Access to a Computer at Work and Achievement Gain Score on Q1-18 and Q1-32 Using t Test

	Q1-18 Gain score				Q1-32 Gain score			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
do[a]	4.60	2.85			5.83	3.10		
do not[b]	4.08	3.47			4.74	4.23		
			.53	.601			.83	.411

[a]*N* = 15 for Q 1-18; *N* = 12 for Q 1-32
[b]*N* = 49 for Q 1-18; N = 43 for Q 1-32

Multiple regression was used for the analysis of Research Question 12, "Is there a combination of variables that predicts achievement gain score better than any predictor variable alone?" Multiple regression is an appropriate statistic to use "when the question is whether some combination of several independent variables predicts the dependent variables better than any one predictor alone" (Gliner & Morgan, 1999, p.70). In this case, there were several independent variables, some normal (age, number of years since last educational experience, number of hours working per week, computer use comfort level and weekly amount of computer use), some dichotomous (gender, requirement to take math courses beyond MAT 036, previous experience using computers, computer ownership and access to a computer at work) and one normally distributed dependent variable (achievement gain score).

The question needing to be answered is whether any of the ten independent variables other than delivery method added anything to predicting the dependent variable

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of achievement gain score. When treatment (presentation method) alone was used to predict gain score on Q1-18, $R^2 = .10$ indicating that approximately 10 percent of the gain score difference can be predicted by the delivery method. The *p* value of .032 supports that presentation method was a significant predictor for success. Following this analysis, all the questions from the information sheet were examined to determine whether any of them would add to the prediction. None did. However, gender had the largest partial correlation, -.28, with a *p* value of .052. Given that the presentation does make a significant difference, knowing gender as well as presentation method would improve the prediction of Q1-18 gain scores. For Q1-32, when treatment and gender were used to predict gain score, the combination was significant with $p = 0.19$. The R^2 value of 17 indicated that approximately 17 percent of the gain score difference can be predicted by treatment with degrees of freedom 2, 43 and $F = 4.37$. As in all social science settings, the multiple and interactive nature of contributing factors presents a very different research environment than of a controlled, laboratory-based study.

Research Question 13 examined all three presentation methods used in the study. A one-way ANOVA was used for the analysis of this research question since there was one independent variable (presentation method) with more than two levels (lecture-discussion, Academic Systems, and group-support) and one normal dependent variable (achievement gain score) (Gliner & Morgan, 1999, p. 212). The group-support method was a modification of the lecture-discussion method that employed group activities and group tests prior to each chapter test and the final exam. For Q1-18, Table 4.10 shows there was an overall significant *F* value of 4.10 with $p = .021$, therefore a post-hoc test, the Least Significant Difference Test, was performed to determine which pairs of means

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were significantly different. As shown in Table 4.11, the mean gain score for lecture-discussion was 4.83, for Academic Systems was 2.55 and for group-support was 5.44. Table 4.12 shows between which pairs there was a significant difference in achievement gain score.

Table 4.10

Research Question 13 – Relationship Between Presentation Method and Achievement Gain Score on Q1-18 Using One-Way ANOVA F and p Values

Source of variation	Sums of squares (SS)	Degrees of freedom (*df*)	Mean squares (MS)	*F*	*p*
Between groups	82.22	2	41.11	4.10	.021
Within groups	612.14	61	10.04		
Total	694.36	63			

Table 4.11

Research Question 13 – Relationship Between Presentation Method and Achievement Gain Score on Q1-18 Using One-Way ANOVA M and SD Values

Presentation method	Count	*M*	*SD*
Lecture-discussion	35	4.83	3.24
Academic Systems	20	2.55	3.24
Group-support	9	5.44	2.65

As shown in Table 4.12, the mean achievement gain score for the Academic Systems classes differed significantly from both the mean of the lecture-discussion classes and the mean of the group-support class. However, when lecture-discussion and group-support were compared, there was no significant difference in their means.

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Therefore, according to this analysis, the only significant difference in the effect of presentation method was that students in the lecture-discussion and group-support classes had a significantly larger improvement from their pretest to posttest scores.

Table 4.12

Research Question 13 –Significant Differences Between Presentation Method and Achievement Gain Score on Q1-18

M	Presentation method	Academic Systems	Lecture-discussion	Group-support
2.55	Academic Systems			
4.83	lecture-discussion	*		
5.44	group-support	*		

Tables 4.13-4.15 show the results of the analysis for Q1-32. Table 4.13 shows there was an overall significant *F* value of 4.37 with $p = .018$ again indicating the need for a post-hoc test to determine which pairs of means were significantly different. Table 4.14 shows the mean gain score for lecture-discussion was 5.50, for Academic Systems was 3.20, and for group-support was 7.44. Table 4.15 shows between which pairs there was a significant difference in achievement gain score.

Table 4.15 shows that as for Q1-18, on Q1-32 the only significant difference in the effect of presentation method was that students in the lecture-discussion and group-support classes had a significantly larger improvement from their pretest to posttest scores.

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Table 4.13

Research Question 13 – Relationship Between Presentation Method and Achievement Gain Score on Q1-32 Using One-Way ANOVA F and p Values

Source of variation	Sums of squares (SS)	Degrees of freedom (*df*)	Mean squares (MS)	*F*	*p*
Between groups	125.06	2	62.53	4.37	.018
Within groups	743.92	52	14.31		
Total	868.98	54			

Table 4.14

Research Question 13 – Relationship Between Presentation Method and Achievement Gain Score on Q1-32 Using One-Way ANOVA M and SD Values

Presentation method	Count	*M*	*SD*
Lecture-discussion	26	5.50	3.24
Academic Systems	20	3.20	4.19
Group-support	9	7.44	4.30

Table 4.15

Research Question 13 –Significant Differences Between Presentation Method and Achievement Gain Score on Q1-32

M	Presentation method	Academic Systems	Lecture-discussion	Group-support
3.20	Academic Systems			
5.50	lecture-discussion	*		
7.44	group-support	*		

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Research Question 14 examined whether there was a difference between presentation methods in regard to retention. A student was considered to have been retained if he or she took both the pretest at the beginning of the semester and the posttest at the end of the semester. The Pearson chi-square (X^2) was used twice for this analysis, once to compare only the lecture-discussion and the Academic Systems classes and once to compare all three presentation methods. According to Gliner and Morgan (1999), with nominal or categorical variables with a few levels on both variables, the use of chi-square is appropriate rather than the Pearson correlation (r). In each case there was no significant difference in the retention rates. Table 4.16 shows that when comparing the two methods, slightly more than 60 percent of the students were retained.

Table 4.16

Research Question 14 – Relationship Between Lecture-Discussion and Academic Systems Presentation Methods and Retention Using Pearson Chi-Square (X^2)

Presentation method	Pretest count	Posttest count	Percent retained	X^2	p
Lecture-discussion	58	35	60.3		
Academic Systems	33	21	63.6		
				0.10	.756

When comparing all three presentation methods, similar results were obtained with retention rates varying approximately from 56 percent to 64 percent. Table 4.17 shows those results.

With regard to the relatively low retention rates, it should be noted that students in these classes are generally first-semester community college students. Many first-semester

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community college students need a semester or two to determine whether they are truly ready to be students and regularly participate in class. According to Dale Baxter, Director of Institutional Research at the community college where this study was conducted, the overall success rate (grade of A, B, C, D, or Satisfactory) was 64.6 percent for MAT 036 during the semester data were gathered (personal communication, April 23, 2002). Therefore, the retention rates of the classes in this study mirror those of the first-semester students at large.

Table 4.17

Research Question 14 – Relationship Between Lecture-Discussion, Academic Systems and Group-Support Presentation Methods and Retention Using Pearson Chi-Square (X^2)

Presentation method	Pretest count	Posttest count	Percent retained	X^2	p
Lecture-discussion	58	35	60.3		
Academic Systems	33	21	63.6		
Group-support	16	9	56.3		
				0.26	.880

In addition to the ten questions posed on the front of the questionnaire, on the back students were asked to respond in writing for five minutes to the following prompt, "What has math been like for you and what do you expect to get out of this class?" This writing prompt was divided into two sub questions, "What has math been like for you?" and "What do you expect to get out of this class?" After reading all of the writing responses from the 107 students that participated in the study, the responses to the first sub question, Research Question 15, were categorized as either "generally positive" (coded as 1) or "generally negative" (coded as 2). The responses to the second sub

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question, Research Question 16, fell into three general categories: "improvement of basic skills" (coded as 1), "preparation for future math courses" (coded as 2) and "job-related" (coded as 3).

Since the response options for the first sub question were dichotomous, a *t* test was used to explore any possible significant relationship to achievement gain score. Table 4.18 shows the results of that analysis.

Table 4.18

Research Question 15 – Relationship Between Previous Experience in Math Classes and Achievement Gain Score on Q1-18 and Q1-32 Using t Test

	Q1-18 Gain score				Q1-32 Gain score			
	M	*SD*	*t*	*p*	*M*	*SD*	*t*	*p*
positive[a]	4.94	3.71			5.82	3.57		
negative[b]	3.97	3.15			4.33	3.85		
			0 .95	.346			1.12	.272

[a] N= 16 for Q 1-18; N= 11 for Q 1-32
[b] N= 33 for Q 1-18; N= 30 for Q 1-32

To rule out a possible connection to attitudes from previous math class experiences affecting achievement in the current class, this question was asked. Based on the analysis, there was no significant relationship between students' previous experiences and gain score. This result would support that the gain score was therefore more dependent on the students' experience in that semester's class rather than previous success or failure or attitudes about math in general.

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Since the response options for the second sub question had three options, a one-way ANOVA was used to explore possible significant relationship to gain score. Tables 4.19 and 4.20 show the results of that analysis for Q1-18. The *F* value of 0.37 was not significant, $p = .693$, therefore no post-hoc test was performed and it was concluded that expectations for this class had no significant effect on achievement gain score.

Table 4.19

Research Question 16 – Relationship Between Expectations for This Class and Achievement Gain Score on Q1-18 Using One-Way ANOVA F and p Values

Source of variation	Sums of squares (*SS*)	Degrees of freedom (*df*)	Mean squares (*MS*)	*F*	*p*
Between groups	8.14	2	4.07	0.37	.693
Within groups	472.84	43	11.00		
Total	480.98	45			

Table 4.20

Research Question 16 – Relationship Between Expectations for This Class and Achievement Gain Score on Q1-18 Using One-Way ANOVA M and SD Values

Group	Count	*M*	*SD*
improved basic skills	36	4.19	3.35
preparation for future math classes	5	3.00	2.83
job-related reasons	5	3.40	3.51

Tables 4.21 and 4.22 show the results of the analysis for Q1-32. The *F* value of 0.78 was not significant, $p = .467$, again indicating no need for a post-hoc test to be

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performed and that expectations for this class had no significant effect on achievement gain score.

Table 4.21

Relationship Between Expectations for This Class and Achievement Gain Score on Q1-32 Using One-Way ANOVA F and p Values

Source of variation	Sums of squares (*SS*)	Degrees of freedom (*df*)	Mean squares (*MS*)	*F*	*p*
Between groups	20.54	2	10.27	0.78	.467
Within groups	475.77	36	13.22		
Total	496.31	38			

Table 4.22

Relationship Between Expectations for This Class and Achievement Gain Score on Q1-32 Using One-Way ANOVA M and SD Values

Group	Count	*M*	*SD*
improved basic skills	29	4.97	3.82
preparation for future math classes	5	2.80	2.59
job-related reasons	5	5.00	3.16

Based on the analysis, there was no significant relationship between students' expectations and achievement gain score. This result would support that gain score was therefore more dependent on the students' experience in that semester's class rather than their purposes for enrolling in the class.

In summary, the quantitative data analysis revealed that students in the lecture-discussion classes had significantly greater pretest-posttest gain scores than those in the

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Academic Systems classes. None of the independent variables of age, gender, number of years since last class, number of hours working per week, need to take a math course beyond MAT 036, previous experience using a computer, computer ownership, access to a computer at work, comfort level working with computers or amount of weekly computer use had any significant effect on achievement gain score, nor did any combination of these variables produce a significantly greater effect than just presentation method. Previous experiences in math classes and expectations for this class also showed no effect on gain score. The group-support class did not differ significantly from the lecture-discussion classes although it did so when compared to the Academic Systems classes. As the group-support method was a modification of the lecture-discussion method, this outcome was reasonable.

Qualitative Analysis

The qualitative portion of the study focused on investigating the experiential side of the MAT 036 course from the students' perspective as well as through observations by faculty (including the researcher). The analysis of the qualitative data was used to answer the following research questions.

5. What is the classroom experience that is observed in the sections using the different presentation methods?
6. What are the dominant themes that emerge from interviews with the faculty using the different presentation methods?
7. What are the dominant themes that emerge regarding students' reporting of their experiences in classes that use the different presentation methods?

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8. From a faculty perspective, what are the dominant themes that emerge regarding the perceived differences between the presentation methods?

For the purpose of the qualitative analysis, the group-support section was merged with the lecture-discussion (LD) sections and these were contrasted to the AS (Academic Systems) sections which were taught using a computer-based delivery method. The classroom setting for the lecture-discussion sections was a standard classroom with either individual combination seat-desks or long tables with chairs. The AS classroom was a larger room that had computer stations around the perimeter and round tables in the middle for individual or small group work. This analysis could be viewed as an ecological study of instruction to determine the effect of different learning environments on achievement.

The first level of coding was based on the raw data that were gathered in four settings: six in-class observations by the researcher plus her notes as participant/observer in her own class; post-observation interviews with each faculty member teaching an observed class plus the researcher's notes on her own class; four classroom feedback sessions, two from sections using the lecture-discussion method one of which was the researcher's group support class and two from the Academic Systems method of delivery; and a post-semester faculty discussion session that included the faculty who participated in the study as well as others who had taught using both methods for MAT 036. A protocol was used for each of these settings. Tables 4.23 and 4.24 show when, during the semester, each of the sets of qualitative data were gathered and the respective settings.

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Table 4.23

Qualitative Data Collection Timeline

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
								Qual Pt 1								
											Qual Pt 2					
													Qual Pt 3			
																Qual Pt 4

Table 4.24

Qualitative Data Sets, Sources, Settings and Times of Collection

Data set	Data source	Setting	Time of collection
Qual 1	in-class observations	classroom	weeks 8-9
Qual 2	faculty interviews	faculty office	weeks 11-12
Qual 3	classroom feedback sessions	classroom	weeks 13-15
Qual 4	faculty feedback session	faculty conference room	post-semester

The coding for data sets Qual 1-4 were based on componential analysis, comparing the two methods of delivery on various contrast sets (Spradley, 1979). Tables 4.25-4.28 contain the first-level coding results for each of the four data collection settings. Along the left side of each table are the respective protocol questions that were used. Under each question are listed the various dimensions of contrast that emerged from the field notes. The contrast sets, lecture-discussion (LD) and Academic Systems (AS) are the headings of the two columns on the right. These columns represent the researcher's evaluation of the presence of each dimension of contrast for each contrast set. Each dimension was coded as follows: 0 if not observed or commented on, 1 if

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observed or commented on once, 2 if observed or commented on multiple (two or more) times. An illustrative citation from the data is provided for clarification in selected dimensions of contrast.

Table 4.25

First-Level Coding Of In-Class Observations Using Componential Analysis

Dimensions of Contrast	LD	AS
Activities		
Review of previous concepts, quizzes, tests	2	1
Teacher-directed activities	2	1
Homework time in class	1	2
Student responses		
Student participation level	2	1
Students appeared on-track	2	2
Faculty presentation		
Predominantly teacher-directed	2	0
Independently directed by student	0	2
Teacher offers elaboration/clarification to class as a whole	2	1
Teacher offers elaboration/clarification on a one-on-one basis	0	1
Additional observations		
Student choice regarding task focus	0	2
One-on-one assistance from teacher	0	2
Interactions between students	1	0

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Table 4.26

First-Level Coding Of Faculty Interviews Using Componential Analysis

Dimensions of Contrast	LD	AS
What has been your experience teaching this class this semester?		
Generally positive	2	2
Generally negative	0	0
Problems with tardiness, absences, immature student behaviors	1	1
How does this class compare to other MAT 036 classes you have taught?		
Basically similar	2	1
"Similar in most ways."		
Basically dissimilar	1	1
"This class seems less mature and weaker in their math background."		
"Students are more perceptive; more mature; seem more into the class."		
Students respond positively to delivery method	2	2
Do you have any particular concerns regarding this class?		
Tardiness and absences	1	1
Concerns about on-task behavior in class	0	1
"Students sometime play computer games instead of working on math."		
Concerns about students getting full content exposure	0	2
"I wonder if they're actually acquiring the material."		
"This format (AS) requires supplemental work from the teacher."		
What other comments would you like to make regarding this class?		
Need a better way to identify which students are most appropriate for AS	1	0
Presentation method does not provide full content exposure	0	2
"The learning is somewhat superficial – students don't make the connections with what the concepts are really about."		
"Seems to be more teaching of mechanics."		

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Table 4.27

First-Level Coding Of Classroom Feedback Sessions Using Componential Analysis

Dimensions of Contrast	LD	AS
What do you appreciate about this class?		
Ability to interact with a teacher	2	2
One-on-one assistance from teacher	0	1
"Teacher is not lecturing, therefore has more time to help."		
Flexibility of delivery method	1	2
"Leniency of the class; allowed to make up tests without penalty from a bad weather day."		
"If I have questions I can use both – the computer program and the teacher."		
Student choice regarding task focus	0	2
"You chose the time when to do your studies."		
How would you compare this math class to other math classes you have had?		
Satisfied with the pace	2	1
"I prefer this pace – it lets the first information soak in before you get more."		
"On the computer, I can go back and go as slow as I want."		
"AS talks too elementary to you."		
Feel supported	2	1
"In larger classes, I'm intimidated to ask questions, so I fall behind."		
"I like and need that it is broken down into simpler steps."		
More dependent on the teacher's structuring	2	0
More dependent on the students' choice of task focus	0	2
Discrepancies between content taught and what is tested	0	1
"Problems are on the tests that are not in the homework."		
"I'll do well on the AS tests, but not on the in-class tests at the end of each chapter."		
What concerns or recommendations do you have for this class?		
Teacher assistance appreciated	0	1
"I wish the computer would show you the shortest and simplest way like our teacher does."		
Too much emphasis on tests	0	1
"Grade should be more influenced by homework."		
Test questions differ from content presented	0	1
"Often see problems on Chapter Review/Test that haven't been seen before."		
"Tests should match AS."		
Too much homework	1	0
Desire more time for working on homework in class	1	0

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Table 4.27 (continued)

Dimensions of Contrast	LD	AS
Would you want to take another class using this presentation method? Why or why not?		
Favor this method	2	1
"But not for all of my classes."		
Prefer more interaction with teacher	2	1
"I get more information from a teacher lecturing and from other students' questions."		
"I'd prefer more teacher interaction; need step-by-step clarification; AS doesn't do that enough. You have to scroll back several screens but you don't see the whole process at once."		
Computer allows for more flexibility and options	0	2
"It's a luxury to be able to study according to my schedule – lots of freedom."		
The following options have been proposed for MAT 036. What do you think?		
1. Separate modules on an independent basis using a computer/workbook combination.		
Favor	1	1
Oppose	2	1
Need for teacher-based structure	2	1
"I need the structure of a class."		
"I would want a teacher available for questions."		
Computer offers options	1	1
"It would be neat because you could bypass what you already know."		
Computer not appealing	2	1
"A computer can't answer all your questions."		
"You can't replace the teacher with a computer."		
2. Blend MAT 036 with the first algebra class using a very quick review of arithmetic.		
Favor	1	1
"It would be cheaper with fewer classes to take."		
Oppose	2	1
"It would be harder because of the mixed content."		
"Need time to learn arithmetic first, especially if you have been out of school many years."		

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Table 4.28

First-Level Coding Of Post Semester Faculty Discussion Session Using Componential Analysis

Dimensions of Contrast	LD	AS
What do you, as a faculty member, see as the significant differences between presenting a class using a traditional lecture-discussion method and Academic Systems?		
Need for significant supplemental presentation	0	2
"I don't have time to fully develop concepts – just summarize."		
Difficulty assessing progress of students	0	2
"Students often misinterpret processes presented in AS."		
Ease of building rapport with students	2	1
"Some feel AS is more difficult to establish relationships with students; others feel it's easier as teacher can walk around the class."		
Role of teacher as director, mentor.	2	1
"A major dynamic – the teacher – is redefined in AS. There the teacher is sort of a guide on the side and is less involved, less effective in motivation, support, "math-talk" and mentoring behaviors."		
What differences do you see, if any, in the way in which concepts are introduced and developed between the two methods?		
Concept development is mechanical, not complete	0	2
"Skills are introduced and practiced but I'm not convinced the 'whole picture' complete with a spiraling review is as effective in AS as in a good lecture class."		
Concepts are developed and related thoroughly	2	1
"Real world can be brought in more."		
"Top students (earning an 'A') in AS get a more solid foundation than in lecture."		
What do you view as the relative strengths of each presentation method?		
Ability for one-on-one assistance with teacher	1	2
"Teacher has time to sit with slower students; can't in lecture classes."		
Self -paced	0	2
Development of relationship and interaction between teacher and student	2	1
Heavily dependent on teacher expertise	2	1
"Easier to have a weak teacher in AS not have as much impact on student achievement."		
Heavily dependent on highly motivated students	1	2
Keeps students engaged	2	2

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Table 4.28 (continued)

Dimensions of Contrast	LD	AS
What do you view as the relative weaknesses of each presentation method?		
Control of concept development	2	1
"Can't control whether AS students access all the options."		
"AS requires some supplemental lecture component."		
Need to be an independent learner	0	2
Need to find the right profile of students for this method to be optimally successful	0	1
Dependent on teacher structuring	2	1
What differences have you noted in the students in terms of achievement, motivation, etc. in each of the two methods?		
Varied achievement levels	2	2
"Better students can make sense of AS more easily."		
Motivated students do well in either method.	2	2
Impact on weaker students	0	1
"At one point, weaker students gave up working on the computers."		
"This level (MAT 036) is not, in my opinion, the best level for having students work semi-independently."		
Do you have a preference for either method and, if so, which one and why?		
General preference for developmental math students	2	1
Opportunity to work one-on-one or in small groups	0	2
Teacher's knowledge of where student learning is at	1	0
"If I'm the 'coach' I like to know more about where students are at in their concept development."		

The second level of coding took the componential analyses from the first-level coding and summarized each section of the analyses in one or two sentences incorporating the relative strength of the responses in different categories. Tables 4.29-4.32 show the results of the second level of coding.

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Table 4.29

Second-Level Coding of In-Class Observations Using Componential Analysis

Data Categories	Lecture-discussion summaries	AS summaries
Activities	Class activities predominantly consisted of teacher-directed review of previous material and presentation of new material.	Class activities predominantly consisted of students working on their own with occasional content embellishment by the teacher.
Student responses	Students appeared to be participating in the class and on-track with the current activity.	Students appeared to be on track during the class with the majority of their time spent in independent work in either their text or on the computer.
Faculty presentation	The teacher maintained focus at the board with the presentation characterized by explanation of new content. Questions from the class were taken and explanations incorporated into the presentation.	The students chose their activities and then referred to the teacher when needed for clarification. Questions were usually dealt with on an individual basis.
Additional observations	There was some interaction between students as they discussed questions about the content with the teacher.	Students had a great deal of freedom to direct the manner in which their time was spent and could readily receive personal assistance from the teacher.

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Table 4.30

Second-Level Coding of Faculty Interviews Using Componential Analysis

Data Categories	Lecture-discussion summaries	AS summaries
What has been your experience teaching this class this semester?	Generally positive with some problems with tardiness, absences and immature student behaviors.	Generally positive with some problems with tardiness, absences and immature student behaviors.
How does this class compare to other MAT 036 classes you have taught?	Although some characteristics differ, this class was basically similar to previous MAT 036 classes. Students have predominantly responded positively to the delivery method.	More differences observed between these classes and those previously taught. Students have predominantly responded positively to the delivery method.
Do you have any particular concerns regarding this class?	Major concern was with respect to tardiness and absences	Major concern was with respect to whether the students were getting a comprehensive command of the material.
What other comments would you like to make regarding this class?	Desire to have better means to determine students best suited to the AS delivery method.	Significant concern that students' learning was more focused on mechanics rather than comprehension of underlying concepts.

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Table 4.31

Second-Level Coding of Classroom Feedback Sessions Using Componential Analysis

Categories	Lecture-discussion summaries	AS summaries
What do you appreciate about this class?	Students appreciated the ability to interact with a teacher and some flexibility of class structure.	Students appreciated the ability to choose how to structure their activities and to be able to access teacher assistance to the degree that they felt necessary.
How would you compare this math class to other math classes you have had?	The teacher-directed class pace allowed for ease of content acquisition and the smaller classes were less intimidating.	The class activities were more determined by the students who had the ability to go back over material on the computer when needed.
What concerns or recommendations do you have for this class?	Some comment on the large amount of homework and expression of desire for time to work on homework in class.	The test questions did not always mirror what was presented on the computer nor did the computer show the shortest, simplest process to perform operations.
Would you want to take another class using this presentation method? Why or why not?	This method was preferred; teacher lecture and other students' questions give more information.	Preference for the flexibility of this method; students' ability to self-direct activities. Some concern expressed about the need to scroll through several screens for an entire process.
The following options have been proposed for MAT 036. What do you think?		
1. Separate modules on an independent basis using a computer/ workbook combination.	Although the computer allows for bypassing of information already known, a strong preference was expressed for a teacher-directed class to provide immediate clarification to questions.	Reactions were mixed with comments that students would want a teacher available when needed.
2. Blend MAT 036 with the first arithmetic class using a very quick review of arithmetic.	Stronger feeling that it would be harder; time needed to understand arithmetic first.	Mixed response although some preference for a quick arithmetic review followed by algebra.

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Table 4.32

Second-Level Coding of Post-Semester Faculty Feedback Session Using Componential Analysis

Data Sets	Lecture-discussion summaries	AS summaries
What do you, as a faculty member, see as the significant differences between presenting a class using a traditional lecture-discussion method and AS?	The traditional approach facilitates building a rapport with students; it provides the opportunity to embellish on the content.	Being free to walk around the class facilitated building rapport with students. It was difficult to assess whether students truly grasped the concepts and there was a frequent need to provide supplemental instruction.
What differences do you see, if any, in the way in which concepts are introduced and developed between the two methods?	Concepts are fully developed and can be related to real world settings as needed.	Although top students who accessed all the options got a thorough development of concepts, for many students the approach focused on mechanics without the "whole picture" gained in a good lecture.
What do you view as the relative strengths of each presentation method?	The method is heavily dependent on teacher expertise to keep students engaged and develop an interrelationship.	The method is heavily dependent on student motivation. Motivated students stay engaged and focused as they pace themselves and access teacher assistance when needed.
What do you view as the relative weaknesses of each presentation method?	There is a high dependence on teacher structuring of concept development for the class to be successful.	The need for students to be independent learners and the fact that there is little teacher control of what instructional options students access.
What differences have you noted in the students in terms of achievement, motivation, etc. in each of the two methods?	Teachers felt that motivated students could do well in either method.	Teachers felt that motivated students could do well in either method, but the AS method was less well suited to the lower level and weaker students.
Do you have a preference for either method and, if so, which one and why?	Many teachers preferred to present a traditional lecture; to be the "coach" of their students' learning.	Some teachers preferred the ability to work one-on-one or in small groups with students rather than being tied to the front of the classroom.

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The third level of coding took the second-level summaries and created a broad statement summarizing each of the four sets of data: in-class observations, faculty interviews, classroom feedback sessions and post-semester faculty discussion session. Tables 4.33-4.36 show those results including illustrative quotes from the data. Quotes that provide counter examples or raise questions about the method are shown in italics.

Table 4.33

Third-Level Coding of In-Class Observations Using Componential Analysis

Data set	Lecture-discussion summaries	AS summaries
In-Class Observations	The class consisted of teacher-directed content presentation that incorporated student questions and participation to maintain focus.	The class consisted of students choosing their own activities, mostly working independently but accessing assistance from the teacher when needed.
	"Return of previous test; discussed questions; students reminded about key words." "Application problems – teacher does one then class does one."	"When teacher is working an example at board, some students move up closer; some use center tables for paperwork; others remain at computer stations."
		"*Teacher comment on too little vocabulary development; quizzes not rigorous enough to prepare for the tests.*"

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Table 4.34

Third-Level Coding of Faculty Interviews Using Componential Analysis

Data set	Lecture-discussion summaries	AS summaries
Faculty Interviews	Faculty were generally positive about their classes and felt they were similar to previous MAT 036 classes with the typical concerns about tardiness and absence. "Students seem to enjoy this class more than the students I had last semester in AS." "I can see them responding to my teaching; in AS I didn't know what they were learning or if they were learning." "*The advantage of AS over this method is that a student could be self-paced if we ran it that way.*"	Faculty were generally positive about their classes but noted more differences from previous MAT 036 classes, expressing concerns about whether students were getting comprehensive content development as well as problems with tardiness and absences. "Students seem to like this delivery method better than students in a traditional class like that method." "*I miss not being able to include interesting facts and history of math.*" "*This format requires supplemental work from the teacher.*" "*I wish there were a better way to separate out which students would really do well in AS.*"

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Table 4.35

Third-Level Coding of Classroom Feedback Sessions Using Componential Analysis

Data set	Lecture-discussion summaries	AS summaries
Classroom Feedback Sessions	Students expressed a strong preference for having a teacher direct the class presentation and be available for clarification of concepts.	Students expressed a preference for being able to self-structure their learning activities but did mention the desire to have a teacher accessible when needed.
	"I get more information from a teacher lecturing and from other students' questions." "A computer setting would seem too cold; not as interactive."	"If I have questions I can use both the computer and the teacher." "No comparison; this is a lot better and easier for me to understand." "I can go back and go as slow as I want."
		"AS is slow to use if you grasp the concepts quickly." *"I'd prefer more teacher interaction."*

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Table 4.36

Third-Level Coding of Post-Semester Faculty Discussion Session Using Componential Analysis

Data set	Lecture-discussion summaries	AS summaries
Faculty Feedback Session	A general preference was expressed for the lecture-discussion method for the majority of developmental-level math students due to the ability of the teacher to maintain the focus of the class and direct the content. "More thorough development of concepts." "The classroom presentation fosters more interaction – student-to-student and student-to-teacher – which is useful in teamwork and the social context of learning." "*The schedule is not as flexible and the student's schedule must fit with that of the course/teacher.*" "*Hard to do individual work with students during class.*"	Some preference was expressed for the AS method as it allowed the teacher to interact more individually with students although most agreed that it was not the best approach for weaker students. "If all options are utilized, then the full development is good." "Teacher has time to sit with slower students; can't in lecture classes." "*Most developmental students are not independent learners.*" "*I'm not convinced the whole picture, complete with a spiraling review, is as effective in AS as in a good lecture class.*"

Finally, the broad statements summarizing each of the four data sets were reduced to an overall summary statement for each of the two presentation methods.

The lecture-discussion method allows for the teacher to orchestrate the learning environment and adjust the presentation according to student needs.

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The Academic Systems method allows highly motivated and self-directed students to pace themselves, accessing teacher assistance when needed, but there is less consistency in depth of concept acquisition.

The audit trail from the field note quotes provides trustworthiness for the concluding broad statements and the fact that similar themes emerged from the four different data sets provides triangulation of the information that was used to shape those final statements (Creswell, 1998).

Summary

Based on the analysis of the qualitative data field notes, each method of delivery was appropriate for some students. The difficulty appeared to lie in clearly assessing which students were best suited to the Academic Systems method as this method requires successful students to be highly motivated and independent learners. Those students who will take the initiative to access all the options available do have the potential for well-grounded concept development. Therefore, a dimension that must be considered is whether gain score is related not only to method but also to student characteristics. The student-method interaction, although not a part of this study, could play a role in determining achievement gain score. Given that developmental math students frequently do not yet possess the skills necessary for independent learning, and based on the feedback from the students as well as the teachers, it is reasonable to conclude that for the vast majority of developmental math students, a traditional delivery method that employs lecture and discussion better suits their needs than a computer-based delivery method. These findings are supported by the quantitative analysis that showed of all the independent variables examined only presentation method had a significant effect on

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achievement gain score, with students in the lecture-discussion classes exhibiting higher gain scores than those in the Academic Systems classes.

The researcher admits to a bias for the lecture-discussion method over the Academic Systems method for the reasons that emerged from the various data collection settings. However, in contrast to her personal feelings that a lecture-discussion class develops better student-teacher relationships, she was surprised to find that some faculty were of the opinion that the freedom to move about the room in an Academic Systems class provided more of that opportunity than was available in the lecture-discussion format. This finding was supported by the student responses as well. Additionally, some faculty noted that, if students accessed all the options available in Academic Systems, they received a background in concept development that was equal to or greater than that acquired by students in the traditional lecture-discussion sections. As stated in Chapter I, the goal of this study was not to determine which of these methods is best for teaching basic arithmetic to adults, but rather what components of each contribute to creating successful experiences for students previously unsuccessful in mathematics. Given the qualitative data, the students' ability to self-pace and access the teacher individually during class should be considered as positive dimensions offered by the Academic Systems method.

The fact that the independent variables, excepting presentation method, had no statistically significant effect on achievement gain score does not imply that these were not significant findings, for they support the presumption that the major factor affecting achievement is the student's experience in the classroom. All students have a unique set of baggage and past experiences that they bring to the classroom. However, the findings

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of this study would suggest that those are not nearly as important as what transpires in the class during the semester. Despite the current ability to create highly sophisticated computer programs to present the background and mechanics of various mathematical concepts, the role of the teacher as a coach, a mentor and a guide is not programmable. This supports the importance of the role of the community college, with its focus on under-prepared students and its ability to offer small classes, as a critical dimension of our commitment to higher education for all students.

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CHAPTER V – IMPLICATIONS FOR PRACTICE AND FURTHER STUDY

The Findings of the Study

The overall implication of this study is that the students' classroom experience is the most significant factor in determining achievement. From the researcher's perspective as a teacher, this is not a trivial finding for community college students bring a broad spectrum of challenges with them. Thus, it is empowering to note that despite these dimensions, how the faculty member structures the class is the pivot point for determining students' success. The community college is a critical part of the higher education infrastructure as it is the gatekeeper for many students who would, at the outset, be unqualified to enroll at a four-year college or university. Thus, it is vital that we at the community college learn as much as we can about what conditions help shape successful academic experiences for our students.

The predominant finding of this study was that the only independent variable that had a significant effect on the dependent variable, achievement gain score, was presentation method. The results showed that students in the lecture-discussion classes had significantly greater pretest-posttest gain scores than those in the Academic Systems classes. The literature on this outcome is mixed. Studies by Norwood (1988), Caston (1995) and Nichols (1996) suggest that lecture-based classes and more structured methods of delivery produce greater success. On the other hand, studies by DePree (1998) and Rupnow and Bogenschild (1998) suggest that methods other than lecture are more successful for developmental math students. Indeed, Roueche and Kirk (1973)

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identified lecturing as singularly inappropriate for developmental students. When considering the use of computer-aided instruction, the results of the National Study of Developmental Education (Boylan, Bonham, Claxon, & Bliss, 1992) identified an inverse relationship between pass rates in a developmental course and the amount of computer technology used.

Other than presentation method, none of the other independent variables showed any significant effect on gain score. With respect to age, this study found a slight but not statistically significant effect of age on gain score. Younger students tended to have somewhat greater gain scores than their older classmates. Refsland (1992), however, noted that older students who initially score lower on placement tests cannot be presumed to also score lower grades when enrolled in a course. Harper (1995) concluded that nontraditional-aged female students exhibited greater success and motivation than traditional-aged female students. With respect to time since last taking a (math) class, this study found no statistically significant effect on gain score. Rives (1992), on the other hand, determined that the relation between length of time since last mathematics course and success is direct and inverse. This would indicate that students with more time since their last mathematics course tend to be more successful. With respect to students' previous experiences in math courses, there was no statistically significant effect on gain score. This result suggests that gain score was more dependent on the students' experiences in that semester's class rather than previous success or failure or attitudes about math in general. Eldersveld (1983) also found that self-assessment of attitude toward mathematics was not a discriminator between success and failure in developmental math classes.

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In the qualitative part of this study, componential analysis revealed various themes from the data sources. It is important to note that unlike quantitative analysis, as noted in Merriam (2002), interpretation of qualitative data is intended to discover what themes emerge rather than to prove a hypothesis. The broad summary statement for all four data sets related to the Academic Systems classes speaks to the shift of control of the learning environment to the student.

> The Academic Systems method allows highly motivated and self-directed students to pace themselves, accessing teacher assistance when needed, but there is less consistency in depth of concept acquisition.

This summary is supported by MacDonald and Caverly (1999) who claimed that newer math software that employs a coaching model offer greater control and flexibility to the student to manage individual learning. They made note of software that gives students choices on various enhancements from which they may choose: some show another way to solve a problem; some picture the problem; some explain why the process works. Students can make choices about what type of enhancement is most effective for their learning style. This empowerment can help developmental students overcome the characteristic feeling of helplessness that they often bring to the classroom (Roueche & Roueche, 1993). Other studies, Lepper and Guertner (1989) and Johnson and Perez (1996), support that computer-assisted instruction can have positive effects on learning.

A surprising outcome from the faculty feedback sessions was that some faculty participants felt that the Academic Systems classes provided more opportunity to interact personally with students. Initially, the researcher had assumed that with the majority of the instruction being driven by a student-computer interaction, the teacher might feel disconnected from his students. Additionally, some faculty noted that if students accessed

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all the options available in Academic Systems, they received a background in concept development that was equal to or greater than that acquired by students in the traditional lecture-discussion sections. Many student responses in the Academic Systems classes were consistent with this perception. The success of these students may have also been affected by various other factors not included in this study. As noted by Burley, Butner, and Cejda (2001) a student's willingness to work hard cannot often be determined by any assessment instrument yet this may make a significant contribution to their eventual success or failure.

The broad summary statement for the lecture-discussion method emphasized the prerogative of the instructor to control the learning environment.

> The lecture-discussion method allows for the teacher to orchestrate the learning environment and adjust the presentation according to student needs.

As noted by Norwood (1988), more structured methods of teaching a developmental arithmetic course tended to reduce math anxiety when compared to less structured models.

Implications of the Findings

The fact that this study was undertaken at a single community college with a relatively small number of participants should be considered when generalizing from its outcomes. Although there is no reason to assume that the students participating in this study differed in any significant aspect from community college students in general, it cannot be assumed that the same results would be found in a repeated study under differing circumstances.

Bell (1998) suggested that there are multiple interactive factors that affect student success. Roueche and Roueche (2001) cited faculty awareness that students' success or

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failure is often tied to factors such as personal support, child care, financial aid or counseling that are beyond the scope of the classroom. Additionally, Waycaster (2001) noted that success rates in her study appeared to be independent of the type of instruction used. The important conclusion to take from this study is that learning all that is possible about what makes for a successful community college experience in a gatekeeper course is critical if we in higher education are to insure that the benefits derived from postsecondary education are experienced by the optimal number of students who are motivated to pursue that end.

Challenges Occurring During the Study

No study is without its challenges and this study was no exception. The first challenge was that initially, there were to be three sections taught using the lecture-discussion presentation method, three sections using the Academic Systems method and one using the group-support method. Unfortunately, during the week prior to classes beginning, one of the sections that was designated to be an Academic Systems section had its computer classroom pre-empted by another discipline, thus changing the balance of three lecture-discussion sections and three Academic Systems sections to four lecture-discussion and two Academic Systems sections. This was a frustration for the researcher, as the parallel nature of the original design would hopefully have provided for a more balanced outcome of data. Although there is no way to know if indeed the data outcomes would have been different, equal numbers of the sections for each presentation method would have been optimal.

A second challenge occurred when the researcher discovered that one of the faculty members had mistakenly informed his class that they only needed to complete the

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first eighteen items on the pretest as those were the items being used as a screening to determine if students were initially placed in the correct course. As described in Chapter IV, this was handled by analyzing data separately for Q1-18 and Q1-32 so that the inconsistency of the pretest administration in the one section could be contained. As noted by Merriam (2002), one needs to be flexible in research. Mistakes will happen; unanticipated factors may emerge; participants may be uncooperative.

A third challenge, which is inherent in any study that uses human subjects, was the fact that students had the option to participate in the study or not. Although the pretest and posttest were given as a matter of course during the semester and all students present took those tests, only data for those who chose to sign consent forms for participation in the study were able to be used for analysis. Significant data may have been lacking due to the omission of those scores from students who chose not to participate. Additionally, it is not known whether the characteristics of those who opted not to participate might have been a dimension that affected the outcomes. Are students with certain profiles less likely to participate in studies of this nature? If so, the impact that might have on the results is a question left to be explored.

A fourth and final challenge is the inherent nature of using entry-level community college students for any study. These students are frequently not yet sure that they really want to be students and thus tend to be somewhat unreliable in terms of attendance, motivation and effort. Brothen (1996) showed that sticking to the task and doing the work was the basic discriminator between developmental students receiving "A" grades and those failing the course. It is difficult at best to separate out how much these factors affect

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any given student's success or lack of success in a class, no matter what presentation method is used.

Recommendations for Practice and Application

As evidenced by this study's qualitative outcomes, students' preferences and learning styles affect how they perceive a particular presentation method. Buchanan (1922) determined there is no cure-all to be found. Waycaster (2001) suggested that one mode of instruction will not have equal effects on all students. Boylan (2002) suggested best practices dictate that an array of instructional methods be used to achieve greatest success. Kulik and Kulik (1991) and Boylan, Bonham, Claxton, and Bliss (1992) stated that the best use of computer-assisted instruction in developmental classes is as a supplement, not as the major mode of delivery. The most effective use of this technology is to provide the student with individual review, tutoring and practice.

The critical question to ask with regard to computer use in the developmental classroom is not whether the technology should be used but how (Roueche, Roueche, & Ely, 2001). Developing programs that incorporate a variety of technology enhancements as well as cooperative work and active discussion should be the goal to help students scaffold learning through a multiplicity of options.

Suggested Changes for Future Study

There are two major suggestions for changes that might have made this a stronger study. The first, which has already been mentioned, is to insure that there are an equal number of sections of all three presentation methods, not only the lecture-discussion and the Academic Systems methods, but also the group-support method. Although the group-support method played a minor role in this study, it may have been more significant if

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there were multiple sections included that employed this method. The second suggestion would be that the group-support method not be taught by, or at least the researcher not teach, all of those sections. Although there were no significant statistical differences between the lecture-discussion delivery method and the group-support method, the fact that the only section using the group-support method was the researcher's class calls into question what conclusions can be made about this method in general if other faculty members using this method had been included in the study.

Recommendations for Future Study

There are a number of recommendations for studies that could expand on the findings of this one. Each of those will be presented with some discussion about why those studies might add new dimensions to the picture of community college students' experience in a basic arithmetic course.

An Academic Systems presentation method that solely uses computer-mediated teaching would give a clearer picture of students' true grasp of the conceptual framework of the content of this course if the only "teacher" was the computer program. The Academic Systems sections used in this study provided supplemental instruction from the faculty members, embellishment on various topics and teacher-generated quizzes to insure that those concepts not well covered by Academic Systems were integrated into these sections. Given that the quantitative data analysis indicated that the students in the lecture-discussion sections achieved greater gain scores than those in the Academic Systems sections and that the qualitative data indicated that most students in the Academic Systems sections still wanted the presence of a teacher when needed, it could be speculated that had the Academic Systems sections been offered in a true lab setting,

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where there was no teacher present and the students had to rely solely on the computer program for their instruction, the difference in achievement gain score would have been even greater than what was found in this study.

This study confined the student participants to those who attended the largest campus of this community college during the traditional class hours between 8:00 a.m. and 3:00 p.m. The inclusion of night students in a future study might have had a significant effect on the data outcomes. Night students tend to be older and, as shown in the data analysis of Research Question 2, "Is there an association between age and achievement gain score?" the younger students tended to have greater gain scores although this was not statistically significantly. Another dimension to the population choice was that the students used in this study were from one campus of the college. It could be speculated that students from the other campuses might have displayed significantly different demographic characteristics that may have affected gain score.

An additional dimension related to age that might be pursued would be the overall achievement levels of younger versus older students. If, in fact, younger students tend to exhibit greater achievement gains than older students across the spectrum of disciplines, then that might be a mitigating factor in considering the outcomes of a study such as this one. If younger students had greater gain scores in MAT 036 and they also had greater gain scores in general, then a future study should control for this difference.

By having a study that deals with a greater number of sections and therefore a greater number of faculty, the impact of any single instructor on the classroom experience would be diminished and the difference in gain score would be more legitimately attributable to presentation method. Although only two of the sections in this study were

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taught by the same faculty member, as there were only seven sections involved, the variety of faculty-specific differences was limited. If ten to twenty sections were studied, the differences among faculty would become a lesser influence and presentation method would be more easily distinguished as a determining factor for achievement.

An assessment of students' learning styles prior to enrollment in specific sections could have a significant impact on outcome. If those students who have a decided preference for independent learning, who are self-motivated and who like working on computers were singled out for enrollment in the Academic Systems sections, it could be postulated that they might have greater achievement gain scores than those in the lecture-discussion sections. The fact that lecture-discussion is a method that is general enough to fit a greater portion of the student population may have accounted for much of the statistical success of that method when in reality, perhaps if appropriate students in the lecture-discussion sections had been identified and placed in the Academic Systems sections, the overall picture may have been significantly altered.

The last issue to address, and there is no easy way to control for this, is the effect on the study's results of those students who choose not to participate. If a study could be constructed that would insure all students in the participating sections were included in the data analysis, then a more realistic picture of achievement gain score could be obtained. However, as long as students have the option to participate or not, we cannot know what data were lost from those who choose not to participate.

The previous suggestions for further study are offered to provide a context for further exploration into what makes for a successful experience in a basic arithmetic course for entry-level community college students. Although this study was based on a

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small sampleof students taking an entry -level math course at one community college, it provides some basis for future study designs. If indeed, greater satisfaction with the learning setting has a favorable impact upon achievement (Rupnow & Bogenschild, 1998), then it is incumbent upon those of us who teach at the community college to bring all those dimensions into play that will create the setting for our students to be successful.

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APPENDIX A – INFORMATION SHEET AND FIVE-MINUTE WRITING PROMPT

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Name________________________________

Student Code________________________________

Information Sheet for Study Participation
A Community College Basic Arithmetic Course: Predictive Factors for Success

Delivery Method (circle one): Lecture Discussion   Academic Systems   Group Support

Please respond to each question by either writing the appropriate number on the blank provided or by circling the correct response.

1. Your current age in years ________

2. Your gender FemaleMale

3. Number of years since your last educational experience (taking a class) ________

4. Number of hours you are working per week ________

5. Does your program require any math courses beyond MAT 036? Yes No

6. Do you have previous experience using a computer? Yes No

7. Do you own a computer? Yes No

8. Do you have access to a computer at work? Yes No
   (If you do not currently work, circle No .)

9. How comfortable are you with using computers?
   (1 = not comfortable at all; 3 = moderately comfortable; 5 = very comfortable)

   1 2 3 4 5

10. On a weekly basis, how much do you use a computer?
    (1 = not at all; 3 = somewhat; 5 = extensively)

    1 2 3 4 5

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Please respond in writing to the following question for five minutes.

What has math been like for you and what do you expect to get out of this class?"

Thank you for your participation in this study!

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APPENDIX B – IN-CLASS OBSERVATION PROTOCOL

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In-Class Observation Protocol
Project: A Community College Basic Arithmetic Course: Predictive Factors for Success

Observation date: _______________
Class section observed: _______________
Faculty member teaching: _______________
Presentation method used: _______________
Introduced to class: _______________

1. **Physical setting of class**

2. **Activities and their length**

3. **Student responses**

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4. Faculty presentation

5. Additional observations

REMEMBER: ***Thank you for your participation in this study!***

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APPENDIX C – FACULTY INTERVIEW PROTOCOL

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Faculty Interview Protocol

Interview date: ______________
Faculty interviewed: ______________
Section(s) teaching: ______________
Presentation method used: ______________

All information will be kept confidential and not associated with any particular faculty member's name for purposes of the study.

1. **What has been your experience teaching this class this semester?**

2. **How does this class compare to other MAT 036 classes you have taught?**

3. **Do you have any particular concerns regarding this class?**

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4. **What other comments would you like to make regarding this class?**

REMEMBER: ***Thank you for your participation in this study!***

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APPENDIX D – CLASSROOM FEEDBACK SESSION PROTOCOL

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Classroom Feedback Session Protocol

Session date: ______________
Section of MAT 036: ______________
Presentation method used: ______________

1. **What do you appreciate about this class?**

2. **How would you compare this math class to other math classes you have had?**

3. **What concerns or recommendations do you have for this class? Please express your responses using statements that begin with "I…".**

4. **Would you want to take another class using this presentation method? Why or why not?**

REMEMBER: ***Thank you for your participation in this study!***

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APPENDIX E – POST-SEMESTER FACULTY DISCUSSION PROTOCOL

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Post-Semester Faculty Discussion Protocol

Discussion date: ______________

1. **What do you, as a faculty member, see as the significant differences between presenting a class using a traditional lecture-discussion method and Academic Systems?**

2. **What differences do you see, if any, in the way in which concepts are introduced and developed between the two methods?**

3. **What do you view as the relative strengths of each presentation method?**

4. **What do you view as the relative weaknesses of each presentation method?**

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5. What differences have you noted in the students in terms of achievement, motivation, etc. in each of the two methods?

6. Do you have a preference for either method and, if so, which one and why?

7. Additional comments.

REMEMBER: ***Thank you for your participation in this study!***

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APPENDIX F – INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

PRETEST AND POSTTEST SCORES, FIVE-MINUTE WRITING RESPONSE, INFORMATION SHEET, IN-CLASS OBSERVATION AND CLASSROOM FEEDBACK SESSION

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COLORADO STATE UNIVERSITY
INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

TITLE OF PROJECT: A Community College Basic Arithmetic Course: Predictive Factors for Success

NAME OF PRINCIPAL INVESTIGATOR: William Timpson

NAME OF CO-INVESTIGATOR: Gayle Krzemien

CONTACT NAME AND PHONE NUMBER FOR QUESTIONS/PROBLEMS:
Dr. William Timpson (970) 491-7630
Gayle Krzemien (719) 540-7336

PURPOSE OF THE RESEARCH:
We want to find out how to help students be more successful in MAT 036. We need to know how your skills improve and what your experiences with math have been.

PROCEDURES/METHODS TO BE USED:

- We are asking to use your test scores from the standardized math test you would normally take at the start and end of the semester.

If you agree to participate in the study,

- You will be given an information sheet with ten questions that we would like you to answer about items such as your age, gender, how comfortable you are with computers and when you last took a class.
- You will be asked to write for five minutes about your experience with math classes.
- Your class may be observed by one or more people from the college. The purpose of their being in your class is to compare the different methods we use in MAT 036. They will not be taking any notes about specific students by name.
- Your class may be chosen for a classroom feedback session during the last half of the semester. This will be a class discussion of your experience in the class.

RISKS INHERENT IN THE PROCEDURES:
There are no known risks. However, it is not possible to identify all potential risks in research procedures. The researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks. You might be concerned about whether your grade can be affected by your choice to participate in this study or not. Your teacher will not know if you have agreed to participate. Your consent forms, written responses and information sheets will be put in a sealed envelope to be coded by the researcher. Your teacher will not see them.

BENEFITS:
Participating in this study should help the researchers improve the teaching methods used in the college classroom to help improve learning. Additionally, the information gained may assist the college in more effectively advising students planning to take MAT 036. There are no known direct benefits for participants.

Page 1 of 2 Participant's initials _______ Date _______

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CONFIDENTIALITY:

- All of your responses will be coded for the study and your name will be removed so that your information will not be able to be identified as belonging to you. Your teacher will not see your name on your responses.
- If you are in the class being taught by the researcher, Gayle Krzemien, your information will be coded by the department chair. She will not know which information came from which students.

Questions about subjects' rights may be directed to Celia S. Walker at (970) 491-1563.

PARTICIPATION:

Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled. Participation (or lack of participation) will not effect your class grade.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing _2_ pages.

____
Participant name (printed)

______________________________ ________________
Participant signature Date

______________________________ ________________
Witness to signature (project staff) Date

PARENTAL SIGNATURE FOR MINOR – If you are 17 or younger, you need a parent's or guardian's permission to be in this research project.

As parent or guardian you authorize ________________________ (print name) to become a participant for the described research. The nature and general purpose of the project have been satisfactorily explained to you by ____________________ and you are satisfied that proper precautions will be observed.

____
Minor's date of birth

____
Parent/Guardian name (printed)

______________________________ ________________
Parent/Guardian signature Date

Page _2_ of _2_ Participant's initials ______ Date ______

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APPENDIX G – INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

FACULTY INTERVIEWS, IN-CLASS OBSERVATION AND POST-SEMESTER FACULTY DISCUSSION

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COLORADO STATE UNIVERSITY
INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

TITLE OF PROJECT: A Community College Basic Arithmetic Course: Predictive Factors for Success

NAME OF PRINCIPAL INVESTIGATOR: William Timpson

NAME OF CO-INVESTIGATOR: Gayle Krzemien

CONTACT NAME AND PHONE NUMBER FOR QUESTIONS/PROBLEMS:
Dr. William Timpson (970) 491-7630
Gayle Krzemien (719) 540-7336

PURPOSE OF THE RESEARCH:
This research is to study various factors to determine if any single factor or a combination of factors can predict success in MAT 036.

PROCEDURES/METHODS TO BE USED:
You may be interviewed for up to one hour by the researcher Gayle Krzemien about the section(s) of MAT 036 that you are teaching during the semester from which data are being gathered for this study and/or about MAT 036 classes that you have taught in the past. This researcher may also observe your classroom at one or more times during the semester. Additionally, after the end of the semester, if you have taught MAT 036 using both a traditional lecture-discussion presentation method and Academic Systems, you will be invited to participate in a faculty discussion about different presentation methods for teaching MAT 036. For purposes of this study, data will be recorded using any of the following means: written notes, tape recording and or laptop computer. If tape-recording is used, the tapes will be transcribed and, at the end of the project, destroyed. You will be provided with the results of the various data gathering sessions in which you were involved.

RISKS INHERENT IN THE PROCEDURES:
There are no known risks. However, it is not possible to identify all potential risks in research procedures, but the researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

BENEFITS:
Participating in this study should help the researchers improve the teaching methods used in the college classroom to help improve learning. Additionally, the information gained may assist the college in more effectively advising students planning to take MAT 036. There are no known direct benefits for participants.

CONFIDENTIALITY:
Your responses will be kept confidential. Any data from you will be coded and have your name removed. It will be identified only as coming from Faculty 1, Faculty 2, etc. for purposes of this study.

Questions about subjects' rights may be directed to Celia S. Walker at (970) 491-1563.

Page 1 of 2 Participant's initials _______ Date _______

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PARTICIPATION:

Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing _2_ pages.

____
Participant name (printed)

________________________________ ________________
Participant signature Date

________________________________ ________________
Witness to signature (project staff) Date

Page 2 of 2 Participant's initials _______ Date _______

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