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A comparison of academic achievement and retention of community college students in college algebra after completion of traditional or technology-based instruction

Jennifer Ferrill Seal

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A COMPARISON OF ACADEMIC ACHIEVEMENT AND
RETENTION OF COMMUNITY COLLEGE STUDENTS
IN COLLEGE ALGEBRA AFTER COMPLETION OF
TRADITIONAL OR TECHNOLOGY-BASED
INSTRUCTION

By

Jennifer Ferrill Seal

A Dissertation
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in Community College Leadership
in the Department of Instructional Systems,
Leadership and Workforce Development

Mississippi State, Mississippi

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This study was designed to compare the success rates in College Algebra between two groups of students attending a Mississippi community college. Eighty students enrolled in a College Algebra course were taught using traditional instructional techniques, and 70 students received technology-enhanced instruction. This study considered the effects of grade scores on a mathematics-achievement pretest and posttest, student attitudes toward mathematics, time-on-task while using technology during mathematics study, mathematics subscores on the American College Test, and withdrawal rates.

Data collected for this study were derived from the official transcripts of students enrolled in spring 2007 College Algebra classes of a Mississippi community college serving as the study site. A total of 150 students participated in the study. Statistical analysis included t tests, chi-square tests, Pearson product-moment correlations, and analysis of covariance to examine relationships between the two groups of students. The

results indicate that the students who received College Algebra instruction via technology-based methods learned equally as well as the students who received the same instruction via traditional methods. The findings also indicate that the students who participated in the traditional College Algebra course had improved attitudes toward mathematics upon completion of the semester. With regard to those who participated in the technology-based College Algebra course, the amount of time devoted to technology use during mathematics study did not correlate to their final grades (i.e., grades were not higher as this expenditure of time increased).

DEDICATION

This dissertation is humbly dedicated to my husband, Michael; my mother-in-law, Lucy Seal; and my parents, Joseph and Joye Ferrill. Your patience, understanding, encouragement, support, and steadfast love made it all possible. I love and cherish you, and will be forever grateful.

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“I can do everything through Him who gives me strength.”

Philippians 4:13 (NIV)

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CHAPTER I

INTRODUCTION

Nature and Scope of the Study

Throughout the continuum of American history, access to higher education has consistently increased primarily due to the efforts of U.S. community colleges. Maintaining this trend involves an academic responsibility to meet the divergent needs of students entering community college classrooms. The need to earn a degree in higher education is greater now than in the past; indeed, it is deemed a necessity for the majority of high school graduates seeking careers within various industries. U.S. college graduates earn an income that surpasses that of the majority of high school graduates by an average of \$23,441 per year. When compared to the incomes of high school dropouts, this figure increases to \$31,595 per year. According to Olsen (2007), “College graduates are more likely than high school graduates to have full-time, year-round employment, and are about 20% more likely to be fully employed as those without a high school diploma” (p. 66).

College Algebra is an essential component of the degree programs of many institutions and often a mandatory requirement. Unfortunately, mathematics is often viewed by students as difficult, impractical, boring, and even torturous, seemingly requiring a special aptitude. For a considerable number of students, College Algebra

represents a barrier to the attainment of a degree in higher education, excluding some students from this system of education. Mississippi requires a low three credits in mathematics to graduate from public high school. The conventional, minimal requirements are pre-algebra, geometry, and Algebra I. These low expectations leave students underprepared for collegiate mathematics courses, compounding their initial fears surrounding mathematics.

Traditional teaching methods often present an unfamiliar learning strategy for many students of the 21st century. Contemporary learners have been consistently exposed to information technology and the Internet throughout their school years and expect nothing less upon entering college (Del Favero & Hinson, 2007). Many are adept at using interactive whiteboards and digital presenters. In short, technology is readily available within middle-school and high school classrooms across the state. Yet, when these students enter collegiate mathematics classrooms, technology use with instruction is limited, whether due to funding deficiencies or inadequate knowledge of the benefits of technology integration within the classroom.

Funding within the state of Mississippi has often introduced a “battle” between elementary and secondary school districts, higher education institutions, and community colleges. These entities compete each fiscal and legislative year for a larger share of increasingly limited funds. Financing technology within the classroom has been a top priority during the past 2 decades for elementary and secondary schools. This primary focus emerged from planned efforts to prepare students for the modern workplace and global economy of this century. Mississippi public schools, from elementary through

high school, have a computer located within each classroom, most equipped with Internet service. Yet frequently, community colleges and universities within the state do not provide such resources.

As succinctly stated by Zeszotarski (2000), “Access to technology improves access to educational opportunities” (p. 2). Community colleges strive to widen the learning horizons of their students, as well as those of future generations. It is critical that the administration of community colleges view technology advancements and their implementation as an investment rather than an expense. Graves (1998) described the necessity and urgency for institutions of higher education to support technology implementation within the classroom in the following manner:

Higher education executives cannot awaken too soon to the need to view information technology as a strategic investment rather than a cost. Most academic executives are aware that the problems facing their institutions do not beg short-term solutions, but few have seriously challenged the culture of traditional instruction. If academic leaders hesitate to act as partners to create national educational fabric, viable alternatives to the present model of institution-based education will present themselves, and higher education as an institution may be hard-pressed to compete. (p. 34)

Gray and Madson (2007) found that actively engaging students in the learning process through interactive approaches has led learners to retain twice as much content, compared to that retained through instruction based solely upon lecture methods.

Statement of the Problem and Purpose of the Study

Mathematics, and College Algebra specifically, are prevalent issues as college students make major decisions; in some cases, influencing whether they pursue a postsecondary degree. The contemporary student communicates in a variety of ways, depending upon technology access. Jennings (2007) reported that, during the first quarter of 2007, students between 18 and 24 years of age sent and received an average of 290 cell calls per month. During the same time frame, students between 13 and 17 years of age averaged 435 text messages per month, indicating this age-group as the highest users of this particular mode of communication. Jennings also found that young adults 25 year of age view cellular telephones as an extension of themselves. Reports such as this clearly portray the stronghold of technology on American society, and particularly on college-age populations. Consequently, the need to infuse technology within classroom instruction must be considered.

This study was conducted in an effort to determine whether the integration of technology would facilitate classroom instruction and learning of College Algebra. College Algebra is an effective platform for this evaluation because it is a required subject for most students seeking to attain an associate or bachelor's degree. Consequently, the specific purpose of this study was to compare the success and withdrawal rates of two student groups enrolled in College Algebra within a Mississippi community college. One group received traditional instruction while the other received instruction via a technology-based approach. The findings will be distributed to the administration of the participating community college, as well as to the State Board for

Community and Junior Colleges, to facilitate their determination of the effectiveness of the differing delivery methods in mathematics instruction.

Research Questions, Hypotheses, and Limitations of the Study

The following research questions guided this study:

1. Do students enrolled in technology-based College Algebra courses perform at a higher level than students enrolled within the same courses taught in a traditional manner?

2. What variances in attitudes toward mathematics emerge between students attending traditional versus technology-based algebra courses? Do the withdrawal rates differ between students enrolled in traditional College Algebra and those enrolled in technology-based College Algebra, and are these differences associated with mathematics scores on the American College Test (ACT)?

To determine the comparative effectiveness of the two instruction delivery methods under study, the following research hypotheses were formulated to investigate their effects on learning within the participating College Algebra classrooms:

1. There is no significant difference in grade scores between students enrolled in College Algebra taught in the traditional manner and those enrolled in technology-based College Algebra.

2. There is no significant difference in scores on the mathematics-achievement posttest of College Algebra students exposed to traditional instruction versus those who received technology-based instruction while controlling for the pretest.

3. With regard to the attitude questionnaire known as the Views About Mathematics Survey (VAMS), there is no significant change in scores from the pretest to the posttest administered to students enrolled in the technology-based College Algebra course.

4. With regard to the attitude questionnaire known as the VAMS, there is no significant change in scores from the pretest to the posttest administered to students enrolled in the College Algebra course delivered in a traditional manner.

5. There is no significant relationship between mathematics achievement, as measured by the achievement pretest and posttest of College Algebra students, and time-on-task during technology use.

6. There is no significant relationship between College Algebra grades and mathematics subscores from administration of the ACT.

7. There is no significant difference in withdrawal rates between students enrolled in the traditional College Algebra course and those enrolled in the technology-based College Algebra course.

The following limitations apply to this study:

1. The participating students were enrolled in College Algebra within a single Mississippi community college during the spring semester of the 2006–07 school year.

2. The study was limited to a traditional College Algebra course and a technology-based College Algebra course as they existed at the time of the study.

3. The context of the study was limited to the College Algebra curriculum determined by the mathematics department of the participating community college.

4. The technology-based College Algebra course was limited to the software and technology described within this research documentation.

Definition of Terms

The following terms used throughout this research documentation are defined for purposes of the study:

Academic success is the achievement of a minimum grade of “C” upon course completion, which will transfer to a state university (“Hattiesburg, Mississippi,” 2003).

The *ACT mathematics subscore* is the score from a mathematics subtest within the ACT.

A *College Algebra grade* is a measure of average scholastic success in College Algebra, obtained by averaging student grades throughout the course.

A *community/junior college* can be described as a body of faculty and students (Carr, 2004). It is a public institution accredited to award the associate in arts or the associate in science as its highest degrees (Cohen & Brawer, 2003; Vaughan, 2000). An associate degree, which is designed to be earned within 2 years or less, represents the completion of a liberal-arts curriculum in preparation for a vocational or technical field. The Mississippi Code of 1972, article 37-29-233, allows for junior colleges to award the associate degree.

Education refers to the process within which experience, knowledge, skills, values, and attitudes are acquired that enable learners to serve as productive members of a social system (Wren, 2006). According to the University of Maryland Institute for Advanced Computer Studies, education is a vehicle for creating knowledgeable, aware

citizens who are capable of viewing the world in a critical fashion to make informed decisions related to their lives and the lives of others. Education is primarily composed of instructional and learning methods implemented within schools or similar settings, as opposed to various informal means of socialization. Education is the transmission of values and accumulated knowledge throughout a society. It can be described as the ability of individuals to gain sufficient knowledge and understanding surrounding the major issues of their time to help guide their society into the future; thus, effective teaching is the key to education (Brinkley et al., 1999).

A final grade is a student's cumulative average for a course with predetermined weights represented by a letter grade on a 10-point scale (A = 90–100, B = 80–89, C = 70–79, D = 60–69, F = 59 and below, W = withdrawal).

Mathematics attitude refers to the views of students with regard to learning mathematics, as measured by the VAMS (Halloun, Carlson, & Hestenes, 1996).

Technology is systematic knowledge and action, usually associated with industrial processes, but applicable to any repeated activity. Technology is closely correlated to science and engineering and is used to facilitate the acquisition of knowledge. It can refer to a myriad of aids, products, and practices based upon the application of knowledge, with examples ranging from an overhead projector to adaptive robotics to microcomputers. Barba and Reynolds (1996) reported that technology motivates students. New technology contributes to student learning within both affective and cognitive domains. It empowers students to produce their own creative work, and allows them to focus on process rather than product. Technology may be described as the application of

knowledge, tools, and skills to solve practical problems and extend human capabilities (Barba & Reynolds, 1996).

Withdrawal refers to students dropping from College Algebra courses prior to completion.

CHAPTER II

LITERATURE REVIEW

The Community College

Historical Perspective

As cited in Cohen and Brawer (2003), the Morrill Act of 1862 created the basis for the community college system by extending open enrollment to students previously denied access to institutions of higher education. With expanded curriculum and efforts toward increasing the collegiate population, a Joliet, Illinois junior college established during 1901 represented the first community college within the United States (Vaughan, 2000). Milliron and Miles (2000) described this event as sparking new thinking surrounding the academic paths available for students across the United States. Mississippi entered into this new phase of developing junior colleges through the establishment of agricultural high schools, which eventually offered college-freshman courses. As an agrarian society transformed into an industrialized economy, junior colleges of the state strove to meet student needs of gaining an education and training beyond high school through the development of vocational and technical programs.

During 1944, the U.S. Congress approved the Servicemen's Readjustment Act which was referred to as the GI Bill and supplied financial aid to World War II veterans desiring to attain higher education (as cited in Cohen & Brawer, 2003). Following the

industrialization phase, the information age emerged, fueled by constant technology development while community colleges endeavored to meet societal needs by preparing students for the contemporary workforce. During the 1960's, the Higher Education Facilities Act of 1963 and the Higher Education Act of 1965 were passed, which allowed a significant increase in financial assistance to community colleges and its students.

During 1972, a change in titles replicated the expanding focus of junior colleges. The American Association of Junior Colleges became known as the American Association of Community and Junior Colleges. In 1998, the Workforce Investment Act of 1998 (as cited in Bramucci, 1999) altered the role of the federal government with regard to job training, adult education, and vocational rehabilitation. Community colleges continued to have a primary role in training. The traditional, three-part mission of the community college includes open access and enabling students to engage in academic transfer, offering vocational/technical and workforce development programs, and serving as a community-based institution of higher education.

The ever-changing role of the community college faces challenges that were summarized in the following forecast by Drucker (1992): "In the next 50 years, schools and universities will change more and more drastically than they have since they have assumed their present form more than 300 years ago when they organized themselves around the printed book" (p. A5). Without the community college, many people would not have access to higher education (Vaughan, 2000). Cohen and Brawer (2003) reported an enrollment of more than 500,000 students during 1960. By the end of the 1990s, that number increased to 5.5 million students. Over 10 million students attend community

college each year, which includes both credit and noncredit enrollees, indicating the wide diversity of students served by these institutions.

Funding Challenges

Funding within the community college system is driven by economic, political, and social factors. These colleges are the lowest funded of all education entities. The following breakdown was cited by the Mississippi State Board for Community and Junior Colleges (2007) and indicates the distribution of fiscal-year 2008 education funding from the general fund: (a) 72.7% public education from kindergarten through Grade 12, (b) 20.8% universities, and 6.5% community and junior colleges. The national budget for all community colleges is over \$21 billion annually (Cohen & Brawer, 2003). Funding sources for each geographical area vary based upon state, diversity, and institution mission. Sources of funds include local taxes, state appropriations, federal contributions, tuition and fees, foundational support, and contract training. Rural community colleges allocate most of their funds to instruction. Within the state of Mississippi, instruction accounts for approximately 59%, which includes all academic, vocational-technical, and other types of instruction. The remaining 41% of the budget is dedicated to institutional support, physical plants, and student support services.

The Mississippi State Board for Community and Junior Colleges (2007) provided the following breakdown of funding sources for Mississippi community colleges during fiscal-year 2008: 44.6% state, 8.8% indirect state, 8.7% federal, 24.3% tuition and fees, 8.9% district taxes, and 4.7% local support. It is notable that state support within Mississippi is higher than the national average and local support is lower than the

national average. Additionally, community college students of the state contribute more in “out-of-pocket” tuition than their national counterparts. As enrollment increases, salaries and expenditures follow. Cohen and Brawer (2003) suggested that, as state funding decreases, community colleges encounter the following two choices: (a) shift the burden to the student through increased tuition and fees or to the local taxpayers with additional taxes or bonds; or (b) generate a greater amount of related innovation.

Paulson and Smart (2001) reported that community colleges were not presenting their needs to key legislators and identified this as a cause for poor funding. Funding disparity is also represented in budget cuts during weak economic periods. From fiscal- year 2000 to fiscal-year 2004, Mississippi community colleges have absorbed overall funding cuts of 17% while confronted with an overall enrollment increase of approximately 24%. Concurrently, the university system experienced cuts of less than 10%, and the education system serving kindergarten through Grade 12 actually received increases in revenue (Gilbert, 2004). State funding is derived from an annual legislative appropriation. Every August, each community college associated with the Mississippi State Board for Community and Junior Colleges submits a budget request to the Mississippi Legislative Budget Office. This request is followed by budget hearings with the budget office and later with House and Senate appropriation committees. Appropriation bills are typically passed late in the legislative session.

Student Population

Characteristics. The greatest relevancy of the Drucker (1992) observation lies in the impact of technology within the classroom. It is highly indicative of potential changes in the fundamental character of college-level instruction. Just as college mission statements adjust to the changing needs of communities and employers, college instructional methods must also adjust to accommodate a generation of students with far more technology exposure and accessibility than was the case with past generations. The contemporary student lives in an age where college tuition has been auctioned on an Internet site to the highest bidder (Downey, 2007a). Students are accustomed to using mobile e-mail and music devices on a daily basis. A survey conducted in 2001 indicated that 65% to 80% of students have computers within their homes (Milliron, 2001). Students of this new millennium are often referred to as “millennials” and are acclimated to a quick-paced society that necessitates the concurrent processing of multiple sources of information. Simultaneously, thought is processed rapidly as learners filter various forms of communication. Millennials are multitaskers, processing information quicker than the spoken word. Students are often disengaged when their minds are left wandering, searching for information to occupy the void.

Continuous integral exposure to computer-aided problem solving, social computing, and mixed-media learning methods may well have produced a generation of students with learning strategies and expectations very different from those traditional methods of instruction can address. Because contemporary students enroll within

community colleges under an open-door policy providing access to all individuals, instructors encounter learners with a wide array of learning styles. College students can experience extreme difficulty in acclimating to varied learning environments, especially considering the varied backgrounds of the estimated 11.6 million community college students across 1,202 U.S. community colleges (American Association of Community Colleges, 2007). Adaptation difficulties seem to be especially prevalent among technology-literate college students oriented to multitasking and enrolled in traditional, lecture-based courses taught via chalkboard. In light of the evolution of technology, such instruction delivery is considered quite archaic.

Academic success. Instructor budgets are often insufficient to acquire new forms of innovative resources due to unstable funding from state legislatures, administration, and businesses. Research has indicated that, when academic environments complement the inherent learning styles of students, students succeed (Jones, Reichard, & Mokhtari, 2003). In turn, when students succeed, retention rates increase, which lead to improved graduation rates. Retention rates may be strongly affected by the degree to which students are acclimated to learning opportunities that are not constrained by time or location. Contemporary students often work within time constraints that hamper dedication to class attendance. Technology infusion has the potential to reduce or eliminate such barriers by providing students more options. The “domino effect” could be a reduction in the need for student contact with a physical campus. As more and more community college classes encounter overloaded classroom situations each semester, technology use within the

classroom could possibly provide a resourceful answer to the dependence upon a physical classroom and the associated costs. Meeting the needs of students equates to more than the development of additional academic programs.

Developmental education is a principle need within community colleges. A significant number of students often enroll during the first semester in remedial courses due to low ACT scores. Developmental education has grown significantly during the last half century, as evidenced by this enrollment. Decaying secondary-school curriculum has contributed to this scenario through the deficient preparation of future college students. The deficiency is simply passed on to the next academic level. Eased college-admission requirements have further contributed to the situation by allowing and even encouraging unprepared students to register for college. Developmental courses teach skills and concepts to which these students should have been previously exposed. A tremendous number of courses are devoted to developmental education. Students also receive assistance through peer tutoring, learning laboratories, counseling services, and study programs. Developmental education is increasingly viewed as a responsibility of the community college system.

Mathematics

Student anxiety. The National Research Council (as cited in Scarpello, 2007) reported that mathematics tends to be one of the most feared subjects by students attending secondary institutions across the nation, as well as those within postsecondary schools. This is rooted in their weak foundation in mathematics and declining confidence

levels. Mathematics anxiety can be described as an “irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations” (Buckley & Ribordy, 1982, p. 2). The need for student confidence in the area of mathematics increases as technology use increases throughout American society. The National Council of Teachers of Mathematics (2000) espoused the importance of students learning and becoming confident in mathematics. The Council documented the following responsibilities of a mathematics educator while engaged in instruction:

- Equity. Excellence in mathematics education requires equity — high expectations and strong support for all students.
- Curriculum. A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated.
- Teaching. Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.
- Learning. Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.
- Assessment. Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.
- Technology. Technology is essential in teaching and learning mathematics; it influences the mathematics that . . . taught and enhances students’ learning.

(p. 11)

Furner and Berman (2004) advocated that mathematics instructors employ best practice in instruction while concurrently addressing student attitudes toward mathematics to increase mathematics achievement.

Curriculum. Mathematics courses offered at community colleges are listed within the curriculum of education. The Southeastern Association of Colleges and Schools requires community colleges to produce a general-education review to maintain accreditation. This type of curriculum supported the origination of the community college system. Because the collegiate function had been strictly recognized according to academic disciplines, liberal arts were driven by the disciplines, the disciplines determined course arrangement, and the courses encompassed the collegiate function. The question concerning the relevance of mathematics study periodically emerges within classrooms across the country. The National Council of Teachers of Mathematics (2000) provided the rationale for this ever-increasing need. Their key elements include studying mathematics for life—not solely as an aspect of cultural heritage and the workplace, but also to benefit the scientific and technical community. This supports the mission statements of numerous community colleges that encourage students to become lifelong learners. Students successfully completing the required mathematics to receive an associate degree significantly increase their future opportunities.

It is possible that the perceived relevance of mathematics study is masked by use of insufficient or obsolete technology in instruction delivery. The rapidity with which technology progresses renders a technological tool purchased today nearly obsolete

tomorrow. With students spending increased time utilizing the newest technological supports of daily life, educational institutions attempt to keep pace with the rapid progression. This “e-challenge” also exists within the arena of mathematics education. The particular instruction tool implemented “influences the mathematics . . . taught and enhances students’ learning” (National Council of Teachers of Mathematics, 2000, p. 25).

Teaching With Technology

Exposure. College campuses receive students with expectations that their instructors are sufficiently savvy to incorporate available technology into the instructional design of the courses they teach. According to Downey (2007b), “To keep America competitive in the 21st century, we must improve the way we teach math” (p. 20). Enhancement of teaching and learning through the utilization of technology begins with an understanding of the eventual differences that will manifest as a result of such implementation. For example, the distance that once existed between teaching colleagues and between instructors and students are reduced. This represents a positive change; however, it is of minimal value unless an authentic difference is perceived.

Research must question and measure the differences that result from technology implementation because “without knowing the differences that technology makes, there is no way to effectively manage the changes that occur – mitigating the impact when negative and building when positive” (Connolly, 2005, p. 6). The term *differences* is a succinct means of describing the emphasis researchers and educators must place on looking beyond the boxes and wires of technology (Al-Bataineh & Brooks, 2003;

Burgess, 2002; Caverly, 2000; Doherty & Ayers, 2002; “Educational Technology,” 2005). Understanding the differences that technology can make allows its use to be more closely related to institutional goals. As aptly stated by Burgess (2002), “The infusion of technology is not an end state but an integration of instructional planning and learning strategies” (p. 10).

Instructional methods would not necessarily incorporate “cutting-edge” technology solely for the sake of relevance. Just technology use can enhance teaching and learning, its overuse can inhibit learning. “If used excessively, technology can cause passive behavior toward the subject and impede the learning process” (Smith & Potoczniak, 2005, p. 30). Relying too heavily upon technology while ignoring the pedagogical influence of the instructor can have a negative impact on student progress. Trinkle (2005) discussed the success of technology initiatives at a specific university and provided 10 key factors for success that have been developed as well-established best practice.

Integration. Regardless of the specific practice used to integrate technology into the classroom, the apparent implication of related literature is critical for community college success. Technology integration is a necessary focus for institutions of higher education. It is the obligation of community colleges to prepare students to be technologically literate upon progression to 4-year institutions and/or within their chosen career paths. According to Schwark (2001), “Reaching more than ten million students and producing 44 percent of all U.S. graduates, our country’s nearly 1200 community

colleges are in a unique position to help prepare workers for this new economy” (p. 6). Community colleges have a long history of responsiveness to the educational needs of local communities. Adams and Burns (1999) stated,

The use of real world tools, relevant experiences, and meaningful data inject a sense of purpose to classroom activity. Part of the mission of educational institutions is to produce workforce-ready graduates who can, among other things, manipulate and analyze raw data, critically evaluate information, and operate hardware and software. This technological literacy imparts a very important set of vocational skills that will serve students well in the working world. (pp. 28)

Burgess (2002) posited that “learners learn by experiences in a real world, problem-oriented approach, and it is on that premise that a design for functional learning for staff, faculty, and students should become reality” (p. 10). Technology should serve as a tool to help meet the needs of instructors and students, not as the primary means of instruction. Caverly (2000) expressed this crucial balance in the following profound statement: “Teaching and learning must take precedence over technological delivery systems” (p. 40). The instructor is the focus of the educational experience for students. Technology is a tool used by both students and instructors to enhance that experience. Alan November (as cited in Downey, 2007a) provided an analysis of the link between students and education. He recently stated,

The key to using technology in the classroom is not to train teachers how to use it, but to train them on how to incorporate technology creatively into lessons in

engaging and stimulating ways. Additionally, students should be able to connect with classrooms around the world, to boost a global perspective on learning.

(p. 38)

Perspectives. Engaging and stimulating students in mathematics has been a high priority within academia. Related concerns began emerging nearly 4 decades ago regarding student attitudes toward mathematics (Callahan, 1971). Student expectations toward mathematics play a role and should be considered in determining learner ability to understand mathematic concepts. Ironsmith, Marva, Harju, and Eppler (2003) stated that “prior attitudes, emotions, and classroom experiences are often difficult to overcome” (p. 282). Such anxiety factors have been addressed in related literature and shown to negatively impact student performance in mathematics.

Ironsmith et al. (2003) measured mathematics anxiety, confidence, usefulness, and effectiveness among college students via administration of a modified version of the Fennema-Sherman Mathematics Attitudes Scales. They suggested that “anxiety and confidence predict mathematics performance better than standardized measure[s] of quantitative ability” (p. 283). Instructors armed with this knowledge would benefit from approaching their profession in light of the psychological factors associated with mathematics learning and, as a result, strive for pedagogical changes. Regardless of the instructional changes considered, however, they should be carefully matched to student learning styles. Griffin (2003) emphasized aligning technology-enhanced experiences with clear-cut objectives to produce increased learning. He found that use of PowerPoint

lecture presentations, interactive CD-ROMS, and computer-based physiological recordings all resulted in measurable effects on student learning. Griffin demonstrated how technology integration into the classroom can be used in conjunction with sound teaching pedagogy toward the academic success of students with a variety of learning styles.

A survey conducted by Marks (2005) indicated a direct relationship between teacher quality and student achievement. Specifically, instructors who tend to implement instructional technology also tend to approach their teaching delivery in creative and innovative ways while allowing students to actively engage in a learning environment suited to specific, individual learning styles. The National Foundation for the Improvement of Education (2000) emphasized that technology can facilitate teaching strategies that promote higher-order thinking skills leading to improved student learning. Peck and Dorricot (as cited in Hopson, Simms, & Knezek, 2002) concluded that technology integration gives students opportunities to organize, analyze, interpret, and evaluate their work.

Technology was later defined by Hopson et al. (2002) as a tool moving students from the acquisition of knowledge to its application. The League for Innovation in the Community College remains a strong proponent of incorporating technology use within classrooms. Milliron and Miles (2000) initiated a study in affiliation with the League during 1997 with a focus on significant forces affecting community colleges now and those expected in the future. The research explained the community college move from a provider-centered institution to more of a learner-centered environment due to

information technology. It was clear the investigators held no doubt that higher education would continue to change.

Summary

Due to increasingly diverse student populations and the ongoing pressures to offer ever-expanding programs to meet their needs, community colleges are in jeopardy of losing sight of the fundamental collegiate function, which is to provide a liberal arts education that prepares students to transfer in to [sic] baccalaureate programs at colleges and universities (Cohen & Brawer, 2003). At a time when developmental course enrollment is sharply increasing and budgets have been concurrently tightened, community colleges must reconsider their services to transfer students and learners who are developmentally challenged. Focus must be maintained on the provision of career education due to the nature of economic fluctuations, as well as on the advancement and well-being of the local community.

Both Cohen and Brawer (2003) and Vaughan (2000) acknowledged the challenges that face community colleges as attempts are made to meet the needs of their new diverse student bodies. Bain (2004) identified the key aspects of excellent teachers (i.e., characteristics) both within the classroom during instruction delivery and out of the classroom during instruction preparation. The study found that exceptional teachers create a “natural learning environment” and expect more from their students. They also expect that their students *want* to learn. Bain also emphasized the importance of a “safe, low-risk” environment for students to try new techniques or approaches to learning

(p. 32). Within such a setting, instructors feel more at ease challenging students to try new things. Students uncomfortable with technology use often find its use possible for them within this safe learning environment.

Open access has benefited community colleges in increased enrollment; however, it has also placed a burden on resources through the provision of remedial education. It is critical that community college education and resources are available to all interested community members. Student access to an education that will allow them to successfully transfer to an institution of higher education or complete a terminal certification enabling their choice of employment must always be a priority. Enabling students to attain their highest potential under this educational system must be a primary focus. Community colleges are constantly striving to meet community needs that encourage further education of the individuals comprising the local population. They have been described as complex, comprehensive institutions and will continue to offer the programs and support worthy of such description. To meet and exceed related challenges, reconceptualizing mathematics curriculum to amalgamate with technology would support academic cohesion and student preparedness. Whether or not students choose to progress to a 4-year institution, they will possess a greater amount of knowledge and the marketable skills necessary to make beneficial contributions to society throughout their careers. The need to infuse technology into the classroom remains imperative.

CHAPTER III

METHODOLOGY

The purpose of this current study was to compare the success and withdrawal rates of two student groups enrolled in College Algebra within a Mississippi community college. In particular, it sought to determine whether the infusion of technology affects the academic achievement of students, as well as their attitudes toward mathematics within a community college algebra course.

Research Design and Instrumentation

The research design applied in this study was quasi-experimental in nature. This design was selected due to the nonrandomization of the control and treatment study groups (Fraenkel & Wallen, 2006). Data collection involved pretest and posttest results, final grades, and attitude classification of the control and treatment participants.

Mathematics Achievement

Data were collected via two study instruments—a mathematics-achievement test and an attitude survey. A mathematics-achievement pretest and posttest were developed by the mathematics department of the study site with consideration to its College Algebra curriculum (see Appendix A). The tests were reviewed by an uninvolved institution to verify correlation of the problems to the curriculum. Pilot administration to two

Intermediate Algebra classes were also conducted during the final week of instruction. Intermediate Algebra is the remedial course preceding College Algebra. The results of the pilot administration revealed a common and expected mean score.

The mathematics-achievement test administered in this study was normalized according to a national test produced by the Mathematical Association of America (MAA). The mathematics faculty of the study site reviewed the research instrument and judged it appropriate for the purpose of this current research. According to the MAA, tests are written by panels of educators teaching the college mathematics served by the placement tests. Final approval for each test is provided by the MAA Committee on Testing, which is composed of faculty members affiliated with a variety of collegiate institutions experienced in testing. Before an instrument can become a MAA test, it is first administered at select institutions. The results undergo detailed analysis with modifications and further trials, as required. This method ensures the best possible standards-based assessment of mathematical aptitude. MAA instruments are known for the reliable assessment of student knowledge based upon the results of a short test. The results are available as soon as the tests are completed. The mathematics-achievement pretest administered in this study was completed the first week of class, prior to any College Algebra instruction. The posttest was administered the final week of class upon completion of all College Algebra instruction delivery. The scores were represented by a percentage of correct answers.

Student Attitudes Toward Mathematics

The VAMS was used in this study to measure student attitudes toward mathematics (see Appendix B) with pretest and posttest administrations of the same instrument. The pretest was administered the first week of the College Algebra class, prior to any instruction, and the posttest was administered the final week upon completion of all College Algebra instruction. The instrument was developed by Halloun et al. (1996) who also provided permission for its use. According to these researchers, the VAMS was designed to

1. Identify differences among the views of students and mathematicians.
2. Identify patterns in student views and classify them in general profiles.
3. Compare student views/profiles of college students at various levels.
4. Assess the relationship between student views/profiles across various demographic strata.
5. Compare student views/profiles across various demographic strata.
6. Measure the effectiveness of instruction in changing student views. (pp. 7)

The VAMS is designed to probe student characteristics on six attitudinal dimensions—three mathematical and three cognitive. Descriptions resemble those identified in the following manner by Redish (as cited in Halloun et al., 1996):

- **Mathematical Dimensions of the Views About Mathematics Survey**
 1. *Structure of mathematics knowledge:* Mathematics is a coherent body of knowledge concerning the study of quantity, structure, space, and change. It developed, through the use of abstraction and logical reasoning, from

counting, calculation, measurement, and the study of the shapes and motions of physical objects.

2. *Methodology of mathematics*: Mathematical modeling for problem solving involves more than selecting mathematical formulas for number crunching.

3. *Validity of mathematic results*: Mathematics is exact, absolute, and final.

- Cognitive Dimensions of the Views About Mathematics Survey

1. *Learnability*: Mathematics is learnable by anyone willing to make the effort, not just by a few talented people, and achievement depends more on personal effort than on the influence of [a] teacher or textbook.

2. *Reflective thinking*: For a meaningful understanding of mathematics one needs to concentrate on concepts, look at things in a variety of ways, and analyze and refine one's own thinking.

3. *Personal relevance*: Mathematics is relevant to everyone's life; it is not of exclusive concern to mathematicians and instructors. (p. 8)

Each of the 33 items of the VAMS contains two response types scored on a scale from 1 through 8. Students respond according to the scale they prefer. If a student strongly favors the response provided in (a), the respondent will mark a 1 on the scale. If a student strongly favors the response provided in (b), the respondent would mark a 7 on the scale. If a student views both response options equally, a 4 would be marked on the scale. If a student is neutral between the responses, an 8 would be selected on the scale.

Of the 33 items, only 27 assessed student classification according to responses of "expert

view,” “mixed view,” or “folk view.” A profile of student attitudes was generated by Halloun et al. (1996) according to the total within the student classifications (see Table 1). The classification system was established from a database formed by results of the VAMS administered to over 2,000 students and 16 mathematicians. Analysis of all responses allowed only 27 survey items to fit the four general profiles outlined.

Table 1
Profile Classifications From the Views About Mathematics Survey

PROFILE	Number of Expert Views	Number of Folk Views
Expert	≥ 16	≤ 11
Upper Transitional	= 14 or 15 = 13	≤ 13 < 13
Lower Transitional	= 13 = 12 = 11 = 10	= 13 or 14 ≤ 12 ≤ 11 ≤ 10
Naïve	= 12 = 11 = 10 ≤ 9	> 12 > 11 > 10 Up to 27 (less expert views)

Population Sample

Sample Origination

This study was conducted on the main campus of a Mississippi community college with an enrollment of 3,500 students, which does not include those enrolled solely in online courses. An open-admissions policy stipulates that placement within developmental courses is according to mathematics subscores on the ACT. A minimum score of 18 is required for placement in a College Algebra class; otherwise, the student is

placed in the appropriate developmental mathematics course. The developmental courses offered at the study site are Developmental Mathematics, Introductory Algebra, and Intermediate Algebra. If the student enrolls in a developmental mathematics course, a minimum grade of “C” must be achieved to advance to the next mathematics course. If the student pursues this path, Intermediate Algebra is required to have been the preceding course.

The minimum mathematics subscore on the ACT is derived from an analysis and review of the respective College Algebra criteria and curriculum. In this current study, the mathematics faculty collected data from 2000 through 2006 that encompassed the fall, spring, and summer semesters (see Appendix C). The population sample consisted of the 6,800 students enrolled in College Algebra within the study-site institution. A comparison was made between the College Algebra success rate and the highest mathematics subscore recorded for each participating student. The analysis indicated that a score of 19 or above eliminated the need to complete developmental mathematics courses. A score of 16 or below indicated the necessity to learn the concepts presented in the developmental mathematics courses offered in preparation for the College Algebra curriculum. A score between 17 and 19 demonstrated the students were reasonably prepared to successfully complete College Algebra; a score of 18 represented the breakpoint at which the overall success rate was not negatively affected.

This study included students who enrolled in all sections of College Algebra during the spring 2007 semester. This was a required class to fulfill the degree plan for either an associate’s or bachelor’s degree. All College Algebra instructors adhere to the

same curriculum outlined within an approved mathematics-department syllabus. On an annual basis, the mathematics curriculum is compared with, and adjusted according to, the College Algebra courses and degree programs of the state universities to which most of these community college students traditionally transfer. The mathematics and laboratory instructors involved in this study had participated in several workshops; training sessions; and international, national, and state mathematics conferences. Information on the latest technology was dispensed at these events and accessible within technology-based classrooms. The campus workshops were selected based upon the specific requests of these faculty members. Students attending the traditional and technology-based College Algebra courses received 150 minutes of instruction per week for 16 weeks. As noted earlier, both courses adhered to the content outlined on the same syllabus.

Population Resources

Mathematics subscores on the ACT were obtained directly from the official student transcripts within the Office of the Registrar. Withdrawal rates and grades in College Algebra were obtained from the Information Technology Department. Two types of College Algebra classes were offered to all students—traditional and technology based. The traditional courses provided instruction primarily through lecturing and use of a chalkboard or overhead projector. Homework assignments focused on problems from a hardbound textbook purchased by students at the beginning of the semester. In contrast, the technology-based College Algebra courses provided instruction using an interactive whiteboard; digital presenter; the MyMathLab, Blackboard, and Graphical Analysis

software; the Internet; Microsoft Office tools, laboratory exercises; and access to the mathematics laboratory. The MyMathLab program contains a wide range of instructional content via PowerPoint instruction, videos of lessons, software tools providing larger displays of graphs and diagrams, audio clips enhancing the visual mathematics, animation illustrating problems solved completely, and electronic supplements that students can access in addition to the concepts presented within the classroom. Hyperlinks transfer students directly to online homework, testing, diagnosis of strengths and weaknesses, and tutorials provided in a variety of formats able to meet the academic needs of each learner. The laboratory experiments were designed to transform rote mathematical skills into a mind-set conducive to understanding mathematics.

Real-world problem solving requires instructional reform to emphasize critical thinking and reasoning, which lie at the center of higher order thinking skills. Experiments assess the abilities of students in analyzing, synthesizing, applying, and evaluating information while forming fundamental skills essential for workforce decision making. Laboratory reports engage students in the structure of the problem, assumptions, data, and consequences. MyMathLab advertises that the software provides instructors with a rich and flexible set of course materials, along with course-management tools, that render all or a portion of mathematics courses easily deliverable in an online format. The online course-management tools include a powerful homework manager, flexible assessment system, comprehensive gradebook tracking system, complete course content and customization tools, the ability to copy courses and share them with other instructors, guided mathematical instruction for students, multimedia learning aids for students,

student study plans for self-paced learning, and tutoring for students from the Math Tutor Center.

The MyMathLab Homework Manager offers instructors the capability to create and manage online homework assignments, which are automatically graded, allowing a greater amount of instructional time. The MyMathLab online gradebook is designed specifically for mathematics and statistics. It automatically tracks performance on tests, homework, and tutorials and provides control over managing results and calculating the grades of participating students. In addition to extensive online tutorial exercises, MyMathLab courses include a variety of other resources, such as video lectures, animation, and audio clips, to improve student understanding of key concepts. The study plans mark the mathematical areas of weakness for each student and provides unlimited resources focusing on these topics for which improvement can be attained. MyMathLab has the capability to require mastery learning. Pearson Education, which provides MyMathLab products, states students can use the Course ID of their instructor to register for free mathematics tutoring from the Math Tutor Center. The Tutor Center is staffed by qualified mathematics instructors who provide one-on-one tutoring via toll-free phone, e-mail, and real-time Internet sessions.

Interactive whiteboards assist in the integration of digital information presented through myriad of interactions. These collaborative products are offered to improve learning and the ability to appeal to student interests by enhancing communication and stimulating audience engagement, all of which save time, effort, and valuable resources. Connecting to tools already within most classrooms, interactive whiteboards enable

instructors to capture and transfer notes, refer to diagrams, access Web sites, and save displayed work for future reference. Blackboard Learning System is a software application used to power virtual learning environments, to enhance educational opportunities for students through a wider range of technology accessibility. This form of instruction engages students in higher order thinking tasks such as group discussion, problem solving, and “hands-on” experiments.

Graphical Analysis 3 and Derive are programs for producing, analyzing, and printing graphs. Data can be displayed graphically or in spreadsheet form. Powerful data analysis tools are provided within the program. Class discussion promotes learning communities by engaging students and faculty simultaneously in learning and evaluating real-world issues. Class demonstrations and discovery methods support collaborative learning by engaging students in group learning activities with a planned set of roles and processes enabling them to work together to accomplish specific goals. Laboratory experiments encourage problem-based learning and the assessment of higher order thinking by engaging students in learning activities focused on real-world problems that require them to research relevant content and present possible solutions. Folders used to collect homework and quizzes provide an opportunity for instructors to conduct item analysis and identify the strengths and weaknesses of students in a time-efficient manner.

Students enrolled in technology-based College Algebra courses of the community college that served as the study site in this current research have unlimited access to the mathematics laboratory located within the building housing the courses. The laboratory is coordinated by a mathematics instructor and laboratory assistant who assist students

using the laboratory hardware, MyMathLab, and other software applications. The instructor ensures that students progress as planned by their classroom instructors and maintain records such as attendance and test files. The assistant works closely with the instructor in the daily operation of the laboratory and provides support with the computer-literacy needs of students using the laboratory facility.

Data Collection and Analysis

The following procedures facilitated data collection in the current study:

1. Approval was initially received from the president of the community college that ultimately served as the study site to obtain permission to conduct this study (see Appendix D).

2. Approval was also received from the Institutional Research Board of Mississippi State University to conduct the study (see Appendix D).

3. The researcher met with the Information Technology Department at the participating community college to discuss the data-collection procedures.

4. Data were collected from the official transcripts of students enrolled in the College Algebra classes of the study site. The transcripts were maintained in the Office of the Registrar, and data collected included student age, gender, race, College Algebra grade, mathematics subscore on the ACT, as well as overall success rates. The data were matched according to identification number with results from administration of the mathematics achievement and VAMS pretests and posttests.

5. Data were analyzed and the findings were interpreted according to the study research questions.

The study hypotheses were analyzed using a variety of techniques. *T* testing facilitated analysis of Hypotheses 1 and 7; Hypothesis 2 was examined via application of an analysis of covariance. Hypotheses 3 and 4 were analyzed with the chi-square method, and Hypotheses 5 and 6 were investigated with a Pearson product-moment correlation. A .05 level was used for statistical significance.

CHAPTER IV

DATA ANALYSIS

In accordance with the methodology applied in this study, appropriate demographical data, test scores, and technology-participation data were collected on the population sample. The data were analyzed by examining mathematics pretest and posttest scores, mathematics subscores on the ACT, attitude-survey results, final grades, time devoted to the required technology by students, and withdrawal rates to determine whether each of the individual hypotheses was true or false. Specifically, data analysis sought to ascertain whether any of the following results were evident:

1. A difference with regard to grades between the two study groups of students attending traditional and technology-based College Algebra classes.
2. A difference with regards to scores on the mathematics-achievement posttest between the two study groups of students attending traditional and technology-based College Algebra classes.
3. A change in the technology-based students with respect to results on the VAMS pretest and posttest.
4. A difference in the traditional students with regard to results on the VAMS pretest and posttest.
5. A relationship between scores on the mathematics-achievement pretest and

posttest and student time-on-task while using technology.

6. A relationship between final grades for the College Algebra course and mathematics subscores on the ACT.

7. A difference in withdrawal rates between students attending traditional and technology-based College Algebra courses.

Demographical Data

Demographical data were collected and analyzed to compare characteristics between the control and experimental study groups and to compare characteristics of both groups to the overall student population during the time of the study. Demographical comparison was undertaken to eliminate any related bias that may need to be considered in evaluating the results of the study. All data analyses were conducted using statistical computer software known as the SPSS, Version 15.0, with appropriate statistical procedures applied to each hypothesis. The study was conducted using an unspecified (i.e., random) sample, consisting of all students enrolled in College Algebra classes at a Mississippi community college during the 2007 spring semester. A total of 150 students participated in the study out of a total population of 3,653 attending the community college during the semester of the research. Of the sample of 150 students, 80 received College Algebra instruction in a traditional manner, while 70 received instruction via technology-based delivery.

As noted earlier, the demographical data were collected from the official transcripts of the 150 participating students. These transcripts were obtained directly from the registrar's office at the Mississippi community college serving as the study site. The

data were analyzed by segmenting the total sample by four characteristics (i.e., gender, age, race, and subscores). The segments were compared to similar segments of the overall student population attending the Mississippi community college during the same period. The results were correlated with those of the control (i.e., traditional instruction) and treatment (i.e., technology-based instruction) study groups. The demographics of the study were subsequently correlated with the mathematics subscores on the ACT.

The population sample in this study was comprised of 74 (49.33%) males and 76 (50.67%) females. The ethnic makeup was 108 (72.00%) European American, 38 (25.33%) African American, and 4 (2.67%) classified as Hispanic American. Those receiving College Algebra instruction through traditional methods numbered 80, of which 41 (51.25 %) were male and 39 (48.75 %) were female, and 63 (78.75%) were European American, 16 (20.00%) were African American, and 1 (1.25%) was classified as Hispanic American. Within the population sample receiving College Algebra instruction through technology-based methods, 33 (47.14 %) were male and 37 (52.86%) were female. The ethnic makeup of this study group was 45 (64.28%) European American, 22 (31.43%) African American, and 3 (4.29%) classified as Hispanic American. Thus, the gender and race distribution between the control and experimental study groups were similar.

The gender and race distributions between the study groups differed slightly from the overall student population of the community college serving as the study site. Of the total student population during the spring 2007 semester, 1,293 (35.40%) were male and 2,360 (64.60%) were female. The ethnic makeup of the total enrollment was 2,455

(67.21%) European American, 1,118 (30.60%) African American, 38 (1.04%) Hispanic American, 15 (0.41%) Asian-American, 6 (0.16%) Native American, and 21 (0.57%) who did not report their race. The demographical segmentation of all three populations groups (i.e., control, treatment, and overall student population) by gender and race is provided in Table 2.

Table 2

Demographic Segmentation by Gender and Race

Characteristic	Control Group		Treatment Group		Overall Student Population	
	Freq	Percentage	Freq	Percentage	Freq	Percentage
Female	39	48.75	37	52.80	1,293	35.40
Male	41	51.25	33	47.14	2,360	64.60
Gender Totals	80	100.00	70	100.00	3,653	100.00
European American	63	78.75	45	64.28	2,455	67.21
African American	16	20.00	22	31.43	1,118	30.60
Hispanic American	1	1.25	3	4.29	38	1.04
Asian American	0	0.00	0	0.00	15	0.41
Native American	0	0.00	0	0.00	6	0.16
Not Reported	0	0.00	0	0.00	21	0.50
Race Totals	80	100.00	70	100.00	3,653	100.00

NOTE. Freq = frequency.

The participating students ranged from 18 to 50 years of age. During the spring 2007 semester, the mean age of the students attending College Algebra classes was 22.29 years with a standard deviation of 5.33 and mode of 20. The mean age of the 70 students enrolled within the technology-based College Algebra course was 22.66 with a standard deviation of 6.57. The 80 students enrolled within the traditional College Algebra course had a mean age of 21.98 years with a standard deviation of 3.95. The two groups of

students were similar in age. The total student population for the entire community college during the spring 2007 semester ranged from 16 to 66 years of age with a mean age of 25.04 years. The mode for this population group was 20 years.

Mathematics subscores from the ACT were submitted to the community college admissions office for 126 (84%) of the 150 students involved in the study. Of the 24 who failed to provide an ACT score, 16 (10.67%) were enrolled in the traditional College Algebra course and 8 (5.33%) were enrolled in the technology-based course. The two reasons cited by the community college for students not reporting mathematics subscores on the ACT were that they either did not complete the test or did not have their scores sent to this institution. Of the 126 students who did report these scores, 67 (53.17%) were male and 59 (46.83%) were female. Their racial makeup is 89 (71.63%) European Americans, 33 (26.19%) African Americans, and 4 (3.17%) Hispanic Americans.

Study Hypotheses

An analysis was conducted to evaluate the validity of the seven hypotheses formulated for this study. Specifically, a statistical analysis was performed on the data supporting the individual hypothesis, each of which was stated as a null hypothesis. With the exception of Hypothesis 7, each hypothesis was tested against a subset of the total population sample due to variations in the number of students present during each stage of data collection. The effective sample for testing each hypothesis is indicated in Table 3.

Table 3

Effective Sample by Hypothesis

Hypothesis	Sample
1	132
2	96
3	37
4	42
5	70
6	109
7	150

Hypotheses 1 and 2

Hypothesis 1 stated, “There is no significant difference in grade scores between students enrolled in College Algebra taught in the traditional manner and those enrolled in technology-based College Algebra. To test this hypothesis, final grades for students within the treatment and control groups were collected and group statistics were computed to reveal the mean, standard deviation, and standard-error mean. It was possible to obtain valid grades for a sample of 132 students, which forms the basis for this analysis. Each final grade was assigned a numerical value consistent with the grading system currently in use by the community college serving as the study site to determine grade-point averages (i.e., A = 4, B = 3, C = 2, D = 1, and F = 0). The statistical assessment of the final grades for the population sample is provided in Table 4. To evaluate whether Hypothesis 1 was rejected, a *t* test was performed. The mean is slightly higher in the student group who participated in the technology-based College Algebra course when compared to that of the student group who participated in the traditional College Algebra course. However, because the *t* distribution variance is relatively small

($t[130] = 1.03$), and the statistical significance is greater than .05 ($p = 0.306$), Hypothesis 1 is not rejected.

Table 4
Group Statistics for College Algebra Grades

Study Group	<i>N</i>	<i>M</i>	<i>SD</i>	Standard Error <i>M</i>
Control	65	2.05	1.32	0.16
Treatment	67	2.28	1.33	0.16

Hypothesis 2 stated, “There is no significant difference in scores on the mathematics-achievement posttest of College Algebra students exposed to traditional instruction versus those who received technology-based instruction while controlling for the pretest.” Pretest and posttest scores were collected for both the treatment and control study groups, calculating separate group statistics including mean and standard deviation. As noted earlier, only 96 of the total student population of 150 participated in both the pretest and posttest. Consequently, the sample size for testing this hypothesis is limited to 46 students within the control group and 50 within the treatment group. These group statistics are presented in Table 5.

Table 5
Group Statistics for Hypothesis 2

Test	Study Group	<i>N</i>	<i>M</i>	<i>SD</i>
Pretest	Control	46	9.37	2.78
	Treatment	50	8.22	2.61
Posttest	Control	46	12.35	3.49
	Treatment	50	11.74	3.17

The group statistics were subsequently evaluated using a univariate analysis of covariance with the posttest scores chosen as the dependent variable. The analysis of covariance was applied to determine whether the dependent variables (i.e., the posttest results) were significantly different between the two groups while controlling for the pretest. Significance was measured by comparing the standard F distribution to the distribution of F ratios among the sample. Specifically, for this study, the F ratio was used to determine whether the variation in achievement test scores between the control and treatment study groups was significantly greater than the variation in scores within the groups, which would tend to indicate that the variation is a real effect, rather than simply a statistical variance. The results of this analysis are presented in Table 6, with the estimated marginal means indicated in Table 7 to characterize the results.

The statistical analysis of Hypothesis 2 indicates a slightly greater increase in performance from the pretest to the posttest for the technology-based College Algebra students. Ultimately, however, this group did not perform as well as the traditional College Algebra students on the mathematics-achievement pretest. Therefore, the effects of treatment were nonsignificant, which is supported by the small (0.28) variation between the F distributions ($F[1.93] = .028$), which are not calculated to be statistically significant ($p = 0.89$). Thus, Hypothesis 2 cannot be rejected.

Hypothesis 3

Hypothesis 3 stated, “With regard to the attitude questionnaire known as the VAMS, there is no significant change in scores from the pretest to the posttest administered to students enrolled in the technology-based College Algebra course.” As

Table 6

Univariate Analysis of Covariance for Hypothesis 2

Source	Type III Sum of Squares	<i>Df</i>	<i>M</i> Square	<i>F</i>	Significance
Pretest	258.85	1	258.85	30.74	.00
Treatment	0.232	1	0.232	.028	0.89
Error	783.21	93	8.42	–	–
Total	14947.00	96	–	–	–

Table 7

Estimated Marginal Means

Study Group	<i>M</i>	Standard Error
Control	11.979	0.433
Treatment	12.080	0.415

noted earlier, the VAMS was used to assess and characterize student views surrounding mathematics knowledge and learning mathematics. This instrument consisted of 33 multiple-choice questions covering six conceptual dimensions and classified participating students into four distinct profiles on a graduated scale. *Naïve* was the lowest ranking mathematical attitude, followed by an improved *Lower Transitional*, *Upper Transitional*, and *Expert*. The profile of *Expert* indicated a mature attitude toward mathematics. The results were confirmed using a chi-square test comparing the distribution of classifications between the pretest and posttest scores on the VAMS to a standard chi-square distribution. As indicated in Table 1, only 37 of the 70 students within the treatment study group participated in the VAMS. The results of the chi-square test are presented in Table 8.

Table 8
Treatment Group Chi-Square Test Results From Scores on the
Views About Mathematics Survey

Measure	Value	<i>df</i>	Asymptotic Significance (2-Sided)
Pearson Chi-Square	8.02	9	0.53
Likelihood Ratio	7.65	9	0.57
Linear-by-Linear Association	0.28	1	0.59
Valid Cases	37	–	–

An insignificant variation of the test-data distribution was indicated from the standard chi-square distribution ($\chi^2 [n = 37, df = 9] = 8.02, p = 0.532$). Consequently, this analysis cannot support rejection of Hypothesis 3. It is noteworthy, however, that 15 cells (93.8% of events) within the cross-classification shown in Table 9 expected a count

less than 5, with the minimum expected count calculated as 0.16. This cross-classification indicates, for example, that 22 of the 37 participating students were ranked as *Naïve* in the pretest. Upon analyzing the posttest results, it was discovered that 9 of these 22 students maintained this ranking, 6 shifted to *Lower Transitional*, 4 shifted to *Upper Transitional*, and 3 transitioned to the *Expert* ranking. The other three rows in Table 9 can be read in a similar manner.

Table 9

Cross-Classification of Treatment-Group Scores on the Pretest and Posttest of the Views About Mathematics Survey

Pretest Attitude	Posttest Attitude				
	Naïve	Lower Transitional	Upper Transitional	Expert	Total
Naïve	9	6	4	3	22
Lower Transitional	3	2	2	1	8
Upper Transitional	4	0	1	1	6
Expert	0	0	0	1	1
Total	16	8	7	6	37

Of particular significance is that a majority of the students ranking within the *Lower Transitional* and *Upper Transitional* categories of the VAMS regressed to a *Naïve* ranking upon completing the posttest, while a number of the students who had achieved a *Naïve* ranking on the pretest tended to rank higher in the posttest. Since these opposing trends likely indicate that the significance of the measurement is indeterminate, a comparison between the distribution of pretest and posttest VAMS rankings was performed (see Table 10). The results revealed the majority of students held naïve views

both prior to and following mathematics instruction. Visual inspection indicated very little observable variation between ranking categories from the posttest to the pretest. Coupled with the observation that 17 (46%) of the participating students scored better between the tests, while 7 (19%) actually scored worse and 13 (35%) scored the same, it is reasonable to conclude that the chi-square test is meaningful. It is therefore also safe to assume on the basis of statistical observation and direct examination of the data that Hypothesis 3 cannot be rejected.

Table 10

Comparison of Absolute Pretest and Posttest Distribution of Treatment-Group Rankings from the Views About Mathematics Survey

Test	Naïve	Lower Transitional	Upper Transitional	Expert	Total
Pretest	22	8	6	1	37
Posttest	16	8	7	6	37

Hypothesis 4 and 5

Hypothesis 4 stated, “With regard to the attitude questionnaire known as the VAMS, there is no significant change in scores from the pretest to the posttest administered to students enrolled in the College Algebra course delivered in a traditional manner.” This hypothesis was tested using a chi-square test similar to that applied with Hypothesis 3. The case-processing summary reiterates the assertion in Table 2 that only 42 students enrolled in traditional College Algebra classes participated in this survey. Table 11 summarizes the statistical analysis, ($\chi^2 [n = 42, df = 9] = 33.14, p < .001$), which justifies rejection of Hypothesis 4. The cross-classification upon which this analysis is

based is provided in Table 12, and indicates that 14 cells, or 87.5% of events, have an expected count of less than 5, with a minimum expected count of 0.48.

Table 11

Chi-Square Test Results From Control-Group Scores on the Views About Mathematics Survey

Measure	Value	<i>df</i>	Asymptotic Significance (2-Sided)
Pearson Chi-Square	33.14	9	.00
Likelihood Ratio	44.80	9	.00
Linear-by-Linear Association	25.24	1	.00
<i>N</i> of Valid Cases	42	–	–

Table 12

Cross-Tabulation of Control-Group Pretest and Posttest Scores on the Views About Mathematics Survey

Pretest Attitude	Posttest Attitude				
	Naïve	Lower Transitional	Upper Transitional	Expert	Total
Naïve	13	2	3	0	18
Lower Transitional	3	0	1	1	5
Upper Transitional	0	1	3	5	9
Expert	0	1	0	9	10
Total	16	4	7	15	42

As can be computed from the cross-tabulation chart (see Table 13), 12 (28.5%) of the participating students who received traditional instruction scored higher between the pretest and posttest of the VAMS, 5 (11.5%) scored worse, while 25 (59.5%) maintained the same scores. Comparing the absolute distribution of posttest and pretest scores, as

shown in Table 13, reveals a significant trend toward the *Expert* ranking between pretest and posttest results, which validates the chi-square results. Thus, statistical analysis coupled with visual inspection confirmed that Hypothesis 4 can be rejected.

Table 13

Comparison of Absolute Pretest and Posttest Distribution of Control-Group Rankings From the Views About Mathematics Survey

Test	Naïve	Lower Transitional	Upper Transitional	Expert	Total
Pretest	18	5	9	10	42
Posttest	16	4	7	15	42

Hypothesis 5 stated, “There is no significant relationship between mathematics achievement, as measured by the achievement pretest and posttest of College Algebra students, and time-on-task during technology use.” This hypothesis was tested with Pearson product-moment correlations against the entire treatment population of 70 students. The results are presented in Table 14. Based upon this analysis, a significant correlation does not exist for the technology-based College Algebra students when comparing the mathematics-achievement pretest and posttest against time-on-task during technology use (pretest $r = .07$, $p = 0.58$; posttest $r = 0.14$, $p = 0.33$). Hypothesis 5 is therefore not rejected.

Hypothesis 6 and 7

Hypothesis 6 stated, “There is no significant relationship between College Algebra grades and mathematics subscores from administration of the ACT. This hypothesis was tested with a Pearson product-moment correlation. The results are

Table 14

Pearson Product-Moment Correlation of Time on Task and
Mathematics-Achievement Test Scores

Measure	Statistic	Time on Task	Pretest	Posttest
Time on Task	Pearson Correlation	1	.07	0.14
	Sig. (2-tailed)	–	0.58	0.33
	<i>N</i>	70	66	54
Pretest	Pearson Correlation	.07	1	0.51
	Sig. (2-tailed)	0.58	–	.00
	<i>N</i>	66	155	112
Posttest	Pearson Correlation	0.14	0.51	1
	Sig. (2-tailed)	0.33	.00	–
	<i>N</i>	54	112	130

NOTE. Sig. = significance.

presented in Table 15 ($r = 0.105$, $p = 0.28$). When the College Algebra grades were compared with the mathematics subscores on the ACT, a significant relationship did not exist; therefore, Hypothesis 6 is not rejected. When analyzing this set of data, it is important to remember that students placed in College Algebra classes have varied backgrounds. For example, some students enter the course with the mandatory mathematics subscore of 18 or higher from the ACT while others completed the required developmental mathematics courses.

Table 15

Pearson Product-Moment Correlation of College Algebra Grades and Mathematics Subscores From the American College Test

Measure	Statistic	Math Subscore of American College Test	College Algebra Grade
Math Subscore of American College Test	Pearson Correlation	1	0.11
	Sig. (2-tailed)	–	0.28
	<i>N</i>	144	109
College Algebra Grade	Pearson Correlation	0.11	1
	Sig. (2-tailed)	0.28	–
	<i>N</i>	109	132

NOTE. Sig. = significance.

Hypothesis 7 stated, “There is no significant difference in withdrawal rates between students enrolled in the traditional College Algebra course and those enrolled in the technology-based College Algebra course. A *t* test was executed against the group statistics shown in Table 16 to evaluate the validity of Hypothesis 7. A Levene Test for Equality of Variances was also applied for confirmation, which yielded an *F* ratio of

18.34 and significance of .01 with equal variances assumed. This confirmed validity of the result. A slightly higher percentage of students withdrew from the traditional College Algebra course than did from the technology-based course; however, the statistical findings ($t [130] = 1.03, p = 0.306$) confirmed that Hypothesis 7 cannot be rejected.

Table 16

Group Statistics for College Algebra Withdrawal Rates

Study Group	<i>N</i>	<i>M</i>	<i>SD</i>	Standard Error <i>M</i>
Control	4	0.18	0.12	.06
Treatment	4	.04	.05	.03

Summary

This study analyzed the relationship between technology-enhanced College Algebra instruction and a traditional instructional format delivered to 150 College Algebra students. The primary mode of analysis was a comparison of mathematics skills and attitudes; specifically, skills and attitudes with respect to College Algebra, as measured both before and after instruction. Specific measurements included course grades; scores on a mathematics-achievement pretest and posttest; scores on the VAMS administered before and after the College Algebra course; time-on-task while using technology during mathematics study; mathematics subscores on the ACT; and rates of student withdrawal from the course. All comparisons were conducted using the appropriate statistical method relevant to the specific type of data under consideration. Demographical data were used to evaluate and reject any demographical biases associated with the research design.

Statistical analysis of the results revealed no significant difference in grades related to the use of technology versus traditional instruction methods. Similarly, there was no statistical difference in performance improvements on the mathematics-achievement tests related to the method of instruction, nor did time-on-task while using technology during mathematics study cause a statistically meaningful difference in results. However, a relatively significant difference in student attitudes toward mathematics was found in the College Algebra students who received traditional instruction, which was clearly evident when comparing the pretest and posttest assessments of the VAMS. Surprisingly, the data indicated no significant correlation between College Algebra grades and mathematics subscores on the ACT.

Although technology use in facilitating College Algebra instruction was not found to significantly affect the academic performance and mathematics attitude of students, the data indicate that technology infusion did not hinder student learning with regard to the College Algebra concepts presented within the classroom. Additionally, valuable correlations were evaluated and characterized, specifically the improvement of attitudes toward mathematics in students receiving traditional instruction, and the lack of a definable relationship between mathematics subscores on the ACT and College Algebra performance. One limiting factor is the small size of the sample population; thus, the described correlations, or lack thereof, are worthy of further study to (a) validate the results of the current research with a larger population, and (b) evaluate potential instructional changes based upon expanded statistical results.

CHAPTER V

CONCLUSION

Summary

The purpose of this study was to compare the success and withdrawal rates of two student groups enrolled in College Algebra within a Mississippi community college. One study group consisted of students who completed one semester of traditional College Algebra, and the other group was composed of students who completed one semester of a technology-based College Algebra course. The research sought to determine if a significant difference exists between the academic performance and mathematics attitudes of students who received traditional College Algebra instruction and those who received technology-based instruction. The following determinants were examined: final grade scores on a mathematics-achievement pretest and posttest, scores on a mathematics-attitude pretest and posttest, time devoted to technology use during mathematics study, mathematics subscores on the ACT, and withdrawal rates.

The findings of this study will be forwarded to the State Board of Community and Junior Colleges with the intent of further distribution to remaining Mississippi community colleges. The results are expected to assist administrators and instructors to

make relevant decisions associated with the format and extent of technology inclusion within traditional mathematics courses. A tremendous potential impact would be an increase in success rates correlated with decreased withdrawal rates. Such improvement would further impact funding received by community colleges through the Full Time Equivalent funding formula.

The population sample in this study consisted of 150 students from a Mississippi community college; specifically, all students enrolled in the College Algebra course during the spring 2007 semester. Instructors of the traditional algebra course used solely a board, marker, and textbook as resources and taught an initial course enrollment of 80 students. The technology-based algebra course was taught to an initial enrollment of 70 students by an instructor trained in the use and pedagogy of instruction supplemented with technology. Students attending the technology-based classes were taught using a Smart Board, Blackboard, digital presenter, and a mathematics laboratory. Following classroom instruction, these students would practice using mathematics software located within the mathematics laboratory where the instructor served in a proctor/tutor role.

Data were collected for this investigation from the admissions office of the Mississippi community college serving as the study site. The data drawn consisted of the official transcripts of the students participating in the study. The students were not identified within in the study documentation, and their identification remained anonymous during all data-analysis procedures. A mathematics-achievement pretest was administered to determine prior knowledge of College Algebra concepts, and a mathematics attitude survey was used to determine the predisposition of each student

with regard to the importance of mathematics. Following instruction, a posttest was administered to measure the mathematics achievement and related attitudes of the students. Data were exposed to t tests, univariate analysis of covariance, chi-square tests, and Pearson product-moment correlations. The results are summarized in the following manner:

1. No significant difference in grades was found between the traditional College Algebra students and those who received technology-based instruction delivery.

2. No significant difference was found in scores on mathematics-achievement posttest between College Algebra students exposed to traditional instruction and those who received technology-based instruction while controlling for the pretest.

3. No significant change was found from the pretest to the posttest of the VAMS attitude category for students who received technology-based College Algebra instruction.

4. A significant change was found from the pretest to the posttest of the VAMS attitude category for the College Algebra students who received traditional instruction.

5. No significant relationship was found between scores on the mathematics- achievement pretest and posttest of College Algebra students and the time they devoted to technology use while studying mathematics.

6. No significant relationship was found between College Algebra grades and mathematics subscores on the ACT.

7. No significant difference was found in withdrawal rates between College

Algebra students who received traditional instruction and those who received technology-based instruction.

Conclusions

The following conclusions were drawn from this study:

1. Students placed appropriately within a College Algebra course, whether determined by mathematics subscores on the ACT or the completion of remedial mathematics courses, learn College Algebra concepts equally well, regardless of whether technology was integrated into instruction.

2. Many students, regardless of their ability, place low value on the study and relevance of mathematics. Technology integration did not improve this perception. Students ultimately withdrawing from the College Algebra course tend to have a naïve attitude toward mathematics.

3. College Algebra instruction enhanced with technology use did not result in higher student comprehension of the curriculum concepts presented.

4. The policy of placing students according to mathematics subscores on the ACT does not represent an effective predictor of student success within the College Algebra course.

5. Technology did not serve as a compelling motivator toward student completion of the College Algebra course.

Prior to this study, only two formats of mathematics courses were offered at the Mississippi community college serving as the study site—(a) traditional classes consisting of 150 minutes of instruction per week and meeting within a classroom, and

(b) a strictly online course monitored by the Office of Distance Learning. This study sought to determine if benefits or detriments existed in blending these types of instruction, as compared to the traditional course received by the majority of students at the time of the study. Community colleges and other institutes of higher learning are offering course schedules in a more creative arrangement with the aid of technology, primarily to attract a larger number of potential students and meet the needs of existing student populations.

Potential bias exists due to the lack of a strict control population of College Algebra instructors. Each instructor in this study taught one traditional College Algebra course and one technology-based course. It is possible that instructor capabilities improved across all teaching settings due to the exposure to the technology-enhanced teaching methods. Within the medical field, this is informally known as the “the white-coat effect,” which refers to interns and residents performing at much higher levels after spending a significant amount of time passively observing a talented physician executing the same procedures. A certain amount of unconscious skill transference occurs due to the respect for the senior physician. Therefore, additional studies may be warranted, using experiments designed to separate the potential effects of technology-based teaching from those of traditional teaching methods. The results of this study have demonstrated that neither mathematics subscores on the ACT nor technology fluency serve as predictors of student performance in College Algebra. Therefore, further research is recommended to isolate the factor[s] correlating student characteristics to student performance in College Algebra.

Recommendations

Replication of this study within other community colleges would provide additional significant data. This may make it possible to determine the effects of implementing technology within existing curriculum and instruction. A larger student sample would also be beneficial because the current study indicated few significant changes related to the success of learning mathematical concepts. Additionally, small sample sizes may leave statistical findings open to interpretation. A larger study could be conducted with at least two strictly controlled groups of instructors—one group teaching solely technology-based College Algebra and the other group teaching this subject area solely via traditional methods.

Because the majority of community college students transfer to 4-year institutes of higher learning, replicating this study with students attending 4-year colleges and universities is highly recommended. Other areas of mathematics, such as developmental mathematics, could also be examined. The results could determine whether technology-enhanced instruction of developmental mathematics courses would be more advantageous than implementing technology instruction within general-education courses. The dramatically increasing demand for community colleges to offer remedial courses could be better served via technological assistance.

Because the current study included only one semester of a newly established course-delivery method, further research is recommended to compare the success and withdrawal rates following several semesters of implementation when a more significant amount of data could be collected. Additionally, a study considering a larger set of

inbound student characteristics and attributes beyond those normally associated with mathematical skills could contribute valuable added data. Such examination may help to isolate correlations with previously unexamined attributes such as linguistic ability, capacity for artistic visualization, natural organizational skill, or other factors that have not been carefully investigated as predictors of mathematics success.

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APPENDIX A
MATHEMATICS-ACHIEVEMENT PRETEST/POSTTEST

Mathematics-Achievement Pretest/Posttest

1. A point where the graph of a line crosses the x-axis:
a. y-intercept **b.** x-intercept **c.** origin **d.** abscissa **e.** ordinate

2. The slope of a horizontal line:
a. zero **b.** undefined **c.** one **d.** positive **e.** negative

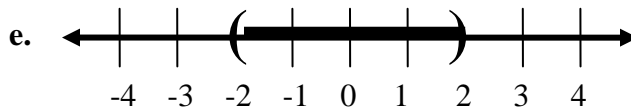
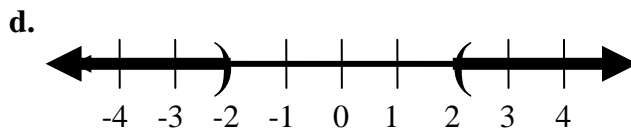
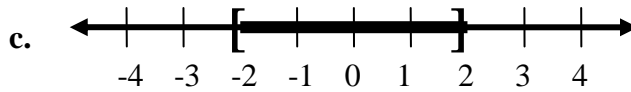
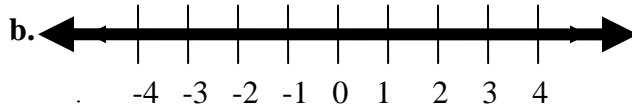
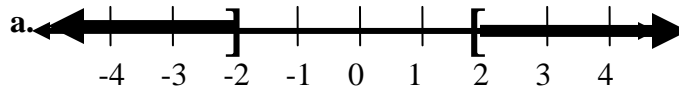
3. The slopes of parallel lines:
a. opposite **b.** equal **c.** opposite inverses **d.** one **e.** zero

4. Solve: $2 - (7x + 5) = 13 - 3x$
a. -5 **b.** $\frac{3}{2}$ **c.** -1 **d.** -4 **e.** 5

5. Simplify: $(-2)^2$
a. $x^2 - 4$ **b.** $x^2 + 4$ **c.** $x^2 + 4x - 4$ **d.** $x^2 - 4x + 4$ **e.** $2x + 4$

6. Solve: $x^2 + 7x + 6 = 0$
a. -2, -3 **b.** 1, 6 **c.** -1, 7 **d.** 2, -3 **e.** -1, -6

7. Graph: $x \geq -2$ or $x \leq 2$



8. Solve: $-7 < 2x + 3 < 5$

- a. $(-5, 1)$ b. $(-2, 4)$ c. $(-\infty, -5) \cup (2, \infty)$ d. $(-1, 3)$ e. $(-2, 1)$

9. Find the y-intercept: $-3x + 7y = 21$

- a. $(-7, 0)$ b. $(0, 3)$ c. $(7, 0)$ d. $(0, -7)$ e. $(-7, 3)$

10. Solve: $x^2 = 16$

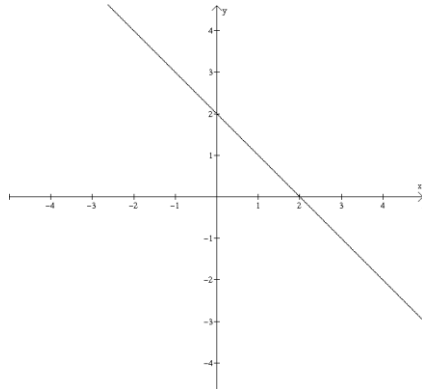
- a. $16i, -16i$ b. $4i, -4i$ c. 4 d. $16, -16$ e. $4, -4$

11. Write the following in interval notation: $x \leq 7$

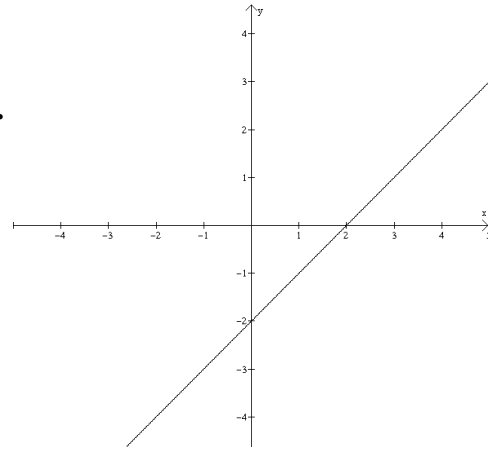
- a. $(-\infty, 7)$ b. $(-\infty, 7]$ c. $(-\infty, 7]$ d. $[7, \infty)$ e. $[-7, 7]$

12. Graph using any method: $x + y = 2$

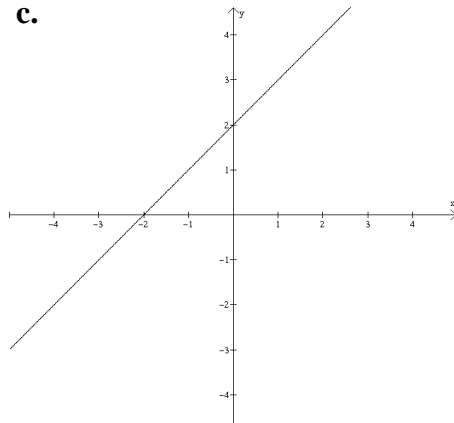
a.



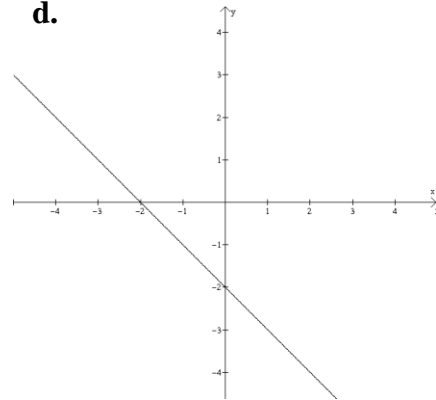
b.



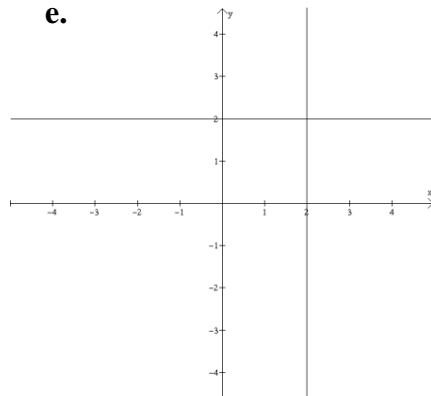
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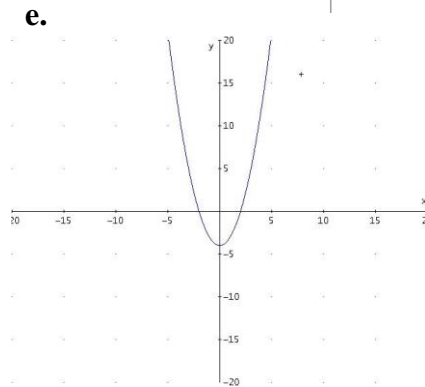
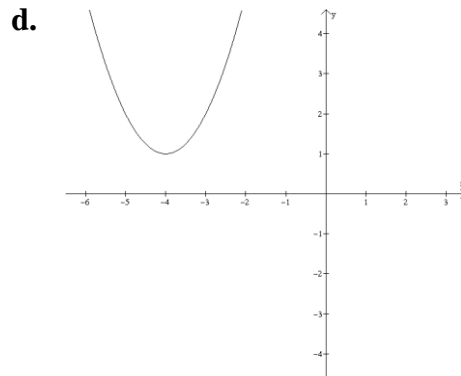
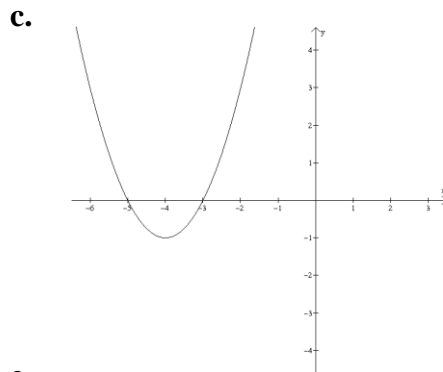
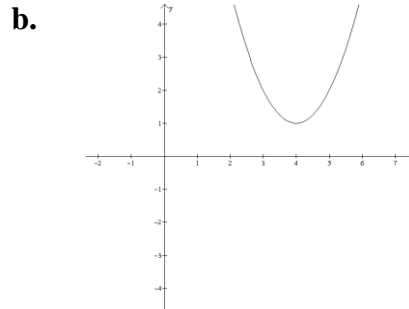
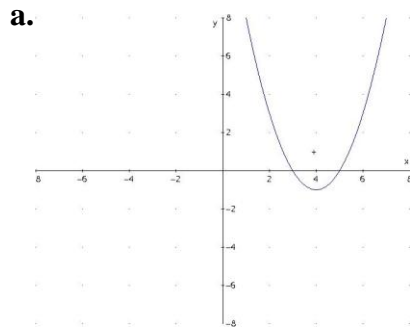
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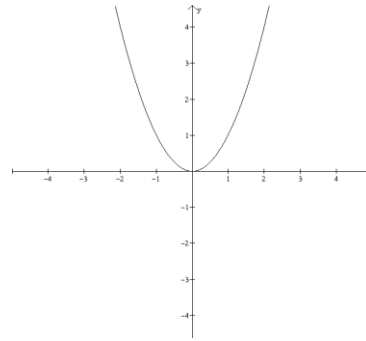
e.



13. Select the graph that best represents the equation: $y = (x - 4)^2 + 1$



14. Find the range of the following graph:



- a. $(-\infty, \infty)$ b. $[0, \infty)$ c. $(-\infty, 0]$ d. $(-5, 5)$ e. no range exists

15. Find the domain of the function: $y = \sqrt{2x+5}$

- a. $x \geq -5$ b. $x \leq 5$ c. $x \leq \frac{5}{2}$ d. $x \geq -\frac{5}{2}$ e. $x \neq -\frac{5}{2}$

16. Given $f(x) = 1 - x$ and $g(x) = 3x + 7$ find: $(f + g)(x)$.

- a. $4x + 8$ b. $2x + 8$ c. $2x - 6$ d. $2x + 6$ e. $4x - 6$

17. Given $f(x) = x - 1$ and $g(x) = x - 5$ find: $\left(\frac{f}{g}\right)(x)$

- a. $\frac{x-1}{x-5}$ b. $\frac{x-5}{x-1}$ c. $\frac{x^2-x}{x-5}$ d. $x^2 - 6x + 5$ e. $2x - 6$

18. Solve the following system of equations: $5x + 8y = -5$ and $-3x + y = 3$

- a. $(-2, -3)$ b. $(0, -1)$ c. $(1, 6)$ d. $(-1, 0)$ e. no solution

19. Solve for x : $\sqrt{2x+8} = 4$

- a. 4 b. 16 c. 2 d. 14 e. -2

20. Find the domain of the function: $\{(4, -8), (-2, 1), (6, -5), (-3, -6)\}$

- a. $\{8, 1, -5, -6\}$ b. $\{4, -2, 6, -3\}$ c. $\{1, 4, 6\}$ d. $\{-8, -2, -5, -3, -6\}$ e. none

APPENDIX B
VIEWS ABOUT MATHEMATICS SURVEY

Views About Mathematics Survey

This survey is designed to identify factors affecting students understanding of mathematics and to assist in the design of instructional material.

Please:

Do not write anything on this questionnaire.

Mark your answers on the scantron sheet.

Use a No. 2 pencil only, and follow marking instructions on the computer sheet.

Make only one response per item.

Do not skip any question.

Avoid guessing. Your answer should reflect only what you believe to be accurate.

Plan to finish the survey in 30 minutes.

1	2	3	4	5	6	7	8
Towards "Only (a)"			Equally (a) & (b)	Towards "Only (b)"			Neither (a) or (b)

- Learning mathematics requires:
 - a serious effort.
 - a special talent.
- If I had a choice:
 - I would never take any mathematics course.
 - I would still take mathematics for my own benefit.
- Reasoning skills that are taught in mathematics courses can be helpful to me:
 - in my everyday life.
 - if I were to major in mathematics or a related field.
- I study mathematics:
 - to satisfy course requirements.
 - to learn useful knowledge.
- My score on mathematics exams is a measure of how well:
 - I understand the covered material.
 - I can do things the way they are done by the teacher or in some course materials.

6. For me, doing well in mathematics courses depends upon:
 - (a) how much effort I put into studying.
 - (b) how well the teacher explains things in class.

7. When I experience a difficulty while studying mathematics:
 - (a) I immediately seek help, or give up trying.
 - (b) I try hard to figure it out on my own.

8. When studying mathematics in a textbook or in course materials:
 - (a) I find the important information and memorize it the way it is presented.
 - (b) I organize the material in my own way so I can understand it.

9. For me, the relationship of mathematics courses to daily life is usually:
 - (a) easy to recognize.
 - (b) hard to recognize.

10. In mathematics, it is important for me to:
 - (a) memorize technical terms and mathematical formulas.
 - (b) learn ways to organize information and use it.

11. Mathematical formulas:
 - (a) express meaningful relationships among variables.
 - (b) provide ways to get numerical answers to problems.

12. After I go through a mathematics text or course materials and feel I that I understand them:
 - (a) I can solve related problems on my own.
 - (b) I have difficulty solving related problems.

13. The first thing I do when solving a real-world problem that involves mathematics is:
 - (a) represent the situation with sketches and drawings.
 - (b) search for formulas that relate givens to unknowns.

14. In order to solve a mathematics problem, I need to:
 - (a) have seen the solution to a similar problem before.
 - (b) apply general problem-solving techniques.

15. For me, solving a mathematics problem more than one way:
 - (a) is a waste of time.
 - (b) helps develop my reasoning skills.

16. After I have answered all questions in a homework mathematics problem:
 - (a) I stop working on the problem.
 - (b) I check my answers and the way I obtained them.

17. After the teacher solves a mathematics problem for which I answered incorrectly:
 - (a) I discard my solution and learn the one presented by the teacher.
 - (b) I try to figure out how the teacher's solution differs from mine.

18. How well I do on mathematics exams depends on how well I can:
 - (a) recall material in the way it was presented in class.
 - (b) do tasks that are somewhat different from ones I have seen before.

19. In order to prove a mathematical theorem one must:
 - (a) produce evidence from the physical world.
 - (b) provide a logically sound argument.

20. When they represent relationships in the physical world, mathematical functions are:
 - (a) exact expressions of what is being represented.
 - (b) approximate expressions of what is being represented.

21. After a theorem has been proven and accepted in mathematics:
 - (a) it will never be changed.
 - (b) it may be rejected at a future time.

22. The relationship among the sides of a right triangle expressed in the Pythagorean theorem is true because it has been:
 - (a) proven by a logical argument.
 - (b) verified by measurement.

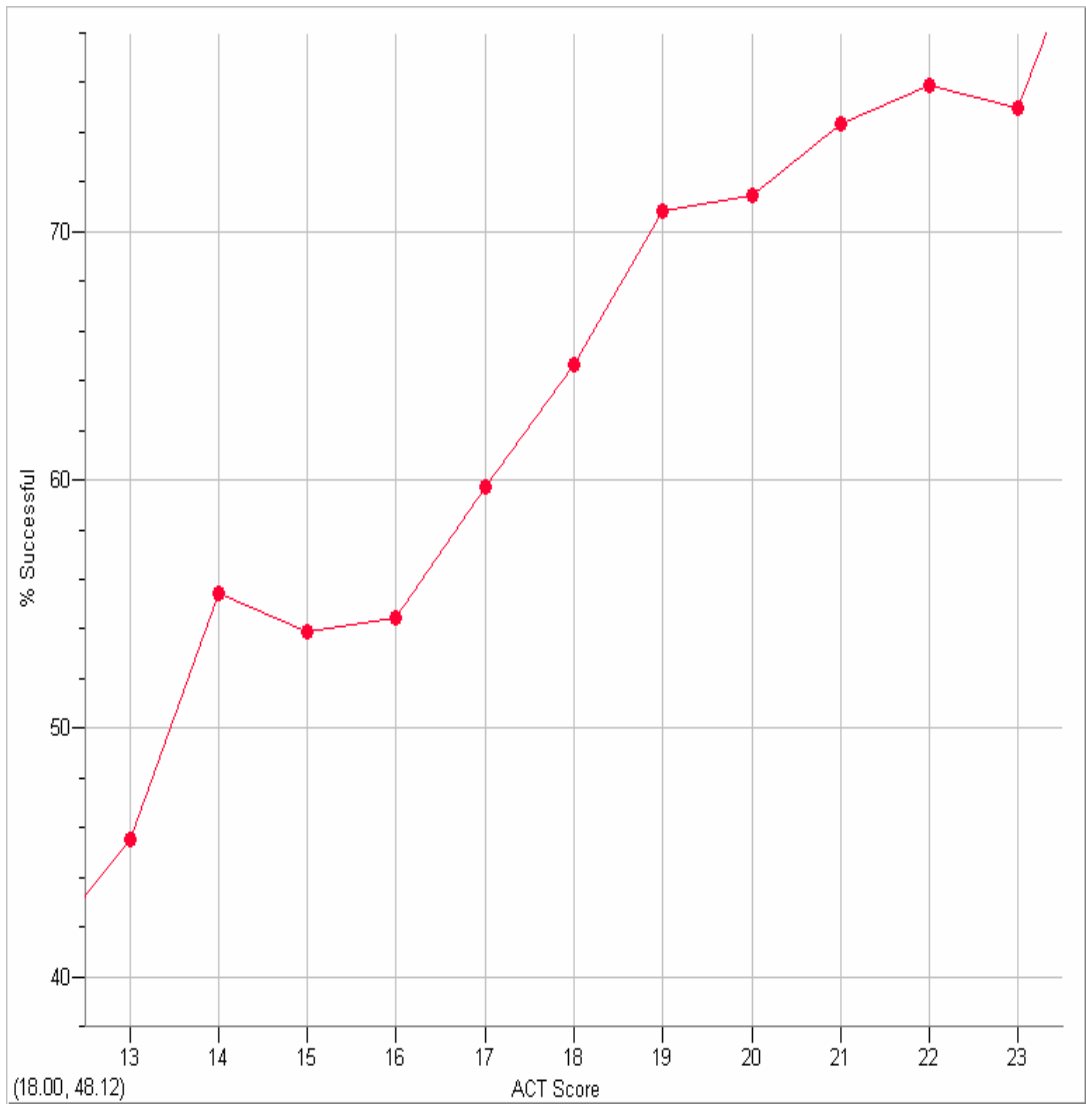
23. Collecting and graphing real-world data is useful for:
 - (a) determining patterns and making general predictions.
 - (b) obtaining numerical answers to specific problems.

24. For me, making unsuccessful attempts when solving a mathematics problem is:
 - (a) a natural pursuit of a solution to the problem.
 - (b) an indication of my incompetence in mathematics.

25. When solving a challenging mathematics problem, a mathematician:
 - (a) makes many incorrect attempts.
 - (b) moves directly to a correct solution.

26. If we want to apply a method used for solving one mathematics problem to another problem, the objects involved in the two problems must be:
- (a) identical in all respects.
 - (b) similar in some respects.
27. Different branches of mathematics, such as geometry and algebra:
- (a) are related by common principles.
 - (b) have no relationship to one another.
28. Scientists use mathematics as:
- (a) a tool for analyzing and communicating their ideas.
 - (b) a source of factual knowledge about the natural world.
29. For me, solving a problem that involves mathematical reasoning is:
- (a) an enjoyable experience.
 - (b) a frustrating experience.
30. Graphing calculators and computers:
- (a) introduce new methods for solving mathematics problems.
 - (b) speed up problem solving via established methods.
31. Using graphing calculators or computers:
- (a) increases my interest in studying mathematics.
 - (b) is a waste of time.
32. In solving mathematics problems, graphing calculators and computers help me:
- (a) understand the underlying mathematical ideas.
 - (b) obtain numerical answers to problems.
33. I answered all the questions in this survey:
- (a) to the best of my ability.
 - (b) without giving them serious thought.

APPENDIX C
COMPILATION OF COLLEGE ALGEBRA SUCCESS RATES ACCORDING TO
MATHEMATICS SUBSCORES ON THE AMERICAN COLLEGE TEST



APPENDIX D
INSTITUTION APPROVAL LETTERS



PEARL RIVER COMMUNITY COLLEGE

MISSISSIPPI'S PIONEER COMMUNITY COLLEGE

January 11, 2007

Mississippi State University
Institutional Review Board
8A Morgan Street
P.O. Box 6223
Mississippi State, MS 39762

To Whom It May Concern:

This letter is to inform the Institutional Review Board that permission for access to data collected in all MAT 1313 courses offered at Pearl River Community College is granted to Jennifer Seal, Pearl River Community College Mathematics Instructor. It is my understanding this information is to be used in the completion of the dissertation process. Please share the results of the study with the appropriate personnel at Pearl River Community College.

Sincerely,

William Lewis, Ed.D.
President



January 12, 2007

Jennifer Seal
23105 Seal's Oak Alley
Picayune, MS 39466

RE: IRB Study #06-328: A Comparison of Academic Achievement and Retention of Community College Students in College Algebra After Completion of Traditional or Technology-Based Instruction

Dear Ms. Seal:

The above referenced project was reviewed and approved via administrative review on 1/12/2007 in accordance with 45 CFR 46.101(b)(4). Continuing review is not necessary for this project. However, any modification to the project must be reviewed and approved by the IRB prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project. The IRB reserves the right, at anytime during the project period, to observe you and the additional researchers on this project.

Please refer to your IRB number (#06-328) when contacting our office regarding this application.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact Christine Williams at cwilliams@research.msstate.edu or 662-325-5220.

Sincerely,

A handwritten signature in blue ink that reads "Christine Williams".

Christine Williams
IRB Administrator

cc: Ed Davis

Office of Regulatory Compliance

P. O. Box 6223 • 8A Morgan Street • Mailstop 9563 • Mississippi State, MS 39762 • (662) 325-3294 • FAX (662) 325-8776