CHAPTER 1

INTRODUCTION

1.1 Opening

As our world becomes more complex and interdependent, change becomes increasingly non-linear, dicontinuous and unpredictable. As Gibson (1997) says, "the future becomes less like the past. And less like we expected it to be. We find that A might lead to E, then on to K and suddenly to Z! This realization calls for an entirely new way of looking at the future in our corporations, in our societies and in our schools."

There is a lack of consensus on why and how technology should be integrated into the educational arena, what students should be taught and how to train educators to use technology (Wilson, 1995). Before education incorporates this new electronic media, educators need to discern what is different about the new technology and what those differences mean in terms of cognition, learning, teaching, and education in general (Kaput, 1992). This process may lead to a better consensus among educators as to the role technology should play in mathematics education.

Computers are used more often in mathematics than in any other subject (Kober, 1992). The distinct potential of visually representing abstract mathematical ideas appears to offer promise to educators who realize the computer's capabilities (Fey, 1989). Henry Pollak from Bell Laboratories has been quoted as saying "With technology - some mathematics becomes more important, some mathematics becomes less important, some mathematics becomes possible" (Cohen, 1995).

1.2 Need

The significant problems we face cannot be solved at the same level of thinking we were at when we created them.

Albert Einstein

Building Communities, written by the commission on the future of community colleges, makes the following recommendations for the future role of educational technology at the community college:

- We recommend that every community college develop a campus-wide plan for the use of technology, one in which educational and administrative application can be integrated.
- We also propose incentive programs for faculty who wish to adapt education technology to classroom needs.
- Further, we recommend that a clearinghouse be established at the American Association of Community and Junior Colleges to identify educational software of special value to the community college.
- The community college- through technology- should continue to extend the campus, providing instruction to the work place and to schools, and scheduling regional teleconferences for the community forums in continuing education.
- Finally, we recommend that new uses of technology be explored. Specifically, community colleges should lead the way in creating electronic networks for learning, satellite classrooms, and conferences that connect colleges from coast

to coast, creating a national community of educators who transcend regionalism on consequential issues.

Although mathematics and science education are vital aspects of the nation's productivity, students' mathematical and scientific competencies fall below what is required for an increasingly technological world. At the same time, recent reports have indicated that changes are necessary in the way mathematics is taught (Baker and O'Neil, 1994). Traditional methods of teaching do not relate mathematical problems to the real world, help students think about realistic situations, or help students to generate and pose their own solutions. As a result, students may become unmotivated and unconnected, developing an overall negative attitude towards mathematics and technology.

The effect on student attitudes as a result of using computer technology to teach and learn mathematics requires further study. This problem will be addressed through the following two research questions. First, "Will the use of cooperative learning activities or instruction on the computer change a student's attitude toward mathematics?". In addition, "Will the use of cooperative learning activities or instruction using computer software change a student's attitude toward computers?"

Relevance of applying mathematics reform across the curriculum through cooperative learning and computer based activities is evidenced by student success rate, especially in lower level courses. Student success rate is measured in terms of the number of students enrolled by the drop deadline who received a grade of A, B, or C. In academic year 1996/1997, the Brevard Community

College (BCC) student success rate in Calculus III (MAC 2313) was relatively high at 82.25%. On the other hand, the success rate is at only 52.94% for Calculus II (MAC 2312), 64.85% for Calculus I (MAC 1311), 68.49% for Precalculus (MAC 1142), 70.85% for Trigonometry (MAC 1114), 59.26% for College Algebra (MAC 1104), and a low 47.94% for Introduction to College Algebra (MAT 1033).

Self-paced instruction on the computer has been implemented in an attempt to improve the retention rate of students as they proceed through the mathematics curriculum at BCC. Will self-paced instruction using Academic Systems mathematics software in Preparatory Algebra courses increase student success rate in current and future mathematics courses? This is the third research question to be addressed in this study.

1.3 Definition of Terms

STUDENT SUCCESS RATE: Number of students enrolled by the drop deadline who received a grade of A, B, C.

COLLEGE ALGEBRA, MAC 1104: An in-depth course in : linear and quadratic equations and inequalities and their systems, exponential, logarithmic and other functions, matrices and determinants, complex numbers, theory of equations, sequence and series and the binomial theorem.

INTERMEDIATE ALGEBRA, MAT 1033: Prepares the student for MAC 1104, College Algebra. Includes vocabulary, symbolism, basic operations with algebraic expressions, polynomials, linear equations and inequalities, exponents, radicals and radical equations, graphing quadratic equations and complex numbers.

PREPATORY ALGEBRA, MATV 0024: An individualized approach to mathematics through an elementary development of the rational number system and an introduction to Algebra through quadratic equations.

ACADEMIC SYSTEMS MATHEMATICS SOFTWARE: A mediated learning system that provides a rich, interactive learning environment. Student's work through the software at their own pace and in their own way, guided by customized learning plans that identify the concepts that must be mastered. mediated learning consists of: comprehensive instruction, mathematics tools, real-time assessment, and individualized learning management.

DERIVE©: A symbolic computer system.

CHAPTER 2

REVIEW OF RELATED LITERATURE AND RESEARCH

2.1 Introduction

A paradigm shift is occurring at all levels of higher education. Educators are moving from a teaching or instructional paradigm to a learning paradigm. "We are beginning to recognize that our dominant paradigm mistakes a means for an end. It takes the means or method -- called 'instructing' or 'teaching' -- and makes it the college's end or purpose. To say that the purpose of colleges is to provide instruction is like saying that General Motor's business is to operate assembly lines ... We now see that our mission is not instruction but rather that of producing learning with every student by whatever means work best" (Barr & Tag, 1995). In a learning paradigm, the mission of the college becomes one of providing environments and experiences that encourage and enable students to explore new concepts. The richness and variety of experiences can enable each student to learn measurably more than prior students.

"A college's purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge for themselves, to make students members of communities of learners that make discoveries and solve problems. The college aims, in fact, to create a series of ever more powerful learning environments" (Barr & Tagg, 1995) For systemic change to occur in higher education computers will become increasingly important as the means to the desired end of learning. "Students, in the not too distant past, learned by reading, listening to lectures, writing papers, and taking part in discussions. Now, however, instructors can take advantage of recent technological developments to increase the depth and efficiency of learning" (tec.h, 1996).

An important question for which we must seek an answer is "How can we describe and compare students' curriculum encounters and their influences on learning?" This question has been systematically observed and data has been analyzed through the use of computer - assisted instruction (CAI), software that teaches through a tutorial model. This method of instruction has constituted the primary use of computers in the classroom since the 1960's. According to James Kulik and his colleagues at the University of Michigan: this method results in a substantial improvement in learning outcomes and speed, perhaps around 20 percent or more on average in mathematics classes where the computer can tell the difference between a student's right answer and wrong answer. A 20 percent increase using CAI could in part be a result of adult learners having increased control over their learning. Students need to have control over their learning, but they must also make some of the decisions regarding what, when and how to study. Because the CAI tutorials allow control only over the when in a student's learning, they are gradually being replaced by newer technologies.

The most popular styles of technology used in the classroom were not designed for that purpose. Wordprocessors, electronic mail, and the Internet are currently some of the most widely used forms of technology in education. There are many reasons for this trend: "they are in demand for instruction because students know they need to learn to use them and to think with them; faculty already are familiar with them from their own work; vendors have a large enough market to earn the money for continual upgrades and relatively good product support; and new versions of software are usually compatible with old files, thus, faculty can gradually update and transform their courses year after year without last year's assignment becoming obsolete" (Ehrmann, 1995). Being fluent in the use of these tools will be crucial for job seekers. This is already apparent according to VanHorn (1996) in the employment section of the classified advertisements of newspapers and many professional journals.

In 1991, Pascarella and Terenzini synthesized all the research they could find bearing on higher learning and discovered that going to college and graduating indeed pays off in many ways. However, they found that performance in school and work achievement after graduation has an insignificant correlation of approximately 1 percent (Ehrmann, 1995). Findings by Boyatzis (Ehrmann, 1995) show the significant value of cognitive skills built through the methods of learning that occur in the classroom, yet unrelated to the content schools are teaching.

2.2 Teaching with Technology

"We know from long experience any evaluation of teaching is a difficult task. A technique or style effective for one instructor may be less pertinent to another. So it is in teaching using technology - it is not for everyone, but in the hands of many instructors it can be very useful" (Cartwright, 1993). According to John Dewey (1929), the sources of a "science of education" should be aimed at the enrichment of the teacher's capacity for heightened understanding and intelligent decision making rather than the control of his or her behavior.

"Technology can save us or sink us in the classroom. Creative applications of technology can restore much of the thrill of exploration by giving even our less skillful students tools to take them where they could not have easily gone before. But we must learn how to pass on the 'mathematical mind' to our students without the drill and manipulations. We must reinfect them with the excitement of discovery, with the dramatic power of analytical reasoning. We have a lot to learn, but we stand at the door to a new era in mathematics education." quote by Michael Davidson, Cabrillo College (Cohen, 1995, p. 43).

Ehrmann (1995) declares what matters most, in teaching with technology, seems to be:

- not the technology per se but how it is used

- not so much what happens in the moments when the student is using the technology, but how those uses promote larger improvements in the fabric of the student's education
- Not so much what we can discover about the average truth for education at all institutions, but more what we can learn about our own degree programs and our own students.

Students should be able to go beyond a basic understanding of the field's content by applying the field's methods to new problems. They should be skilled at working through the process of scientific discovery, theory construction, and research methodology. They must be able to rely on these methods of thinking to consider critically ideas that are relevant to mathematics (tec.h, 1996). "The illiterate of the year 2000 will not be the individual who cannot read or write, but the one who cannot learn, unlearn, and relearn" (Alvin Toffler in tpinfo.html, 1996).

According to William (1994), technologies provide tools that can increase the cognitive power of students by:

- Reducing or eliminating the need for extensive development of routine manipulative skills before concepts can be studied.
- providing multiple perspectives on important concepts that will help students to construct their mathematical knowledge, and

– Promoting a broader, more unified view of basic mathematical notions, particularly functions, that can serve as a common thread running through courses (Philipp, Martin, & Richgels, 1993).

According to *Teaching and Technology* (1996), these higher-order conceptual and analytic skills can be taught effectively using hypertexts, simulations, and computer-based laboratory replications. Hypertext programs present text material, but they also provide graphics and interlinked topic lists. These programs are interactive ones, for students can control the pace of their movement through topics. "Applied academics is designed to help students learn through the combination of theory and application. Relevancy of what the students are learning and how the material applies to the careers they have chosen enhances the student and the classroom." (tpinfo. html, 1996).

All of this research indicates the increasing importance placed upon the tools used for learning. To make visible improvements in learning outcomes using technology, use that technology to make large-scale changes in the methods and resources of learning.

Stephen Ehrmann (1995) states the following three lessons:

– Technology can enable important changes in curriculum, even when it has no curricular content itself.

– What matters most are educational strategies for using technology, strategies that can influence the student's total course of study.

– If such strategies emerge from independent choices made by faculty members and students, the cumulative effect can be significant and yet still remain invisible.

In the search for effective use of computers in the mathematics classroom, scientific researchers must continue to investigate student learning in order to derive a more scientific basis for curriculum design, and examine, describe, and compare curricular activities that utilize the computer, and their variously defined effects.

2.3 Computers in the Mathematics Classroom

In recent years much attention has been focused on the reform of mathematics education with the aid of technology. Mokros and Tinker (1987) conducted studies to determine how middle school students learn graphing skills through microcomputer-based laboratories. Scores on graphing items indicated a significant improvement in students' ability to interpret and use graphs between pretests and posttests when using microcomputer-based laboratory units.

Several researchers have found that technologies can be used to enhance learning in precalculus and calculus classes (Beckmann, 1989; Dugdale, 1990; Heid, 198; Schrock, 1989; Tufte, 1990). Studies suggested that students in the experimental courses performed just as well as traditional groups on routine computational tasks (C^2PC field test data, Harvey, et al., unpublished; Heid, 1988; Judson, 1988). One study looked for transfer of skills from graphing precalculus to a graphing unit in a subsequent physics course; in that study, Nichols (1992) detected no transfer of graphing skills from the prior use of graphing technologies in precalculus mathematics to the use of graphs in introductory physics.

Ganguli (1990) conducted a study to investigate the effect of the microcomputer as a demonstration tool on the achievement and attitudes of college students enrolled in an intermediate algebra class in which two classes were taught selected topics with teacher-demonstrated microcomputer graphs and two classes were taught the same selected topics with graphs drawn by the teacher on the chalkboard. After completion of five weeks of instruction, a 16-item multiple choice posttest was administered; at the end of the quarter, a two-hour comprehensive examination was administered. The treatment effect was significant for the comprehensive examination but not for the posttest. Ganguli concluded that the significant difference in the final examination indicated that students had acquired and retained conceptualizations of algebra better in the treatment group than in the control group.

2.4 Attitudes

Human-computer interaction is a complex phenomenon and the attitudes and feelings involved with the relationship are difficult to identify (Willis, 1995). However, as the role of the computer expands in our global society, it is increasingly important that educators become aware of anxiety about computers among students. Fennema and Sherman (1976) suggest that anxiety toward a subject area may affect the learning process, negative or ambivalent attitudes toward computers exist, and could be a deterrent to using computers in the learning environment. It seems likely that students' attitudes toward and acceptance of computer technology, as well as learning about computers, may be important in the integration of electronic technologies in the classroom, workplace, and home.

Data collected by Willis (1995) indicates a significant change in attitudes toward computer technology. When computers are introduced to students many respond positively and master the necessary computer skills quickly. However, for other students the computer represents an unpleasant and anxious experience leading to difficulties in mastering appropriate skills (Loyd & Gressard, 1984). This anxiety may take the form of hostility, fear, and/or resistance, attitudes, which may inhibit the acquisition of computer skills, much as math anxiety can inhibit achievement in mathematics (Fennema & Sherman, 1976).

Bretscher (1989) indicated the following strategies, which may help math anxiety and effectance motivation:

- The use of small classes, enabling the teacher and student to work together frequently on a one-to-one basis;
- A math lab with computer and tutors, providing individual instruction and hands-on practice in concepts and skills;

– Math journals, stimulating writing in math and encouraging students to verbalize thought processes in problem solving, analyze study skills and express feelings.

If positive attitudes increase (Clement, 1981) students can master the computer skills involved, which then offers many advantages in the educational process: informal student interaction, absence of embarrassment, student-paced operation, problem solving, tutoring, immediate feedback, and absence of subjectivity.

CHAPTER 3

METHODS AND PROCEDURES

3.1 Research Questions

1. Will the use of cooperative learning activities or instruction on the computer change a student's attitude toward mathematics?

   Hypothesis: There is no significant difference in the change in Fennema-Sherman Mathematics Attitudes Scales scores between students grouped by experimental treatment.

   Hypothesis: There is no significant difference in the change in Fennema-Sherman Mathematics Attitudes Scales scores between students grouped by teacher.

   Hypothesis: There us no significant difference in the change in Fennema-Sherman Mathematics Attitudes Scales scores between students grouped by class period.

   Hypothesis: There is no significant difference in the change in Fennema-Sherman Attitudes Scales scores between students grouped by gender.

2. Will self-paced instruction using Academic Systems mathematics software in Preparatory Algebra courses increase student success rate in current and future mathematics courses?

Hypothesis: There is no significant difference in a student success rate in College Algebra between students grouped by experimental treatment.

3. Will the use of cooperative learning activities or instruction using computer software change a student's attitude toward computers?

   Hypothesis: There is no significant difference in the change in Computer Attitude Scales scores between students grouped by experimental treatment.

   Hypothesis: There is no significant difference in the change in Computer Attitude Scales scores between students grouped by teacher.

   Hypothesis: There is no significant difference in the change in Computer Attitude Scales scores between students grouped by class period.

   Hypothesis: There is no significant difference in the change in Computer Attitude Scales scores between students grouped by gender.

3.2 Instruments

Two attitude instruments, which have been used in other studies and have been statistically validated, were used in this study. They are the Computer Attitude Scale (CAS), and the Fennema-Sherman Mathematics Attitudes Scales.

The Computer Attitude Scale (CAS), developed by Loyd and Gressard, is a likert-type instrument consisting of 40 items, which present statements of attitude toward computers and their use. Three main types of attitudes are represented: (a) computer anxiety or fear; (b) liking of computers or enjoying working with computers; and (c) confidence in ability to use or learn about computers.

The CAS consists of 40 statements, such as “I would like learning with computers.” The individuals indicate the degree to which they agree with the statement on a five-point scale, with “agree strongly” on one end and “disagree strongly” on the other. Each response is given a value of 1 to 5, with 5 indicting a more positive attitude towards computers.

The Fennema-Sherman Mathematics Attitudes Scales are 10 separate scales designed to measure some domain-specific attitudes related to the learning of mathematics by all students. Each scale consists of 12 statements related to the learning of mathematics. Six are positively worded and six are negatively worded. Individuals respond to a statement by indicating the degree to which they agree or disagree with that statement. The possible responses are “strongly agree”, “agree”, “undecided”, “disagree”, and “strongly disagree.” Each response is given a value from 1 to 5 with 5 indicating a more positive attitude. Each scale has a possible score of 12 to 60. The scales used in this study are The Confidence in Learning Mathematics Scale, The Mathematics Anxiety Scale, and The Mathematics Usefulness Scale. Scores from each of these scales were used in this study.

The Confidence in Learning Mathematics Scale is intended to measure the confidence in one’s ability to learn and to perform well on mathematical tasks. The dimension ranges from distinct lack of confidence to definite confidence.

The scale is not intended to measure anxiety or mental confusion, interest, enjoyment, or zest in problem solving. The Mathematics Anxiety Scale is intended to measure feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics. The dimension ranges from feeling at ease to feeling distinct anxiety. The scale is not intended to measure confidence in, or enjoyment of, mathematics. The Mathematics Usefulness Scale is designed to measure students' beliefs about the usefulness of mathematics currently, and in relationship to their future education, vocation, or other activities.

Retention data will be provided by Data Processing at Brevard Community College. Demographic information will be obtained from a preliminary survey and student transcript information.

3.3 Validity

A study used the Computer Attitude scales with 155 students in grades 8 through 12, who were involved in a computer-based education program in a large school district. Ages of the subjects ranged from 13 to 18; 51 were males and 104 females. An overall reliability score of .95 (Cronbach alpha) along with scores of .86, .91, and .91 for anxiety, confidence, and liking were obtained (Loyd & Gressard, 1984). In a study of 1,541 junior high school students, the authors concluded that their factor analysis provided "support for the theoretical structure" of the CAS scales (Broadbooks, 1981).

A study of 1,233 high school students found split-half reliability scores ranging from.86 to .93 (Fennema & Sherman, 1976; Broadbooks, 1981). Measurement integrity was explored by using data in a study by Thompson (1993) from 174 elementary school teachers of mathematics in an urban public school system. Both the factor structure and sensitivity to social desirability response set were investigated. Results of factor structure analysis were generally favorable with regard to the validity of scores. Divergent construct validity coefficients were also favorable.

3.4 Population

The population for this study consisted of students from Brevard Community College. Brevard Community College (BCC), is a multi-campus, co-educational community college located on the East Coast of Florida. BCC serves students in a suburban service area of over 420,000 residents on full-service campuses in Cocoa, Melbourne, Titusville, and Palm Bay. BCC offers a broad range of programs to the degree seeking student and provides postsecondary, technical, and vocational education for persons who have completed or left high school and desire preparatory or supplemental instruction for employment and personal development. BCC employs 1,340 faculty and support staff. In the past year, the combined BCC campuses and centers served a headcount of over 40,000 students, with over 22,000 students taking credit level courses.

With faculty and staff of over 400, the Melbourne Campus enrolled over 9,400 students in credit level courses in 1995-1996. The Mathematics Department, with over twenty full time and adjunct faculty, offers fifteen mathematics courses. The population for this study will be made up of students enrolled in MATV 0024 Preparatory Algebra, MAT 1033 Introduction to College Algebra, and MAC 1104 College Algebra on the Melbourne campus of BCC during the 1997/1998 academic ear.

3.5 Assumptions

It is assumed that:

1. All subjects will answer the surveys honestly.
2. The sample will be representative of introductory level mathematics students at a community college.
3. The subjects are able to understand english to interpret the surveys.

3.6 Limitations

1. All subjects in the study were from Brevard Community College.
2. The surveys, selected by the researcher, focused on the areas perceived as significant to the study.
3. Success in mathematics is measured as pass rate. No pre or post-test scores were analyzed for problem solving abilities or change in knowledge level.

4. The Computer Attitude Scales and Fennema-Sherman Mathematics Attitude Scales were only analyzed for students who completed both the preliminary and final survey.

3.7 <u>General Procedures</u>

Data will be collected over two consecutive semesters, fall 1997 and spring 1998. During the first and last week of each term, the attitude scales will be administered to the participants using computers in College Algebra, Introduction to College Algebra, and Preparatory Algebra. Surveys will also be administered to the control groups, where computers are not used, in both College Algebra and Introduction to College Algebra. During the term the experimental treatment classes, in Preparatory Algebra and Introduction to College, will receive all instruction on the compupet using Academic Systems mathematics software. The experimental treatment groups in College Algebra will supplement their regular classroom activity with weekly cooperative learning activities on the computer. The control classes will follow the regular schedule as determined by their teacher.

Paragraph describing Academic Systems

All of the computer based activities involve participants' use of Derive©, or slideshows designed by the investigator and participating faculty using PowerPoint© or Astound©. They were designed to coincide with the topics and concepts that are covered in the regular classroom activities. Each activity includes a written handout and presentation file. Students worked in groups of 2-4 to complete each handout.

Each activity handout contains information about:

– The lesson objective;

– The name of the software file to be used with the activity;

– Problems to be solved.

On each activity worksheet the student recorded:

– General information on the students doing the activity;

– Students' responses to the various questions, and information on how they solved the problems.

Each associated slideshow contained information about:

– The software package used;

– Concepts to be mastered in each lesson;

– Explanations, definitions, and sample problems;

– Practice problems.

See Appendix A for sample presentations and examples of activity sheets.

3.8 Data

The following data will be gathered:

Personal data: the gender and prior mathematics experience.

Class data: the instructor, class period, and course name and number for each student.

Survey data: pre- and post-measures of attitude towards mathematics, and attitude towards computers.

Retention data: Success rates for all Algebra classes that either utilized Academic Systems software or had students who came from a prior course that utilized Academic Systems software.

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