Assessing Pedagogical Practices in Mathematics Using Captured Class Content

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ABSTRACT

This mixed-methods study examined the variability in Exit COMPASS exam scores for Learning Support mathematics students accounted for by Entrance COMPASS exam scores, average chapter exam scores, and time spent reviewing captured class content. The COMPASS exam is a college placement exam in the University System of Georgia that community colleges use to measure a student's abilities in English, reading, and mathematics. Two-year college students who were required to take Learning Support mathematics courses were provided access to all class content through online recorded sessions. Students also took entrance and exit exams, called COMPASS exams, that were standard throughout the state where the study took place. A correlated *t*-test analysis revealed that Exit COMPASS exam scores were statistically higher than Entrance COMPASS exam scores. Students made significant gains in knowledge of mathematics, as measured by the COMPASS exam, during the course. However, there was no statistical evidence to prove that academic achievement occurred because of reviewing captured class content. A grounded theory quantitative approach was used to decipher students' impediments to using technology to review captured class content in a blended learning environment. The results of this study indicate that a blended learning environment may have academic advantages for some students. Further research should be conducted with larger sample populations and fewer limitations to identify effective pedagogical strategies involving reviewing captured class content.

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DEDICATION

I would like to dedicate this dissertation to my parents for encouraging and teaching me from a small child to reach for the highest stars, both academically and socially.

PREFACE

This dissertation is prepared in a journal-ready format. The first part of the dissertation consists of two journal articles, which have been prepared for submission to refereed journals. Manuscript I, “Developing Pedagogical Practices for Mathematics Using Captured Class Content,” is prepared for the Journal of Developmental Education. Manuscript II, “Overcoming Ordinary in the Mathematics Classroom,” is prepared for the Community College Journal. The complete prospectus for this study is found in Appendix A. The survey titled Math 99 Blended Learning Classroom Survey is found in Appendix B.

Developing Pedagogical Practices for Mathematics Using Captured Class Content

This manuscript is prepared for submission to the *Journal of Developmental Education* and is the first of two manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

This study was conducted to determine if using tablet personal computers to capture class content and providing online access to the content increased student achievement in remedial mathematics courses at a community college. Impediments to students' use of technology to review captured class content in a blended learning environment were also identified. Students took entrance and exit exams, called Computer Adaptive Placement Assessment and Support System (COMPASS) exams, that were standard throughout the state where the study took place. A correlated *t*-test analysis revealed that Exit COMPASS exam scores were statistically significantly higher than Entrance COMPASS exam scores, indicating that student achievement increased during the course; however, there was not a statistically significant correlation between Exit COMPASS exam scores and time spent reviewing captured class content in the blended learning environment. Students' misconceptions of their own understanding of mathematical concepts and lack of time proved to be the main impediments to students' use of technology to review captured class content. Providing students with captured class content may be a constructive pedagogical approach for the mathematics classroom if impediments are addressed.

Developing Pedagogical Practices for Mathematics

Using Captured Class Content

Introduction

Problem

Record numbers of students who are not prepared for a college curriculum are enrolling in college (Levin & Calcagno, 2008; Spann, 2000). International comparisons, though not an unambiguous source, indicate the United States (U.S.) is no longer the educational powerhouse and its position as the economic superpower may be endangered by a rising tide of mediocrity among U.S. students (Schleicher, 2011; Steen, 2003). These comparisons are an illustration of the educational crisis that the U.S. is currently experiencing, and without a drastic intervention, the U.S. may continue in a downward spiral both educationally and economically (Schleicher, 2011; Steen, 2003). This problem is not limited to one classroom, or one college, or one university system, but is an issue with national and global implications.

Academically underprepared students. A combination of an influx of college students who have been culturally acclimated to an environment saturated with technology and a large number of academically underprepared students have created a unique dilemma in higher education. The challenge, though existent for all colleges and universities, is most prevalent in community colleges. Over the past few decades the enrollment in community colleges has nearly quadrupled and these two-year institutions have become the fastest growing sector in higher education (Boswell, 2004; Kalogrides & Grodsky, 2011). Many observers would deem the record enrollments in community colleges to be advantageous to the institutions but most fail to see the dilemma at hand.

With record enrollments comes an influx of students entering college who lack the necessary reading, writing, and mathematics skills to succeed academically (Spann, 2000).

Mathematics as the weakest link. Though academically underprepared students are weak in many areas, the most prominent area of deficiency for college students is mathematics (Hagedorn, Lester, & Cypers, 2010). Mathematics has proven to be the weakest link in education for decades (McGlaughlin, Knoop, & Holliday, 2005). Research suggests that college students with mathematics deficiencies demonstrate weaknesses in many other academic areas, creating major stumbling blocks for students pursuing a college degree (McGlaughlin et al., 2005). The success or failure within college mathematics courses is so profound that mathematics courses often act as gatekeepers to earning a degree for many college students (McGlaughlin et al., 2005). The typical college student places little value on mathematics as a discipline and most do not see the value of mathematics in their daily lives or their future career goals (Perin, 2006). It is evident that students fail to realize the importance of college mathematics.

With an emphasis on graduation rates and retention rates in higher education, educators across the nation have been forced to reexamine pedagogical strategies in the mathematics classroom (McGlaughlin et al., 2005). Many analysts believe the issue is the result of an underachieving K-12 mathematics curriculum in the U.S. International comparisons suggest that mathematics curricula in the U.S. are excessively repetitive and omit important topics (Steen, 2003). Too much emphasis is placed on developing routine drill skills to prepare students to do well on high-stakes testing rather than engaging students in high-level mathematical thinking (Steen, 2003).

Challenges in Mathematics Education

The state of mathematics education in the U.S. appears to be in a downward spiral, and The National Commission on Excellence warned of a rising tide of mediocrity among U.S. students (Steen, 2003). A comparison of U.S. students against international standards provides evidence of sub-par achievement in mathematics in American schools. Repeated national assessments have shown that the U.S. remains uncompetitive internationally and that the national achievement gap is widening as students progress through school (Steen, 2003).

International assessments in 2000 by the National Assessment of Educational Progress (NAEP) showed that only one in six 12^{th} grade students achieved a proficient level and only 1 in 50 performed at the advanced level on the mathematics assessment (Steen, 2003). Similarly, the Organization for Economic Cooperation and Development (OECD) administered a comprehensive test of applied mathematics and problem solving to 15-year-olds in 40 countries (Shuster, 2005). The international government group representing 30 highly industrialized countries that created the Programme for International Student Assessment (PISA) reported that 15-year-old students in the U.S. performed lower than average on mathematics literacy and problem solving when compared with their international counterparts (Lewis, 2005). Furthermore, the U.S. had more students at the lowest level of performance and fewer students at the highest level than other OECD countries (Bybee, 2005).

During the same time, the Trends in International Mathematics and Science Study (TIMSS) reported that U.S. fourth graders ranked 12th out of 25 nations (Lewis, 2005). More than half a million school children were tested in grades 3, 4, 7, 8, and 12 within 41 participating countries. Twenty-seven countries achieved higher scores than the U.S. on the eighth-grade mathematics assessment (Valverde & Schmidt, 2000). An even more disturbing statistic from the NAEP indicated that 95% of Americans between the ages of 18 to 24 had calculating skills commensurate with having completed only five or six years of primary school (Markus & Zeitlin, 1998).

A summary of international comparisons of student achievement can be put in perspective by looking at a headline in the December 7, 2004, *Wall Street Journal* that read "Economic Time Bomb: US Teens are Among Worst at Math" (Bybee, 2005). Though the media has frequently reported about how poorly American students fare when compared with their international peers, the comparisons do not provide unambiguous data about the effectiveness of American high schools (Kortez, 2009). The findings of the two main tests, the TIMSS and the PISA, are often inconsistent, and comparing U.S. students against an international average can be misleading because the findings vary widely from survey to survey. Many observers speculate that the lackluster performance of American students on the TIMSS and the PISA arise because of the large population of minority and low-income students attending low-performing schools (Kortez, 2009). However, the international comparisons provide valuable information about American secondary schooling even if these data do not provide a clear evaluation of the performance of American students.

Mathematics Deficiencies

One consistent finding is that mathematics continues to be an area of weakness for American students. Weinstock (2006) contended that the most pressing educational crisis in America relates to the decreasing popularity of mathematics education in the

U.S. A recent technology conference report stated that only 5% of U.S. students graduate with engineering degrees, compared with 40% of Chinese students who leave college with a degree in engineering (Weinstock, 2006). The American Institute for Research, Inc. reported even more disturbing data showing that fewer than half of today's college graduates leave with a broad proficiency in mathematics (Lipka, 2006). The bottom line is that the vast majority of American students have difficulty in entry level college mathematics (Cerrito & Levi, 1999). The growing demand for mathematics competency in the work place necessitates an increased awareness and understanding of students with mathematics difficulties (McGlaughlin et al., 2005).

The U.S. Department of Education stated in President George H. W. Bush's America 2000 proposal that continued poor performance in mathematics is unacceptable and that the U.S. should seek to regain the number one ranking in the world in mathematics (Goldschmidt & Eyermann, 1999). The goal was reiterated via the National Research Council (NRC), which took an unprecedented step to deal with the crisis in education and began focusing on ways in which college-level mathematics classes needed to improve. The NRC challenged colleges and universities to elevate the quality of mathematics education by teaching faculty to engage students and achieve parity for women, minorities, and the disabled (Ferman & McCafferty, 1992). School administrators were encouraged to provide students with well-trained, experienced, full-time faculty as well as appropriate instruction to meet the needs of American college students (Beard, Harper, & Riley, 2004).

Remedial mathematics. As a result of the need for increased proficiency in mathematics, remediation has become an important priority in higher education. Goals set by the U.S. Department of Education focused the spotlight on community colleges. The burden of remediation in higher education became the primary focus of two-year colleges and not four-year universities. Community colleges were called upon to accept the responsibility of teaching remedial courses in order to better prepare students for upper-level mathematics courses. By understanding students who struggle in mathematics in higher education, community college faculty and administrators can better assist students by identifying appropriate remediation techniques both during and before college (McGlaughlin et al., 2005). Effective interventions for struggling mathematics students are currently scarce but there is ample evidence that successful participation in remedial courses has a positive impact on student success in subsequent college courses (Beard et al., 2004).

A review of the educational history of remedial students provides clues to what interventions might be effective to help struggling students succeed. Students who exhibit difficulties in reading comprehension often have problems in mathematics, especially in problem solving or word problems (McGlaughlin et al., 2005). College students identified with mathematics disabilities in elementary and secondary schools usually still demonstrate significant weaknesses in reading comprehension, nonverbal reasoning, working memory, and mathematics fluency (McGlaughlin et al., 2005). Though estimates vary, research indicates that up to 70% of incoming college freshman need remediation, and over 75% of those students fail to graduate or transfer within four years (Blume, 2007). The high failure rates in Learning Support mathematics courses appear to be a national phenomenon, not a rare occurrence limited to certain colleges or specific student profiles (Blume, 2007).

A complex and flawed educational system must have corrective measures in place to overcome its weaknesses (Rose, 2009). Rather than marginalize remediation, community colleges must re-examine remedial education to make it as effective as it can be. The idea of an educational system with a safety net offers a robust idea of education and learning (Rose, 2009). Rose (2009) pointed out that to make remedial courses an effective safety net, new pedagogical strategies must be in place to help students develop the knowledge, skills, and social networks for success beyond the classroom.

Community College Statistics

An analysis of developmental courses at a community college located in the southeastern U.S. illustrated the severity of the problem existent in higher education. The small college was located in a rural area with the majority of the approximately 1,700 students attending from surrounding counties. During the years of 2002-2005, 1,979 students enrolled in Learning Support courses at the two-year college level. Those courses included English 99, Reading 99, and Math 99. A total of 95 sections of Learning Support courses were taught during the fall and spring semesters of those three years, with an average section enrollment of 21. From spring 2003 to spring 2006, 11 students were placed on Learning Support suspensions for failing Learning Support English and 7 students were suspended for failing Learning Support Reading.

A preliminary examination of Learning Support mathematics at the two-year college level provided evidence that the main area of academic deficiency at the college is mathematics. In comparison with other types of Learning Support courses, 42 students were suspended for failing Learning Support mathematics. When examining a correlation between Entrance Computer Adaptive Placement Assessment and Support

System (COMPASS) exam scores and a subsequent college-level mathematics course, the community college study found that students with higher Entrance COMPASS exam scores typically have a better chance of successfully completing their first college-level mathematics course. Research supported this claim and concluded that a student's mathematical placement score was one of four main variables that predicted students' graduation rates with an Associate of Arts Degree (Mentzer, Cryan, & Teclehaimanot, 2007).

Under a University System of Georgia (USG) policy, students who took the Entrance COMPASS exam had to score at least a 37 on the mathematics section to avoid having to take a remedial course. This non-percentile score was calculated by combining students' scores on the basic skills, application, and analysis sections of the mathematics test. A score of 0-25 placed a student into the first level of Learning Support, Math 97. A student who scored 26-36 on the Entrance COMPASS exam was placed directly into the second level of Learning Support, Math 99. To complete all Learning Support Mathematics requirements, a student placed into Learning Support Math 97 must successfully complete both Math 97 and Math 99 before registering for college-level mathematics courses.

The higher a student scored on a college placement exam, the more likely it was that she (he) would remain in college and graduate in two to four years (Mentzer et al., 2007). Students who did not pass Learning Support Math 97 after one attempt had a small chance of successfully completing their first college-level mathematics course on the first attempt. Approximately 18% of students were successful in College Algebra after passing Math 97 after only one term. If a student had to repeat Math 97, the success rate in passing College Algebra fell dramatically to 1.2%.

Between the years of 2001-2005, 774 graduates completed degree requirements for the local college. Thirty-three percent of the graduates began their college careers with at least one Learning Support requirement. Only 19% of students who were required to take Learning Support Math 97 or Math 99 graduated from the community college. Research shows that students who are concurrently enrolled in remedial courses and college level courses do not perform as well overall as students who are not required to take any Learning Support courses (Illich, Hagan, & McCallister, 2004). The graduation rate for students who took two levels of Learning Support mathematics dropped to 14%. Those results suggest that the number of Learning Support mathematics courses a student takes at the community college is a good predictor of future academic success. The more Learning Support courses a student was required to take, the less likely that student was to complete the community college's degree requirements. Furthermore, the strongest predictor of success in College Algebra is a student's performance in their last developmental mathematics course (Aivazidis, Lazaridou, & Hellden, 2006).

College Algebra. The course success rates at the community college in this study for Math 97, College Algebra, and Pre-Calculus were: 49.6%, 53.2%, and 44.2%, respectively. These calculations were similar to a university system-wide report of the success rates, for Math 97, College Algebra, and Pre-Calculus, which were 52.21%, 50.85%, and 59.85%, respectively (Illich et al., 2004). During the same time, the university system reported that 6,820 students enrolled in College Algebra with at least one Learning Support mathematics requirement. Only 3,181 (47%) students who took at least one Learning Support mathematics course successfully completed College Algebra with at least a C average (Illich et al., 2004). The statistics indicate that the success rates for Learning Support mathematics and college credit mathematics courses in the USG hovered around 50%; however, students who were required to take Learning Support mathematics were less successful in College Algebra than students without any Learning Support mathematics requirements. Data revealed that students placed into the lowest level of Learning Support mathematics had a slightly greater chance of success in College Algebra than students who were placed directly into the second level of Learning Support mathematics, if and only if the student exited both levels after one attempt (Illich et al., 2004). College-level pass rates were much lower for students who did not successfully complete one or more remediation courses (Illich et al., 2004).

The purpose of this study was to investigate the hypothesis that pedagogical practices that encourage students to use captured class content to supplement their Learning Support Math 99 course would increase students' academic achievement in Learning Support mathematics courses. The focus of this research was to improve student achievement in Learning Support mathematics courses by developing pedagogical practices that encouraged students to study by reviewing captured class content. However, the broader goal was to improve student achievement in Learning Support mathematics courses in order to help students succeed in College Algebra and ultimately, in other college credit courses. The purpose of this research was to develop sound teaching strategies that benefit all students in the Learning Support mathematics classroom, and to promote academic achievement across the college curriculum.

Four research questions that guided this study were as follows: (a) What variability in Exit COMPASS exam scores for Learning Support mathematics students can be accounted for by Entrance COMPASS exam scores, and time spent reviewing class captured content; (b) What is the relationship between student age and time spent reviewing captured class; (c) What is the relationship between average chapter exam scores and time spent reviewing captured class content; and (d) What are the impediments to students' use of technology to review captured class content in Learning Support mathematics courses at a two-year college? An Institutional Review Board (IRB) application was completed, submitted, and approved prior to data collection (see Appendix A). An approval letter from the President of the two-year college involved in the study was included permitting the researcher to collect data during the spring 2010 semester (see Appendix B).

Methodology

Sample

The sample for this research study consisted of 47 Learning Support Math 99 students at a rural community college in the southeastern U.S. Learning Support Math 99 is a developmental mathematics course that focuses on intermediate algebra concepts. The sample for this study was not a random sample; instead, students voluntarily enrolled in a Math 99 course, choosing both the instructor and time of the class. Students who participated in the study were required to take Learning Support Math 99 because they scored below the passing rate of 37 on the Entrance COMPASS exam. The Entrance COMPASS exam is a placement exam in the USG that many community colleges use to measure a student's abilities in English, reading, and mathematics. Low Entrance

COMPASS exam scores indicated that the students were academically weak in the area of mathematics and failed to demonstrate knowledge of basic mathematics skills and content.

Students participating in the study were required to score an average of at least 65 on four chapter exams given during the semester to be eligible to take the Exit COMPASS exam. Information on participants is provided in Table 1. Eleven students were ineligible to take the Exit COMPASS exam and failed the course due to low exam averages. Thirty-one students qualified to take the Exit COMPASS exam based on average chapter exams ≥ 65. Of these 31 students, 28 scored ≥ 37 on the Exit COMPASS exam and successfully passed Learning Support Math 99. Three students failed the Exit COMPASS exam and did not pass the course. Five students withdrew, dropped, or stopped attending class and did not pass Learning Support Math 99.

Table 1

Program Completion Data for Participants

Category	*N*	Program Status
Scored < 65 on Average of Chapter Exams and Ineligible for Exit COMPASS Exam	11	Failed
Scored ≥ 65 on Average of Chapter Exams and Failed the Exit COMPASS Exam	3	Failed
Scored ≥ 65 on Average of Chapter Exams and Passed the Exit COMPASS Exam	28*	Passed
Dropped/Withdrew from Program	5	Failed
Total Sample	47	

*Two students did not have Entrance COMPASS exam scores because they previously attended college and were not required to take a placement exam. Therefore, some data uses (n = 26).

Students enrolled in the courses were from very diverse backgrounds and included traditional and non-traditional students, as well as students from various ethnic and socioeconomic backgrounds. The following demographics represented the ethnic diversity of both classes: Caucasian (59%), African American (37%), and Asian (4%). A majority of the sample population was female (76%). For the purpose of this research, a non-traditional student was defined as a student who did not attend college immediately after high school and was older than 25 years of age. Twenty-three percent of the sample population were non-traditional students. Because Learning Support Math 99 is a prerequisite for many mathematics courses, the sample included students from various majors.

Research Design

Two sections of Math 99 were being taught by the researcher and were included in the study. Because the community college places great value on a small teacher- to-student ratio, the class size for each section was a maximum of 21 students. Both sections met twice a week for 1 hour and 40 minutes, with one section meeting Mondays and Wednesdays and the second section meeting Tuesdays and Thursdays. The research study began in January of the spring semester and ended in May, lasting a total of 16 weeks. Both classes were taught by the same instructor using the same pedagogical strategies, which involved lecturing, mentoring, note-taking, group work, and discussion. The researcher is a full-time tenured Associate Professor of Computers and Learning Support who has over 13 years of teaching experience in the area of mathematics. The researcher holds a Bachelor of Science degree in Computer Information Systems, a Master of Education degree in Curriculum and Instructional Technology, and has 18 graduate hours in mathematics.

Implementation and Data Collection

A blended learning environment was created using traditional face-to-face lecture combined with voluntary participation in the community college's virtual classroom. The virtual classroom was a password-protected educational Web site used by the community college to provide online and hybrid courses. Participation in the virtual classroom was encouraged but not required.

All classes were taught in a technology-enhanced classroom that included a computer for each student. On the first day of class, students reviewed the syllabus and student learning outcomes, and participated in training for the virtual classroom. Students were taught how to log into the virtual classroom and navigate properly through the course. Both sections were informed that the on-campus classroom would be reserved for them each day between the hours of 3:00-4:00 p.m. to access their virtual classroom and view the recordings outside of class time. The lab time was provided so that students who did not have a computer at home could access the virtual classroom to review the captured class content. Each student was also informed that they could access the virtual classroom at any time and from any location with an Internet-enabled computer.

The virtual classroom was designed as an additional resource for students who were enrolled in the Learning Support Math 99 courses. The main purpose of the virtual classroom was to provide students with access to captured class content recorded for each class session. The virtual classroom provided students with a gateway to access the voluntary online portion of the course and served as an instrument to collect tracking information to determine the amount of time students spent reviewing captured class content.

The Monday and Wednesday sessions of Learning Support Math 99 were recorded using Camtasia (4.0, TechSmith, Okemos, MI) and Mimio (9.12, Mimio Studio, Cambridge, MA) , which are computer programs used to record and write using tablet personal computers (PC). Mimio provided the ability to write lecture notes on a notebook and project example problems on a screen instead of a marker board. Using Camtasia, each class was recorded in its entirety including all visual and auditory examples. The recordings were available to all students in both sections of the course.

All examples and lecture notes were captured using a Tablet PC and converted to a flash movie. Essentially, all instructional activity, including all teacher explanations, was recorded for students to review at any time. Each class recording was stored in a virtual folder titled with the class date and topic. The virtual folders were created to allow students to review class material to gain a better understanding of the content presented in the face-to-face class and to present the material in a way that allowed the researcher to track the amount of time students actually spent reviewing captured class content.

Several limitations of the virtual classroom had to be addressed in order to correctly track the amount of time students actually spent reviewing class content. The first limitation dealt with a security feature standard within the virtual classroom software that caused the program to time-out after 20 minutes of inactivity. The software only recognized a student as being active if they were actually clicking on folders or tools located within the virtual classroom. Because of this feature, if a student watched the class recording for any amount of time over 20 minutes, the program would automatically time-out and the researcher would not be able to determine the amount of time the student actually spent reviewing captured class content. Due to the limited tracking capabilities in the software, each class recording was divided into segments of approximately 15 minutes to prevent the program from timing-out.

All students' tracking reports were reviewed at the end of each week. Using Microsoft Excel (2003; Microsoft Corp, Redmond, WA), each student's name was entered into a spreadsheet. Weekly tracking statistics were recorded for each student. These statistics included how much time the student spent reviewing captured class content each day and which 15-minute sessions were observed. Additional information, including Entrance and Exit COMPASS exam scores, was recorded. At the end of the semester, average chapter exam scores were computed and stored in a spreadsheet. Students who had an average chapter exam score of at least 65 were eligible to take the Exit COMPASS exam. Students who were eligible to take the Exit COMPASS exam and scored at least a 37 on the Exit COMPASS exam were identified as passing the program. Students who were ineligible to take the Exit COMPASS exam due to failing chapter exam scores (< 65) or failed the Exit COMPASS exam (< 37) were identified as failing the program. A preliminary survey was administered during the first week of the semester to collect demographic data, including age.

Survey. On the first class day of every other week for the entire semester, participants of the study were administered a survey created by the researcher to determine why they may have chosen not to participate in the virtual classroom. The purpose of the survey was to identify any impediments that may have prevented students from using technology to review the captured class content. Students were provided with a list of reasons for not reviewing the captured class content. Students were asked to check all that applied and space was provided for them to list their own reason(s) if not presented on the list. A grounded theory quantitative approach was used to decipher students' impediments to using technology to review captured class content in the blended learning environment (Cutcliffe, 2005).

Results

An analysis of data from Entrance and Exit COMPASS exam scores, average exam scores, pass/fail program status, age, and time spent reviewing class captured content provided insight into the effectiveness of pedagogical practices involving reviewing captured class content in Learning Support mathematics classes. The survey data were analyzed to determine the impediments to the students' use of technology in the blended learning environment.

Data Results

Prior to comparing other statistics related to students in the course, it was necessary to determine whether there were initial differences between students who were successful in the course and students who were not. An independent-samples *t* test was conducted to compare the Entrance COMPASS exam scores of students who were successful in the program to those same scores of students who failed to successfully exit the program. Entrance COMPASS exam scores for two students were missing because these students attended college previously before the Entrance COMPASS exam was used for placement and were not required to retake a college entrance exam. Students who successfully exited the program ($n = 26$) scored no differently ($t(43) = .304$, $p = .763$) on the Entrance COMPASS exam ($M = 22.69$, $SD = 4.90$) than those students ($n = 19$) who failed to successfully exit the program ($M = 22.21$, $SD = 5.71$). There were no initial differences in mathematical knowledge between students who were successful at the end of the course and students who were not.

In order to determine whether student knowledge of mathematics increased during the course, mean Entrance COMPASS exam scores were compared to mean Exit COMPASS exam scores. A correlated *t*-test analysis revealed that Exit COMPASS exam scores ($M = 51.97$, $SD = 12.46$) were significantly higher than Entrance COMPASS exam scores ($M = 22.24$, $SD = 4.83$), $t(28) = 13.28$, $p < .001$. Students made significant gains in knowledge of mathematics, as measured by the Exit COMPASS exam, during the course. The effect size calculation for participation in the course yielded a Cohen's *d* = 3.44. Students who took the course improved test scores, on average, by over three standard deviations, when compared to their scores prior to taking the course.

Data on time spent by students reviewing captured class content were gathered and analyzed. Seventeen of the 47 (36.2%) students participating in the study viewed the captured class content for less than one hour for the entire 16-week semester. Of these students, only 9 (53%) passed the course. During the semester, 35 out of 47 (74.5%) students viewed the captured class content for less than 20 hours. Of this group, 21 (60%) students passed the course. The remainder of the sample population, 12 out of 47 students, viewed the captured class content between 30 and 250 hours during the semester. Seventy-five percent of these students passed the course. All of the students who accessed the captured class content for more than 70 hours passed the course and the average increase between Entrance COMPASS exam scores and Exit COMPASS exam scores was 22 points for these students. The student who spent the most time reviewing captured class content in the blended learning environment (216.6 hours) increased her COMPASS exam score by 23 points and the student with the second highest amount of time reviewing captured class content increased his COMPASS exam score by 36 points.

A bivariate correlation was conducted to determine whether there was a relationship between total time spent reviewing captured class content and Exit COMPASS exam scores. The analysis yielded no statistically significant correlation between the two variables ($n = 31$, $r = -.069$, $p = .714$). There was not a statistical relationship between time spent reviewing captured class content and Exit COMPASS exam scores. Less than half of 1% (r^2 = .0047) of variability in Exit COMPASS exam scores can be attributed to time spent reviewing class content.

Average exam scores were calculated for all students. Students took four chapter exams, and each student's mean exam score was computed. Those scores were used to determine whether there was a relationship between total time spent reviewing captured class content and average exam scores. A bivariate correlation was conducted on total time spent reviewing captured class content and average exam scores. The analysis yielded no statistically significant correlation between the two variables (n = 31, r = -.19, p = .307). Students who spent more time reviewing captured class content did not score significantly higher on chapter exams.

The age for each student was determined from information provided on an introductory survey given during the first week of class. Student ages ranged from 18 to 47. A bivariate correlation was conducted to determine whether there was a relationship between total time spent reviewing captured class content and age of the student. The analysis yielded a statistically significant correlation between the two variables (n = 47, r = .569, p < .001). Older students tended to have spent more total time reviewing captured class content than younger students.

For the following analyses, students were classified as passing or failing. Students classified as passing (n = 26) were those who passed the Exit COMPASS exam and passed the course with a class average of 65 or higher. Those classified as failing did not pass the Exit COMPASS exam (n = 3), dropped out of the program (n = 5), or were ineligible to take the Exit COMPASS exam because they failed the course (n = 11). Note that the differences in the number of passing and failing students is different in these analyses as a result of missing data from the two students who did not take the Entrance COMPASS exam. Both students not reflected in this data passed the Exit COMPASS exam and successfully completed all Learning Support mathematics requirements.

An independent-samples *t* test was conducted to determine whether there was a difference in mean chapter exam scores for students (n = 28) who successfully exited the program (M = 81.82, SD = 7.91) compared to the mean chapter exam scores for students (n = 14) who failed to successfully exit the program (M = 52.89, SD = 16.71). Successful students scored, on average, significantly higher on chapter exams than students who failed to successfully exit the program ($t(40) = 6.145$, $p < .001$).

Analysis of the qualitative data indicated numerous reasons for the lack of student participation in the voluntary blended learning environment. The survey was given six times with 120 total responses. Data from the surveys indicated that 55 out of 120 students (46%) "understood the concepts in class" and therefore did not need to review the class sessions. Twenty-eight percent indicated that they "did not have enough free time" and therefore did not review the class sessions. Five students specified that they "should have watched" the class sessions but chose not to watch the recordings. Fewer than one percent of students indicated "technological problems" or "computer issues" as reasons for not participating in the blended learning environment. Only two students remarked that they were "always reviewing" and that the recordings were "very helpful."

Discussion

Four questions were to be answered by this study. The first question sought to determine whether student review of captured class content could have an effect on student success in remedial mathematics courses, and the next question addressed the impediments that might exist in the use of such online content. The results of this study indicated that there was no statistical evidence to substantiate the hypothesis that providing students the opportunity to review captured class content in a blended learning environment was an appropriate instructional strategy to increase student achievement in Learning Support mathematics courses at a two-year college. There was no statistically significant correlation between time spent reviewing captured class content in the virtual classroom and Exit COMPASS exam scores. However, a more detailed analysis of the data indicated that students who spent a large amount of time (70 or more hours) reviewing captured class content successfully completed the course. Because there was a significant difference between Entrance COMPASS exam scores and Exit COMPASS exam scores, learning did occur. However, the data did not provide evidence that learning occurred because of students' ability to review captured class content, from participation in the face-to-face class, or from other factors such as self-motivation, tutoring, etc. The results do not indicate that providing this resource cannot be successful, and it is clear that a number of students did benefit, but the findings did not show overall success for the small sample size (n = 28) involved in this research project.

The research data showed that there was a relationship between student age and time spent reviewing captured class content. Older students spent more time reviewing captured class content providing evidence that non-traditional students were more willing to use available resources to succeed in the mathematics classroom. The data suggests that older students recognized their weaknesses in mathematics and sought help by reviewing captured class content. Older students appeared to be more self-motivated than there younger traditional peers.

Students' average exam scores were compared to the amount of time they spent reviewing captured class content to determine if a relationship existed. Analysis of the research concluded that students who spent more time reviewing captured class content did not do better on chapter exams. A quick analysis of the research data showed that reviewing captured class content did not help students score higher on chapter exams; however, a closer analysis is needed to adequately determine the relationship between these two variables. Were students who spent the most time reviewing captured class content reviewing daily or were these students cramming an entire chapter into one day of reviewing? Did students only watch the recordings or did they take notes while reviewing captured class content? More research is needed to determine how students were using captured class content to prepare for chapter exams.

Further analysis of the research data indicated that though some students were successful, a few students who viewed captured class content regularly throughout the semester still struggled and failed to pass the course. The data further supported the conclusion that there was no correlation between time spent reviewing captured class content in the blended learning environment and the Exit COMPASS exam scores. Additional research should be conducted to identify the needs of these students. Reviewing captured class content may not be the solution to improving their academic performance. Perhaps additional pedagogical strategies such as required reviewing of captured class content could give these students an academic tool to be successful in mathematics courses.

The findings of the study indicated three main impediments to students' use of technology to review captured class content in the Learning Support mathematics course.

A major finding of the study was that students failed to access the online content. Over three-fourths of the students remarked on the survey that they “understood the concepts” in class and did not need to review the captured class content. Based on the fact that only 57% of the students enrolled at the beginning of the semester passed the course and exited Learning Support mathematics, it is evident that a significant portion of the students could have used extra help. Some students found it difficult to view entire class sessions quickly and efficiently online. Therefore, a few (< 1%) chose not to access the blended learning environment because of technological problems.

The findings of this research indicated that new pedagogical strategies are necessary for the academic success of Learning Support mathematics students. This research is the beginning of a search for a pedagogical strategy that works for the majority of Learning Support mathematics students. The development of such a strategy will produce an academic impact that will expand beyond developmental courses into college credit courses that ultimately will lead to increased graduation rates and retention. Further research should be conducted to determine whether capturing class content in a blended learning environment can be a constructive learning environment for students with academic difficulties in mathematics.

Future research should examine the limitations of this research project that may have contributed to the lack of statistical significance. Because of the community college’s low teacher-to-student ratio, the sample population for this research project was extremely small and the success or failure of a few students could easily influence the results. The sample size for this research project was too small to adequately predict valid results. Only 29 out of 47 students involved in the research project were able to take the

Exit COMPASS exam. Eighteen students were ineligible to take the Exit COMPASS exam because they did not have the required class average of 65. Nearly 40% of the sample population were ineligible and had no Exit COMPASS exam scores that could be reflected in the final data. Further research could yield significant results if participation in the blended learning environment were an essential component of the course pedagogy and not a voluntary resource only available to students if they chose to access it.

A larger sample size and additional data on actual time spent in the blended learning environment could yield enlightening results that could be beneficial in redesigning remedial mathematics curricula using blended learning environments.

One factor that influenced the implementation of the research was the restrictions of the Blackboard (8.0, Blackboard Inc., Washington, DC) course-management system used to create the blended learning environment. The Blackboard course-management software prevented students from easily accessing the captured class content. In addition, participation in the blended learning environment was completely voluntary. Student participation in the blended learning environment was not graded and students received no incentive for participating, so most chose not to participate in the optional online portion of the blended learning environment. Nearly 76% of the class accessed the blended learning environment for less than 20 hours the entire semester.

The growing demand for mathematical competencies in higher education and in the workforce necessitate additional research to identify potential avenues to assist mathematically challenged students. The findings of this study provided strong support that, though mathematics continues to be an area of weakness for students at community colleges, a simple change in pedagogy may not be the answer. Further research should be conducted with larger sample sizes and fewer limitations in order to further the research base of pedagogical strategies involving reviewing captured class content. Perhaps the captured class content only provided students with repetitious drilling rather than a deeper understanding of the concepts presented in class. A deeper understanding of mathematical concepts is necessary for students to succeed in the mathematics classroom. Future research can develop innovative pedagogical strategies to promote learning that will help academically weak mathematics students succeed. Reviewing captured class content may be a useful resource for mathematics students, but it may not be a pedagogical practice that works for all.

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APPENDIX A: Institutional Review Board Approval

VALDOSTA STATE UNIVERSITY

Institutional Review Board (IRB)
or the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

PROTOCOL NUMBER: IRB-02443-2009 **INVESTIGATOR:** Cindi Kirkland

PROJECT TITLE: Does using technology to capture class content increase student achievement?

DETERMINATION:

☑ This research protocol is exempt from Institutional Review Board oversight under Exemption Category(ies) 1. You may begin your study immediately. If the nature of the research project changes such that exemption criteria may no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research.

☐ Exemption of this research protocol from Institutional Review Board oversight is pending. You may **not** begin your research until you have addressed the following concerns/questions and the IRB has formally notified you of exemption. You may send your responses to irb@valdosta.edu.

ADDITIONAL COMMENTS/SUGGESTIONS:

Although not a requirement for exemption, the following suggestions are offered by the IRB Administrator to enhance the protection of participants and/or strengthen the research proposal. If you make any of these suggested changes to your protocol, please submit revisions so that IRB has a complete protocol on file.

Barbara H. Gray Date: 12/02/09 ***Thank you for submitting an IRB application.***

Barbara H. Gray, IRB Administrator ***Please direct questions to irb@valdosta.edu or 229-259-5045.***

cc: Dean – Dr. Phil Gunter
Advisor – Dr. Brian Gerber

Form Revised: 09.02.2009

APPENDIX B: Permission Letter

South Georgia College
A Degree of Difference

Office of Academic Affairs

COPY

November 20, 2009

Institutional Review Board
Valdosta State University
1500 North Patterson Street
Valdosta, GA 31698

To Whom It May Concern:

Ms. Cindi Kirkland, a graduate student in your Department of Curriculum and Instruction, has requested a letter of support for her doctoral project, "Does Using Technology to Capture Class Content Increase Achievement?" I have reviewed her Application for Use of Human Participants in Research, as well as her project draft chapter on methodology, and I have discussed her project with her. As a result, I offer my wholehearted support of her project.

If I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Carl B. McDonald, Ph.D.
Vice President for Academic Affairs

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Overcoming Ordinary in the Mathematics Classroom

This manuscript is prepared for submission to the *Community College Journal* and is the second of two manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

The purpose of this article is to introduce an innovative pedagogical strategy in the mathematics classroom using the tablet personal computer (PC). The influx of academically underprepared students has challenged community college educators to find strategies that are effective with this group of mathematics students. Teachers can use tablet PCs to create a blended learning environment that captures class content and makes it available for student review outside of class. In this research study, students responded positively to the use of the tablet PCs to record lessons in the mathematics classroom. The focus of this article is to encourage community college educators to use different pedagogical strategies to escape the traditional classroom, which often relies solely on lecture to teach mathematics concepts.

Overcoming Ordinary in the Mathematics Classroom

Introduction

Providing a quality education to all students has always been a challenge, but higher education institutions are finding it more difficult than ever to academically prepare the diverse population of students entering college. External factors have always affected educational reform but none so much as the influx of technology in society. For example, Web search engines are commonly used to access information on the World Wide Web, laptops are in most students' backpacks, and there is now more computing power in a cell phone than was in a personal computer (PC) 10 years ago (Kaku, 2012). The evolution of technology has forced higher education institutions to realize that traditional approaches to teaching may not yield the same results as in the past. Courses must be designed and developed with innovative means of delivery to engage learners who are comfortable in a technology-based society.

A combination of students who have been culturally acclimated to an environment saturated with technology and an increase in the number of academically underprepared students has created a unique dilemma in higher education. The challenge, though existent for all colleges and universities, is most prevalent in community colleges. Over the past few decades, the enrollment in community colleges has nearly quadrupled and these two-year institutions have become the fastest growing sector in higher education (Boswell, 2004). Many observers would deem the record enrollments in community colleges to be advantageous to the institutions, but many fail to see the dilemma that has accompanied those increases. With the record enrollments has come an influx of students who lack the basic skills to succeed academically.

Mathematics Deficiencies in Community Colleges

Studies indicated that community college students struggle predominantly in mathematics (Penny & White, 1998). Students fail to see the importance of mathematics in academic or career choices. Even though mathematics is essential in almost every career, many college students fail to see the relevance of mathematics in the real world. This failed connection often leaves students with a lack of understanding and more importantly, a negative perception of mathematics that is echoed in the classroom. Students cannot see the significance of mathematics in a society evolving around science and technology. Most students do not realize that their success or failure in the mathematics classroom often determines their probability of graduating with a bachelor's degree (McGlaughlin, Knoop, & Holliday, 2005).

Community college mathematics educators have a responsibility to take the weakest college students and teach them to be academically successful. This responsibility of reaching out to academically challenged students is an integral part of every community college's mission. But, it is exactly this mission that defines the character of community college institutions and educators. It is at the community college level that educators can make a dramatic difference in the lives of students.

Innovative Pedagogical Strategies

Community college students may be engaged by educators who are willing to be innovators of new pedagogical strategies that work for today's students. Albert Einstein defined insanity as doing the same thing repetitively and expecting different results (Tangredi, 2011). Einstein's definition of insanity may be applicable to the issue of pedagogy and today's college population. If current pedagogical practices are not working, a change in practice is necessary. Traditional teaching methods, such as lecture-facilitated learning environments, may work for ordinary students but the community college educator's attention is focused on students who are not ordinary students. Their attention is required for weak, academically underprepared students whose journey to become a college graduate is full of obstacles and challenges that must be overcome.

Obstacles in the Mathematics Classroom

Educators must identify and overcome obstacles and challenges in the mathematics classroom as well as help students overcome their classroom challenges. Because math students often fail to see a relationship between course requirements and future career goals, educators must answer the relevance question, "Why do I really need this to succeed?" (Bryk & Treisman, 2010). Mathematics remains unpopular and difficult for most students and few see mathematics as an opportunity to discover and create (Yushau, 2006; Ahrendt, 1987). Remedial students need help understanding mathematics conceptually and in a positive perspective (McGlaughlin et al., 2005). Students often perceive that they understand how to work a problem or how to apply a mathematical principle, but when they are away from the classroom and attempt to work the same types of problems, they realize that they did not really understand the concepts presented in class. However, innovative pedagogical practices in the mathematics classroom can be used to help students overcome these challenges by creating learning environments that are embedded with technologies familiar to community college students.

Culturally, our society has changed over the last few decades and our educational system has struggled to keep up with the rapidly changing times. These cultural changes have necessitated a new educational paradigm that reflects not only the needs of the students but their interests as well. Technology is an important component of students' environments outside the classroom, and resourceful educators can use technology advantageously in the classroom environment. There is ample research that suggests that using technology as an instructional tool improves student learning and student achievement (Yuliang & Huang, 2005).

Exploring Tablet PCs

Exploration of the new technology of tablet PCs has piqued the interest of educators, and these devices have become more prevalent in community colleges (Godsall, Crescimano, & Blair, 2005). Tablet PCs are portable computing devices that are as powerful as a modern desktop but use specialized software, including ink-enabled applications, to make tablet PCs a useful technology in the classroom (Machado, 2004). Teachers can use tablet PCs to increase student learning, understanding, and ultimately retention by using digital ink to clarify, emphasize, or visually expand what is present on a projection (Godsall et al., 2005). Students can become actively involved in lectures by viewing their own comments and notes in class during discussions. In addition, the tablet PC has over 100 specialized programs that can make it almost indispensable in the classroom (Godsall et al., 2005).

There is little research on the educational use of tablet PCs and most studies involve only student use of tablet PCs. However, these devices can be used by educators to overcome learning obstacles in the mathematics classroom by creating a blended learning environment. Blended learning is any combined learning approach that uses technology as a supplement but does not completely replace face-to-face learning (Welker & Berardino, 2005-2006). A blended course design incorporates a mixture of learning and doing and includes any combination of instructional technology and instructor-led teaching. Tablet PCs can be used to create an ideal learning environment, combining the advantages of a face-to-face classroom with the benefit of the constant availability of an online classroom.

Developing Blended Learning Environments

After gaining approval from the Institutional Review Board (IRB) (see Appendix A) and the president of the two-year college (see Appendix B) involved in the study, an educational experiment was conducted at a community college in rural South Georgia. Learning Support students at a community college were placed in a remedial course, Math 99, because they failed a placement exam, Entrance COMPASS (Computer Adaptive Placement Assessment and Support System) exam. The Entrance COMPASS exam is a college placement exam in the University System of Georgia, and is used by community colleges to measure students' knowledge of English, reading, and mathematics. If a student failed the Entrance COMPASS exam, the student was required to enroll in a Learning Support course in the area in which they did not demonstrate academic proficiency. In the area of mathematics, a student had to earn a score of 37 or higher to proceed to a college-level mathematics course. Learning Support Math 99 students who successfully completed all course requirements took the Exit COMPASS exam at the end of the semester. Students had to achieve a passing score ≥ 37 on the Exit

COMPASS exam to be eligible to enroll into subsequent college credit mathematic courses.

To determine the effect of using tablet PCs to capture class content, and of making those class projections available through an online course section, Learning Support mathematics students participated in a blended learning course involving the use of tablet PCs. The researcher used a tablet PC to project notes onto a screen. In conjunction with the tablet PC, Camtasia (4.0, TechSmith, Okemos, MI) and Mimio (9.12, Mimio Studio, Cambridge, MA) software were used to record the mathematics notes as well as the teacher's explanations of the problems. The recordings containing both the explanations and the notes were placed into a Blackboard (8.0, Blackboard Inc., Washington, DC) learning system as a flash movie, allowing students to watch the recording as many times as they chose.

The captured class content was provided to help students review concepts that were not understood in class and to review for exams. Students could log into the course at any time and watch the course recordings. If a student was having difficulty with homework problems, they could watch the recordings to see and hear the problems be reworked by their teacher. Shy students who were too afraid to ask questions in class could easily review the class content without being embarrassed in class. Students who were slow note-takers could review their notes online outside of class without holding up the entire class. Regardless of a student's personality, learning style, or level of academic achievement, this innovative teaching strategy provided students' with an opportunity to have a tutor 24 hours a day.

The pedagogical strategy encouraging the reviewing of captured class was evaluated to determine the effectiveness of using tablet PCs to provide daily review for Learning Support students. Student activity in the blended learning environment was tracked in the virtual classroom. The amount of time students spent reviewing captured class content was recorded and analyzed to determine if a correlation existed between Exit COMPASS exam scores and time spent reviewing captured class content. A survey was administered to determine the impediments to students' use of technology to review captured class content the Learning Support mathematics classroom.

Research Analysis

A bivariate correlation using the Statistical Package for the Social Sciences (SPSS) (18.0, IBM, Armonk, NY) was conducted on total time spent reviewing captured class content and Exit COMPASS exam scores. The analysis yielded no statistically significant correlation between the two variables (n = 31, r = -.069, p = .714). Analysis of the results seems to indicate that the pedagogical strategy encouraging the use of captured class content in the blended learning environment was not effective because there was no statistically significant correlation between time spent reviewing captured class content in the blended learning classroom and Exit COMPASS exam scores. A closer analysis revealed that learning did occur because there was a significant difference between Entrance COMPASS exam scores and Exit COMPASS exam scores. A correlated t-test analysis indicated that Exit COMPASS exam scores (M = 51.97, SD = 12.46) were statistically significantly higher than Entrance COMPASS exam scores (M = 22.24, SD = 4.83), $t(28) = 13.28$, $p < .001$. In addition, all students who spent 70 or more hours reviewing captured class content in the blended learning classroom successfully passed the Exit COMPASS exam. However, there was no statistical evidence to support the hypothesis that learning occurred because of the innovative pedagogical strategy used in the study instead of other intrinsic or extrinsic factors. The results do not indicate that this pedagogical strategy cannot be successful, but they indicate that it was not successful for the small sample size (n = 28) involved in this study.

Qualitative analysis of students' responses on a brief survey administered six times during a 16-week semester showed support for reviewing course content captured using a tablet PC. One student remarked "[I'm] always reviewing," which indicated that the student believed the captured class content was a useful resource for learning. Two students remarked that they "loved the recordings," which implied that they watched the recordings regularly. A few students wrote that the recordings were "very helpful" and remarked "I wish other teachers did this." Similar positive comments were recorded throughout the study. No student commented that the recordings were not useful or that they were ineffective. The only negative comments were related to students' difficulty in accessing the captured class content. Many students remarked that they did not have enough time to watch the recordings like they really wanted or needed.

Students who used the captured class content did come to depend on having it available in a timely manner. If the classes recorded using the tablet PC were not placed in the blended learning environment within a couple of hours after class, three students sent e-mail messages inquiring about when the recordings would be available. Because of the popularity of the class recordings with those students who used them, students in other classes sent e-mail messages to the mathematics instructor to request access to the recordings to help them in their own mathematics class. In addition, the director of the college tutoring center sent an e-mail message asking to have access to the recordings because of requests she had received from students. A fellow faculty member remarked "All of my students want to know why I do not use the tablet PC in my class to record my lessons." The positive response from the use of the tablet PC to capture class content caused other faculty members to evaluate their own courses to determine whether this pedagogical strategy could be effective in the courses they teach.

However, though there was strong support for the use of captured class content in the mathematics classroom from the students who accessed that material, few students took advantage of this resource. Students were encouraged to review the captured class content, but participation in the blended learning environment was completely voluntary. No incentives were given to students for reviewing the captured class content. Nearly 75% of the students participating in the study reviewed the course recordings for less than 20 hours during the 16-week semester and 36.2% reviewed the recordings for less than 1 hour. The majority of the students in this study (46%) indicated on the survey that they understood the concepts in class and did not need additional help. The final data reflected students' misconceptions of their own academic abilities in the mathematics classroom. Fifty-seven percent of the sample population failed Math 99, indicating that students did not, in fact, understand the concepts presented in class.

Potential for More Effective Practice

The hypothesis that pedagogical strategies involving the review of captured class content increases achievement in Learning Support mathematics courses was not proven in this research. However, the need for innovative pedagogical strategies that work in the mathematics classroom is clearly evident. New pedagogical strategies must continue to be explored to overcome academic deficiencies in the mathematics classroom. Based on potential improvements identified by the instructor and through student feedback, the pedagogical strategy of using a tablet PC and a combination of other resources may develop into a method that educators can successfully incorporate in college mathematics. Future research should be conducted with adequate sample sizes and fewer limitations to determine the effectiveness of reviewing captured class content.

It is the responsibility of community college educators to try different techniques in the classroom to assist the academically challenged student. The challenge facing community college educators is not unfamiliar. Since the 1900s when the first community college came into existence, two-year schools have recognized the importance of preparing the academically challenged student to succeed in higher education. Even though the problems in higher education remain similar from generation to generation, community college educators recognize that each new generation of students brings new academic challenges. To achieve solutions, community college educators may need to use different pedagogical strategies.

Community college mathematics courses can become a place where technology provides a platform for a variety of pedagogical practices that can reach weaker students. Community college educators across the nation should continue to courageously step out of the traditional classroom learning environment and embrace technologies that can benefit a student's academic progress. In finding effective pedagogical practices, community colleges can provide a unique and significant service to higher education by reducing failure rates, increasing community college retention rates, and promoting more student access to four-year institutions.

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APPENDIX A: Institutional Review Board Approval

VALDOSTA STATE UNIVERSITY

Institutional Review Board (IRB)
for the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

PROTOCOL NUMBER: IRB-02443-2009 **INVESTIGATOR:** Cindi Kirkland

PROJECT TITLE: Does using technology to capture class content increase student achievement?

DETERMINATION:

☑ This research protocol is exempt from Institutional Review Board oversight under Exemption Category(ies) 1. You may begin your study immediately. If the nature of the research project changes such that exemption criteria may no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research.

☐ Exemption of this research protocol from Institutional Review Board oversight is pending. You may **not** begin your research until you have addressed the following concerns/questions and the IRB has formally notified you of exemption. You may send your responses to irb@valdosta.edu.

ADDITIONAL COMMENTS/SUGGESTIONS:

Although not a requirement for exemption, the following suggestions are offered by the IRB Administrator to enhance the protection of participants and/or strengthen the research proposal. If you make any of these suggested changes to your protocol, please submit revisions so that IRB has a complete protocol on file.

Barbara H. Gray Date:12/02/09 ***Thank you for submitting an IRB application.***

Barbara H. Gray, IRB Administrator ***Please direct questions to irb@valdosta.edu or 229-259-5045.***

cc: Dean – Dr. Phil Gunter
Advisor – Dr. Brian Gerber

Form Revised: 09.02.2009

APPENDIX B: Permission Letter

South Georgia College
A Degree of Difference

Office of Academic Affairs

COPY

November 20, 2009

Institutional Review Board
Valdosta State University
1500 North Patterson Street
Valdosta, GA 31698

To Whom It May Concern:

Ms. Cindi Kirkland, a graduate student in your Department of Curriculum and Instruction, has requested a letter of support for her doctoral project, "Does Using Technology to Capture Class Content Increase Achievement?" I have reviewed her Application for Use of Human Participants in Research, as well as her project draft chapter on methodology, and I have discussed her project with her. As a result, I offer my wholehearted support of her project.

If I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Carl B. McDonald, Ph.D.
Vice President for Academic Affairs

100 West College Park Drive • Douglas, GA 31533-5098 912.260.4204 912.260.4440 (fax) www.sgc.edu

APPENDIX A: Prospectus

Assessing Pedagogical Practices in Mathematics Using Captured Class Content

A Prospectus submitted
to the Graduate School
Valdosta State University

in partial fulfillment of requirements
for the degree of

DOCTOR OF EDUCATION

in Curriculum and Instruction

in the Department of Curriculum, Leadership, and Technology
of the Dewar College of Education

July 2012

Cindi M. Kirkland

MED, Valdosta State University, 2001
BS, Valdosta State University, 1999

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Chapter I

INTRODUCTION

College professors in our current educational system face significant challenges in engaging their students in learning. Today's cohort of college students, frequently referred to as "Generation NeXt," demonstrate educational and social characteristics that challenge post-secondary educators in ways not previously experienced (Taylor, 2005). Generation NeXt is the predictable product of our consumer-driven society, and students have been led to believe that, "education is supposed to be entertaining, easy, and fun" (Taylor, 2005, p. 100). Many of today's college students are academically disengaged and complacent. Research provides evidence that many college students spend little time studying, arrive to class late, and appear bored during class (Taylor, 2005).

The consequences of such dispositionally challenged students transcend the classroom. After World War II, the U.S. had the most educated labor force when compared to other industrialized nations, yet the advantage that the U.S. once possessed is diminishing as other countries have prioritized educational reform (Schleicher, 2011). In 2000, 38% of U.S. jobs requiring a Ph.D. in science or technology were filled by people who were born abroad, up from 20% in 1990 (Langford, 2005). Ultimately, the erosion of America's educational advantage represents a threat to the nation's status as an economic superpower (Steen, 2003). Thus, students' lack of educational competence when compared to other major countries serves as an indicator that improvements in higher education are imperative for continued U.S. economic stability.

Providing a quality education to all students has always been a challenge, but higher educational institutions are finding it more difficult than ever to academically prepare the diverse population of students entering college (Boswell, 2004). External factors have affected educational reform, but none so much as the influx of technology in our society. For example, Web search engines are commonly used to access information on the World Wide Web, personal laptops are ubiquitous, and there is now more computing power in a cell phone than was in a personal computer (PC) 10 years ago (Kaku, 2012). The evolution of technology has forced higher educational institutions to recognize the need to design and develop innovative course delivery to engage learners who are comfortable in a technology-based society.

The combination of an influx of students who have been culturally acclimated to an environment saturated with technology and a surplus of academically underprepared students has created a unique dilemma in higher education (Boswell, 2004). The challenge, though extant for all colleges and universities, is most prevalent in community colleges. Over the past few decades the enrollment in community colleges has nearly quadrupled, becoming the fastest growing sector of higher education (Boswell, 2004). While the record enrollments would seem to be advantageous for junior colleges, they actually mask a serious problem. With the large enrollments come substantial numbers of students who lack the necessary reading, writing, and mathematics skills to succeed academically (Spann, 2000).

The need for remediation and an open door admission policy has helped define the mission of community colleges to provide underprepared and diversified students an opportunity to earn an advanced degree (Perin, 2006). Remediation has been a part of education policy since the mid-1800s, but after the passage of the Higher Education Act of 1965 remediation became an integral part of community college curricula in order to meet the needs of a growing student population (Batzer, 1997; Illinois Community College Board, 2003). Though remediation is a controversial topic in most educational arenas, there is ample evidence that students who participate in remedial education programs are positively impacted and students who successfully complete remedial courses have a strong chance of performing better in college level courses (Penny & White, 1998; Singer & Willett, 2003).

The most prominent area of deficiency in remedial studies is in mathematics (Penny & White, 1998). Though mathematics plays an important role in almost all careers, students find mathematics to be more difficult, making it one of the most unpopular subjects for students and one of the most difficult subjects for educators to teach (Yushau, 2006). Students' inability to relate mathematics to real work experiences and failure to view mathematics in a positive manner creates challenges in the mathematics classroom (McGlaughlin, Knoop, & Holliday, 2005). Mathematics has such a critical effect on students' success that mathematics courses are referred to as gatekeepers for students earning a college degree (McGlaughlin et al., 2005).

Statement of the Problem

Record numbers of students are enrolling in college who are not prepared to undertake a college-level curriculum (Spann, 2000). International comparisons indicate the U.S. is no longer educationally superior, and its position as the economic superpower is endangered by an increasing number of academically challenged students (Steen, 2003). Specifically, U.S. students are weaker in mathematics than students in other industrialized nations, and even America's brightest students only perform as well as other industrialized nations' average students (Markus & Zeitlin, 1998). These comparisons are an illustration of the educational crisis that the U.S. is currently experiencing and, without intervention, the U.S. will continue to fall further behind other nations both educationally and economically (Steen, 2003). Hence, this problem has national implications that extend beyond the educational field.

While a change in pedagogy cannot overcome the complex issues in education in the U.S., this study can address issues in educational pedagogy. The purpose of this study is to address issues in remedial mathematics courses in community colleges with the intent of improving student achievement in these courses, ultimately leading to scholastic improvement across disciplines.

Albert Einstein defined insanity as doing the same thing over and over again and expecting different results (Tangredi, 2011). Therefore, it would be impractical to assume that educators could continue to teach courses in the same manner and expect student achievement to improve. Culturally, our society has changed considerably over time and our educational system has failed to keep up with those rapid changes. As previously mentioned, many students have consistent Internet access at home, and they have become accustomed to being entertained by technology. Personal Digital Assistants (PDAs), iPods, cell phones, and digital audio players are just a few of the technologies that many students have readily available. These technologies have become an integral part of students' culture and can be used beneficially in the classroom.

In addressing the problem with remedial mathematics courses in community colleges, educators must understand that cultural changes have necessitated a new educational paradigm that reflects not only the needs of the students but their interests as well. Technology is an important component in students' environments outside the classroom, and resourceful educators can use technology advantageously within the classroom environment. There is evidence that using technology as an instructional tool improves student learning and student achievement (Hanna & de Nooy, 2003). A thorough understanding of the pedagogy of technology integration is crucial because only the appropriate use of technology in the classroom will facilitate student learning (Okojie, Olinzock, & Okojie-Boulder, 2006).

Educators can incorporate appropriate pedagogical strategies and technology into classrooms to create a learning environment suitable for today's technology-savvy student. With the use of tablet PCs and the Internet, the traditional face-to-face classroom can be changed into a blended learning classroom which integrates the advantages of face-to-face classrooms with the positive characteristics of online learning (Davis & Fill, 2007). Tablet PCs are a type of computer that does not require a keyboard (Machado, 2004). With a stylus pen, users can create or edit documents using a variety of tools. Blended learning classrooms capitalize on the strengths of each mode of delivery and form a learning environment that is appropriate for students of varying learning styles (Beard, Harper, & Riley, 2004). The focus of this research is to determine if using tablet PCs to capture class content in a blended learning environment increases student achievement in Learning Support mathematics courses at a two-year college.

Theoretical Framework

The conceptual model for the research presented in this study is based on two distinct theories, behaviorism and cognitive theory. Appropriate educational pedagogy should be based on behavioral theories of instruction, particularly in the mathematics classroom. Behavioral theorists such as Skinner and Gagne believe that behaviors are predictable and there exists a link between stimulus and response (Qing & Edmonds, 2005). In the classroom, teachers can apply this theory by understanding that student learning behaviors can be predicted and that each student will respond differently (Qing & Edmonds, 2005). Therefore, learning styles must be considered and teachers should incorporate instructional strategies that include different teaching styles to maximize student achievement. Teachers must realize that students learn using a variety of styles, but each learning style is present at different levels. Grasha and Yangarber-Hicks (2000) use the illustration of an artist's palette to describe learning style. All of the colors are present within students' personalities, but some blend more readily and some are more dominant than others (Grasha & Yangarber-Hicks, 2000). Because students learn differently, teachers must recognize the need for pedagogical practices that addresses the needs of each type of learner.

Gagne, a popular behavioral theorist, believed that educators should focus on mastering concepts by first mastering subskills (Qing & Edmonds, 2005). The theory is appropriate in the mathematics classroom because students are taught subskills that build upon each other until mathematical concepts are mastered. In remedial mathematics courses, students learn basic skills to build a solid mathematical foundation. As the course progresses, the mastery of subskills leads to an overall mastery of course objectives that potentially enables students to successfully exit remedial mathematics.

Cognitive theories should be considered in conjunction with behavioral theories for a solid theoretical framework (Qing & Edmonds, 2005). Cognitive theorists believe that a link exists between stimuli and responses; however, they believe these links involve complex factors including individual mental processes (Qing & Edmonds, 2005). In the mathematics classroom, students who become actively engaged in the learning process are more likely to experience authentic learning (Qing & Edmonds, 2005). A combination of these theories is appropriate in the remedial mathematics classroom because instruction that builds master skills and knowledge prepares students for a successful academic experience (Qing & Edmonds, 2005).

Purpose of the Study

The purpose of this study is to investigate the hypothesis that an innovative approach to teaching mathematics can build a solid mathematical foundation to help students succeed in College Algebra courses. The focus of this research centers on improving student achievement in Learning Support mathematics courses. Learning Support is the term used at the community college where the research takes place to identify remedial courses. The broader idea, however, is to improve student achievement in all remedial mathematics courses in order to help students succeed in College Algebra and, ultimately, in other college credit courses. The purpose of this research is not to improve student achievement in a single classroom in a community college, but to find a new approach to teaching mathematics that can be successful in other mathematics classrooms, as well as other disciplines, in colleges and universities across the nation.

Research Questions

There are two specific research questions that will guide this study.

1. What variability in Exit COMPASS exam scores for Learning Support mathematics students can be accounted for by exam scores, Entrance COMPASS exam scores, Learning Support mathematics attempts, and time spent reviewing captured class content?
2. What are the impediments to the students' use of technology to review captured class content in Learning Support mathematics courses at a two-year college?

Significance of the Study

Of all the subjects taught in higher education, mathematics is the one subject that remains unpopular and difficult for most students (Yushau, 2006). The typical college student places little value on mathematics as a discipline, and few students see the use of mathematics in their daily lives or as part of their future career goals (Perin, 2006). Specifically, College Algebra has the lowest pass rate of any course taught in higher education, yet is a required core course for most mathematics and science degrees in the majority of colleges and universities (Wynegar & Fenster, 2009). There is evidence that students who successfully complete College Algebra have a higher chance of obtaining a college degree (McGlaughlin et al., 2005).

Chapter II

REVIEW OF LITERATURE

Overview

Community colleges comprise an important level in the multitier institutional hierarchy of American higher education (Lucas, 1996). Relatively few community colleges were in existence until after World War II, when community colleges and their enrollments began increasing across the U.S. The massive expansion of higher education in the 1960s, including the construction of hundreds of new two-year colleges and the expansion of state higher education systems, created an influx of first generation college students (Ahrendt, 1987). Thirty years later, these multi-purpose institutions have remained the fastest growing sector in higher education. Community college enrollments have increased nearly 375% over the last three decades compared to a 103% enrollment increase for four-year universities (Boswell, 2004). In 2004, statistics indicated that over 6.5 million students were attending 1,200 community colleges in America, accounting for a large segment of the population of students in higher education (Boswell, 2004).

The combination of rapid growth and the demand for more academically prepared students has helped define the nature and character of community colleges, and as a result, helped these institutions establish a unique identity in higher education. Though many educators define the role of community colleges as simply a means to provide access to higher education, community colleges fill many roles and must provide accessibility and low tuitions by “engaging in active aggressive outreach, counseling, support, and job placement" (Garza & Eller, 1998, p. 34). However, the central role of community colleges is seen by some educators as providing access to higher education for all students by maintaining an open door admissions policy as well as continuing to uphold high academic standards (Perin, 2006). In comparison to four-year universities, community colleges have lower tuition rates and are more numerous and accessible to disadvantaged students (Lucas, 1996). Due to community colleges' admission criteria being less restrictive than four-year universities, two-year colleges are sometimes identified as agencies for the democratization of opportunity in higher education (Lucas, 1996).

Diversification of Community Colleges

Boone (1997) referred to community colleges as the "people's college" (p. 1) because of their tradition of serving the needs of a diversified population. The demographics of a community college are different from those of a four-year university. Community colleges serve a large socioeconomic cross section of the college student population (Garza & Eller, 1998). Students requesting admission to community colleges typically originate from less affluent families than students attending major universities. Most community college students are from working middle-class families with as many as 65% of students coming from families who make less than $20,000 annually (Boswell, 2004). In addition, up to 40% of community college students are commuter students who hold full-time or part-time jobs while attending school (Lucas, 1996).

Some advocates of community colleges have called community colleges "America's democracy colleges" because they offer millions of students a chance of receiving an education who normally would not have an opportunity to attend college, including 5.4 million ethnically and age-diverse students (Franco, 2002). Community college students are commonly non-traditional students with an average age of 29-30 years (Lucas, 1996). They enroll the highest percentage of minority students, new immigrants, and female students of any type of higher education institution (Boswell, 2004). Statistics show that students at community colleges are more likely to be female with an estimated enrollment of 57% to 65% of the total student population (Lucas, 1996). Approximately one-fifth of the community college student populations are minority (Boone, 1997). Statistics provide confirmation that community colleges are a good educational choice for disadvantaged students who seek an educational experience that is both challenging and nurturing, regardless of their long-term academic goals (Vanwagoner, Bowman, & Spraggs, 2005). Many college administrators and faculty believe that remedial courses fill an important niche in higher education by providing opportunities to rectify race, class, and gender disparities while teaching students skills necessary to participate formally in society (Bahr, 2008).

Remediation in Higher Education

The growth among two-year colleges suggests that community colleges are meeting the student needs not adequately met by four-year academic institutions (Lucas, 1996). A large number of students entering college lack the reading, writing, and mathematics skills necessary to succeed in higher education, and those students have a need for remedial education (Spann, 2000). Most academically underprepared students attend community colleges to receive developmental education (Spann, 2000). Thus, remediation has become an integral component of their mission as part of the open door admissions policy. Some educational scholars view remedial education as an illustration of community colleges' commitment to educational access for all types of students (Perin, 2006).

Studies conducted by Lewis and Farris (1996) reported that all public community colleges offered at least one developmental course in reading, writing, or mathematics, according to the National Center for Educational Statistics (Kozeracki, 2002). A troubling statistic by Perin (2006) suggested that up to 80% of community college students are required to enroll in at least one remedial course.

History of Remediation. The need for remediation in higher education can be traced back to the mid-1800s. In 1849, the University of Wisconsin offered the first documented remedial programs in reading, writing, and mathematics (Batzer, 1997). In 1965, the passage of The Higher Education Act increased the number of students able to attend college, increasing the need for remedial courses (Batzer, 1997). Community colleges began to offer remedial education to assist underprepared students in improving basic academic skills (Washington State Board for Community and Technical Colleges, 1998). Today, remedial education is defined as "a class or activity intended to meet the needs of students who initially do not have the skills, experience, or orientation necessary to perform at a level that the institutions or instructors recognize as 'regular' for those students" (Perin, 2006, p. 339). Components of remedial education include the following: "Preparatory studies, academic support programs, compensatory education, learning assistance, and basic skills" (Kozeracki, 2002, p. 81).

Remediation Controversy. Though remedial education, also referred to as developmental education, has been around since the 19th century, its existence remains controversial. Scholars continue to debate the issue of its place in higher education.

Opponents of remedial education claim that it drains resources from other academic priorities and turns community colleges into overpriced high schools (Kozeracki, 2002). Another argument against remedial education is that the government should not have to pay a second time for a student to learn in college what they should have learned in high school (Handel & Williams, 2011). A further criticism is that remedial education programs at community colleges lower retention rates (Hoyt, 1999; Kozeracki, 2002). Many educators believe that remedial education lowers academic standards and decreases the quality of higher education institutions by encouraging students who lack the basic skills to be successful in college to enroll in academic institutions (Kozeracki, 2002).

Proponents of remedial education counter that educating everyone is less expensive than creating an uneducated society with a large number of people who possess minimal skills and minimal educational development (Astin, 2000). A study by the Institute of Higher Education Policy (1998), which investigates the costs of remedial education, concluded that from a societal perspective, remedial education is less costly than the alternative of a society with a high unemployment rate, low-wage jobs, welfare participation, and incarceration (Kozeracki, 2002). Remedial education can be beneficial to society by providing the potential of “increased tax revenue, greater productivity, increased consumption, greater workforce flexibility, reduced crime rates, increased community service, and better quality of civic life” (Kozeracki, 2002, p. 89).

Cost of Remediation. Economically, remedial education costs the nation’s public colleges and universities approximately $1 billion annually (Handel & Williams, 2011). However, this amount is less than 1% of the $115 billion current fund revenue of higher education institutions. The cost of remedial education varies by state and ranges from

$1.4 million in Kentucky to over $300 million in California. By a considerable margin, the majority of money spent on remedial education is spent by community colleges. Community colleges spend about 6.5% of their budgets on faculty salaries compared to only 1.1% at four-year universities (Kozeracki, 2002). Another major cost of remedial education comes from the increase in the number of students enrolling in remedial courses. Lewis and Farris (1996) indicate that 55% of community colleges claim an increase in remedial education enrollment. According to the American Association of Community Colleges, enrollment in remedial courses at community colleges has increased by 17% in the last two years (Adams, 2010).

Remedial Students**.** A closer look at the students enrolling in remedial courses reveals even more troubling statistics than those of typical community college students. Remedial students are characteristically recent high school graduates, non-traditional students, and immigrant students (Hermida, 2010; Washington State Board for Community and Technical Colleges, 1998). In addition, more than one-half of remedial students are women and up to one-third are minorities (Berkner & Choy, 2008). As many as three-fifths of the students in remedial courses are younger than 23 years old (Aud et al., 2011; Merisotis & Phipps, 2000). Fifty-percent are financially dependent and the majority of remedial students are from low-income families (Martinez & Snider, 2003; Washington State Board for Community and Technical Colleges, 1998). Low-income, minority students are more likely to require remediation than their wealthier, Caucasian peers (ReadyMath, 2012).

Most remedial students receive financial aid and attend school only part-time (Calcagno, Crosta, Bailey, & Jenkins, 2007; Felix & Pope, 2010). One-fifth of the remedial student population are not U.S. natives, and more than 50% score less than 800 on the Scholastic Assessment Test (SAT) (Teranishi, Suárez-Orozco, C., & Suárez-Orozco, M., 2011; Washington State Board for Community and Technical Colleges, 1998). Normally, remedial students are first-generation learners with little family support and many have a poor self-image (Jaschik, 2005; Washington State Board for Community and Technical Colleges, 1998). A majority work more than 30 hours per week and are academically weak (Bailey, 2009; Washington State Board for Community and Technical Colleges, 1998). A large percentage of remedial students only have General Education Diplomas (GEDs) and many consistently score low on exams (Washington State Board for Community and Technical Colleges, 1998). The driving force behind a remedial student's decision to return to school is frequently because of desperation or financial insecurity (Batzer, 1997; Felix & Pope, 2010).

Faculty

A more in-depth look at the faculty of remedial students shows that there is a substantial difference between faculty who teach remedial classes and faculty who only teach college credit courses (Shultz, 2009). Boylan, Bonham, and Bliss (1994) report that 66% of all remedial education faculty teach on a part-time basis. This is twice as much as part-time faculty as a whole (31%) (Boylan, Bonham, & Bliss, 1994; Shultz, 2009). The employment status of community college faculty is significant and may be directly related to student outcomes in remedial courses (Fike & Fike, 2007). Research indicates that students perform better in classes where full-time faculty teach remedial classes voluntarily as opposed to being arbitrarily or even punitively assigned to do so (Penny & White, 1998).

Traditionally, remedial faculty members teach more classes with fewer, if any, teaching assistants (Boyer, Butner, & Smith, 2007). The authors state that 70% of faculty who teach remedial courses have five or fewer years of teaching experience. Remedial education faculty are less academically prepared in terms of education and are more likely to have only a bachelor's degree (Penny & White, 1998). Statistics show that only 57% of community college faculty have a master's degree (Penny & White, 1998; Views and Characteristics of Community College Professors, 2005).

Remedial education faculty members have unique challenges in the classroom. Miglietti, Strange, and Carney (1998) wrote that remedial education faculty members are faced with trying to meet the needs of Learning Support students and must consider "learning styles, classroom environment preferences, teaching styles, and remedial course outcomes" (p. 1) for remedial college students. Students in remedial courses need learning approaches that relate to their own personal experiences as well as encouragement in the learning process. Faculty must create a learner-centered classroom that includes activities and personalized instruction in order to create positive outcomes for remedial students (Miglietti et al., 1998). A classroom in which there are no assumptions about a student's abilities is the most successful learning environment (Perin, 2006). This type of environment can be the ultimate motivator and a driving influence for future educational endeavors for remedial students.

An evaluation of both the faculty and students involved in remedial education only underscores the importance to society of understanding the problems and remedies of remedial education. A survey conducted by Immerwahr (1999) led to the conclusion that college, business, and government personnel believe that the largest problem facing higher education is that too many students need remediation. The critical need for remediation emphasizes the role community colleges play in higher education. The overall controversial issue is whether community colleges can protect access to education without lowering the academic bar (Perin, 2006). This situation threatens remedial education, which is an essential component of the mission of community colleges.

Remedial Education Programs

The importance of successful remedial education programs and the positive effect these programs have on institutions and society as a whole have been noted in research. The literature provides examples from studies of certain characteristics that are commonly associated with effective remedial programs. Some of these characteristics include "early intervention, required entry-level testing, mandatory basic skills course placement, and strong ties associated between basic skills courses with subsequent college level courses" (Washington State Board for Community and Technical Colleges, 1998, p. 15). Students who participate in remedial education programs are positively impacted and have greater success in subsequent courses in the college credit curriculum (Penny & White, 1998). Students who take remedial English, mathematics, or reading courses tend to stay in school longer and have higher retention rates at community colleges than students who do not take these courses (Singer & Willett, 2003). Successful completion of remedial courses increases a student's chance of performing better in college-level courses (Singer & Willett, 2003).

The negative effects of the failure to complete remedial courses are as evident as the positive results of successful completion of remedial courses. The results of a study by Illich, Hagan, and McCallister (2004) indicated that students who did not successfully complete one or more remedial courses performed significantly lower in college-level courses than their peers. Students who took three or more remedial courses had the lowest degree completion rate of any group of students. Remedial students' cumulative grade point averages were less than one-half a grade point lower than students who were not enrolled in remedial courses (Batzer, 1997). In addition, students who were not required to take remedial courses earned credit hours at a slightly higher rate than remedial course takers (Washington State Board for Community and Technical Colleges, 1998).

Mathematics Remediation. The most prominent area of deficiency in remedial studies is in the area of mathematics (Penny & White, 1998). By far, of the three types of remedial courses, the pass rates are lowest in remedial mathematics courses with rates ranging from a low of 44% to a high of 50% (Washington State Board for Community and Technical Colleges, 1998). Mathematics is the one subject that remains unpopular and difficult for most students, though it plays an important role in almost all careers, especially in science and technology-related fields (Yushau, 2006). Most remedial students lack the basic skills necessary to deal with concepts, constructs, and the language of mathematics. College students with mathematical deficiencies demonstrate weaknesses in "reading comprehension, nonverbal reasoning, working memory, and mathematics fluency" (McGlaughlin et al., 2005, p. 229). Students tend to place little value on mathematics as a discipline and do not see the use of mathematics in their daily lives or as a part of their career goals (Perin, 2006).

Remedial students need help understanding mathematics in a positive manner, especially with the world rapidly evolving scientifically and mathematically

(McGlaughlin et al., 2005). The study of mathematics allows students to discover, create, and communicate knowledge, but very few remedial students see mathematics in this perspective (Ahrendt, 1987). Remedial mathematics students' perception of mathematics is often affected by their past experiences and past failures. Negative attitudes, feelings, and emotions from past performances in mathematics have a detrimental effect on their performance in remedial mathematics courses (Perin, 2006).

A study by Fleischner and Manheimer (2002) suggested that students with mathematical disabilities at the elementary and secondary level will continue to have problems at the college level (McGlaughlin et al., 2005). In contrast, if students increase their knowledge of elementary mathematics skills, they will maintain an advanced level of mathematic skills when they enter college (Mentzer, Cryan, & Teclehaimanot, 2007). There are many factors that are central to completing mathematics successfully, including the quality of textbooks, student attentiveness, class academic standards, and faculty credentials (Viadero, 2005). Students who are unsuccessful typically attend schools with fewer resources, less experienced teachers, and have more teachers instructing subjects for which they are not trained (Viadero, 2005). The effects of success or failure in college mathematics courses is so profound that research implies that mathematics courses often act as gatekeepers to earning a degree for many college students (McGlaughlin et al., 2005). Research shows that fewer than half of high school graduates are prepared for college-level mathematics (Schwartz, 2007).

International Comparisons

Many analysts believe that the problem with mathematical proficiency in the U.S. is the result of an underachieving curriculum. International comparisons suggest that mathematics curricula in the U.S. are excessively repetitive and leave out important topics (Steen, 2003). Too much emphasis is placed on developing routine drill skills to prepare students to do well on high-stakes testing rather than engaging students in higher-level mathematical thinking to prepare them to succeed academically in the future (Steen, 2003).

The state of mathematics education in the U.S. appears to be in such decline that The National Commission on Excellence warned of a rising tide of mediocrity among U.S. students (Steen, 2003). A comparison of U.S. students against international standards provides evidence of sub-par achievement in mathematics in American schools. Repeated national assessments show that the U.S. remains uncompetitive internationally and that the cross national achievement gap is widening as students progress through school (Steen, 2003). Assessments show that scores for the top 10% of students are 40% to 66% higher than scores of those students in the bottom 10%, indicating a significant gap between the students who perform well on standardized assessments and those who perform poorly (Aivazidis, Lazaridou, & Hellden, 2006).

International assessments in 2000 by the National Assessment of Educational Progress (NAEP) showed that only one in six 12^{th} grade students achieved the proficient level and only 1 in 50 performed at the advanced level (Steen, 2003). Another international group, the Organization for Economic Co-operation and Development (OECD), administered a comprehensive test of applied mathematics and problem solving to 15-year-olds in 40 countries (Shuster, 2005). Students were tested in four areas including space and shape, change and relationships, quantities, and uncertainty. The main purpose of this assessment was to determine how well students could recognize and interpret mathematical problems, translate problems into a mathematical context, and use mathematical knowledge and procedures to solve problems. The internal government group representing 30 highly industrialized countries that created the Programme for International Student Assessment (PISA) reported that 15-year-old students in the U.S. performed lower than average on mathematics literacy and problem solving when compared with their international counterparts (Lewis, 2005). Furthermore, the U.S. had more students scoring at the lowest level of performance and fewer students at the highest level than other OECD countries (Bybee & Stage, 2005).

During the same time, Trends in International Mathematics and Science Study (TIMSS), reported that U.S. fourth graders ranked 12th out of 25 nations (Lewis, 2005). TIMSS is "a study of educational systems as they exist to deliver educational experiences to students" (Valverde & Schmidt, 2000, p. 651). In essence, TIMSS was created to examine student performance as well as background characteristics of students, teachers, and schools (Bybee & Stage, 2005). More than half a million school children were tested in grades 3, 4, 7, 8, and 12 in 41 participating countries. Twenty-seven countries achieved higher scores than the U.S. on the 8th grade mathematics assessment (Valverde & Schmidt, 2000). An even more disturbing statistic by the NAEP concluded that 95% of Americans between the age of 18 to 24 have calculating skills commensurate with having completed only five or six years of primary school (Markus & Zeitlin, 1998).

A good summary of international comparisons of student achievement can be gained with one quick glimpse at the headline in the December 7, 2004 *Wall Street Journal* that read "Economic Time Bomb: US teens are Among Worst at Math" (Kronholz, 2004). Though news media frequently report about how poorly American students fare when compared with their international peers, Koretz (2009) explained that the comparisons do not provide unambiguous data about the effectiveness of American high schools. The findings of the two main tests, the TIMSS and the PISA, are often inconsistent, and comparing U.S. students against an international average varies widely from survey to survey. Many observers speculate that the lackluster performance of American students on the TIMSS and the PISA arise because of the large population of minority and low-income students attending low-performing schools (Koretz, 2009). However, the international comparisons provide valuable information about American secondary schooling, even if these data do not provide a clear evaluation of the performance of American students.

Mathematics as the Weakest Link

Mathematics continues to be an area of weakness for American students. Weinstock (2006) contended in his article that the most pressing educational crisis in America relates to the decreasing popularity of mathematics education in the U.S. A recent technology conference reports that only 5% of American students graduate with engineering degrees, compared with 40% of Chinese students (Weinstock, 2006). The American Institute for Research, Inc., reports even more grim data stating that fewer than half of today's college graduates leave college with a broad proficiency in mathematics (Lipka, 2006). The bottom line is that the vast majority of American students have difficulty in entry level college mathematics (Cerrito & Levi, 1999). The growing demand for mathematical competency necessitates an increased awareness and understanding of students with mathematics difficulties (McGlaughlin et al., 2005).

The U.S. Department of Education stated in *America 2000* that continued poor performance in mathematics is unacceptable and that the U.S. should seek to regain the number one ranking in the world in mathematics (Goldschmidt & Eyermann, 1999). The goal was reiterated via The National Research Council (NRC) when they took an unprecedented step to deal with the educational crisis in education and began focusing on ways in which college-level mathematics classes need to improve. The NRC challenged colleges and universities to elevate the quality of mathematics education by teaching faculty to engage students and achieve parity for women, minorities, and students with disabilities (Ferman & McCafferty, 1992). School administrators were encouraged to provide students with well-trained, experienced full-time faculty as well as appropriate instruction to meet the needs of American college students (Beard et al., 2004).

Remedial Mathematics. As a result of the need for increased proficiency in mathematics, remediation became an important priority in higher education. The goals set by the U.S. Department of Education (1998) focused attention on community colleges as the burden of postsecondary remediation became the primary responsibility of two-year colleges and not four-year universities. Universities in states such as New York, Massachusetts, and South Carolina made drastic changes to their remedial curricula (Mark, 1998). Trustees at City University of New York (CUNY) removed remedial courses from their curriculum altogether, while other states made dramatic budget cuts to remedial education (Mark, 1998). Community colleges were called upon to accept the responsibility of teaching remedial courses in hopes of better preparing students for upper-level mathematics courses. By understanding students who struggle in mathematics in higher education, community college faculty and administrators can better assist students by identifying appropriate remediation techniques both during and before college (McGlaughlin et al., 2005). Effective interventions for struggling mathematics students are currently scarce. There is ample evidence, however, that successful participation in remedial courses have a positive impact on students' success in subsequent college courses (Beard et al., 2004).

Problems with Mathematics. A glance at the educational history of remedial students provides clues to what effective interventions are needed to help struggling students succeed. Students who exhibit difficulties in reading comprehension often have problems in mathematics especially in problem solving or word problems (McGlaughlin et al., 2005). Fleischner and Manheimer (2002) found that some students who have difficulties in nonverbal reasoning have trouble with mathematics knowledge. College students identified with mathematics disabilities in elementary and secondary schools usually continue to demonstrate significant weaknesses in reading comprehension, nonverbal reasoning, working memory, and mathematics fluency (Fleischner & Manheimer, 2002).

Learning Support at a Specific Community College

An analysis of developmental courses at a community college located in the southeastern U.S. illustrates the severity of the problem existent in higher education. The college is located in a rural area with the majority of the approximately 2,000 students attending from surrounding counties. During the years of 2002-2005, 1,979 students enrolled in Learning Support courses at the two-year college, including English 99, Reading 99, and Math 99. Ninety-five sections of Learning Support courses were taught during the fall and spring semesters of those years with an average student enrollment of

21 per section. From spring 2003 to spring 2006, 11 students were placed on Learning Support suspensions for failing Learning Support English and 7 students were suspended for failing Learning Support Reading 99.

An examination of Learning Support mathematics at the two-year college provides evidence that mathematics is the main area of academic deficiency at the college. In comparison with other types of Learning Support courses, 42 students were suspended for failing Learning Support mathematics. The community college found that when examining a correlation between Entrance COMPASS (Computer Adaptive Placement Assessment and Support System) exam scores and subsequent college-level mathematics courses, students with higher Entrance COMPASS exam scores typically have a better chance of successfully completing their first college level mathematics course. Research supports this claim and states that a student's mathematical placement score is one of four main variables that predict students' graduation rates with an Associate of Arts Degree (Mentzer et al., 2007).

The higher a student scores on a college placement exam, the more likely it is that the student will be retained and graduate in two to four years (Mentzer et al., 2007). Students who do not exit Math 97, the lowest level of remedial mathematics, after one attempt have almost no chance of successfully completing their first college-level mathematics course on the first attempt. Approximately 18% of students are successful in College Algebra after exiting Math 97 after only one term (Mentzer et al., 2007). The percentage falls dramatically to 1.2% when students have to take Math 97 for a second or third attempt (Mentzer et al., 2007).

Between the years of 2001-2005, 774 graduates completed the degree requirements for the local college. Seventy-three percent of the graduates began their college career with no Learning Support requirements. The remaining 27% of the graduates were required to take at least one Learning Support class. The percentage of college graduates decreased to 19% when this community college's graduates were required to take one Learning Support mathematics course (Mentzer et al., 2007). Research shows that students who are concurrently enrolled in remedial courses and college-level courses do not perform as well as students who are not required to take any Learning Support courses (Illich et al., 2004). The graduation rate for students who took two levels of Learning Support mathematics dropped to 14%. The results show that the number of Learning Support mathematics courses a student takes at the community college is a good predictor of future academic success. Furthermore, the strongest predictor of success in College Algebra is a student's performance in his last developmental mathematics course (Aivazidis et al., 2006).

College Algebra

Data indicate that students placed into the lowest level of Learning Support mathematics have a slightly higher chance of success in College Algebra than students who are placed directly into the second level of Learning Support mathematics, if and only if, the student exits both levels after one attempt. Research shows that college-level pass rates are much lower for students who do not successfully complete one or more remediation courses (Illich et al., 2004). The course success rates at the community college for Math 97, College Algebra, and Pre-Calculus are 49.6%, 53.2%, and 44.2%, respectively. These calculations were similar to a university system-wide report of the success rate for Mathematics 97, College Algebra, and Pre-Calculus which are 52.21%, 50.85%, and 59.85%, respectively (Illich et al., 2004). During the same time, the university system reported that 6,820 students enrolled into College Algebra with at least one Learning Support mathematics requirement. Only 3,181 (47%) students successfully completed College Algebra with at least a C average.

College Algebra is a required core course for most mathematics and science degrees in community colleges, yet is has the lowest pass rate of any course taught in higher education (Wynegar & Fenster, 2009). In fact, College Algebra is the primary reason students quit school (Viadero, 2005). There are many factors that affect completion rates in College Algebra including faculty characteristics such as age, gender, educational preparedness, teaching experience, and employment status (Beard et al., 2004). Community college students who have part-time mathematics instructors are less likely to pass College Algebra than students who have full-time mathematics instructors (Penny & White, 1998). Many students do not complete College Algebra because they are very weak in basic concepts (Aivazidis et al., 2006). The National Science Foundation and National Science Board report that almost a quarter of high school students and more than half of middle school students study mathematics with a teacher who did not major or minor in mathematics or a related field (Lewis, 2005).

The age of students may also be a factor in College Algebra success rates. In a study of community college mathematics, Kagan and Budros (1992) found 62% of students under twenty years of age passed College Algebra on the first atempt while only 27% of students over thirty-five were successful. Younger students are more likely to complete their first semester of College Algebra than non-traditional students. Minority students such as African Americans and Hispanic students perform more poorly in College Algebra than students of other ethnicities. Findings of the study suggest that successful college students are typically Caucasian or Asian students that are slightly older than the typical freshman and are enrolled fulltime (Penny & White, 1998).

Affective and Cognitive Factors

Various affective and cognitive factors can contribute to the success or failure of mathematics students. Research indicates that correlations exist between non-cognitive variables such as mathematics anxiety, test anxiety, perceived usefulness of mathematics, and lack of confidence in one's mathematical abilities (Pucel & Stertz, 2005). Test anxiety is an important cognitive factor that affects the learning process in mathematics courses. Test anxiety refers to "the negative effect, worry, physiological arousal, and behavioral responses that accompany concerns about failure or lack of competence on an exam or similar evaluative situation" (Matthews, Zeidner, & Roberts¸ 2006, p. 175). Students with high levels of test anxiety perform more poorly on classroom and aptitude mathematics test than students with lower levels of test anxiety. Research by Bembenutty (2009) using a correlation analysis indicated that the highest negative association with test anxiety is self-efficacy.

Kesici and Erdogan's (2009) research determined that college students' test and self-efficacy for learning and achievement are significant predictors of college students' level of anxiety in mathematics courses. Mathematics anxiety is a common phenomenon among college students (Perry, 2004). Mathematics anxiety is defined as an "inability by an otherwise intelligent person to cope with quantification, and more generally mathematics" (Perry, 2004, p. 21). Research suggests that as many as 60% of college students experience mild to moderate levels of mathematics anxiety (Thilmany, 2009). As many as 85% of students claim at least mild mathematics anxiety in introductory mathematics courses (Perry, 2004). Psychological symptoms of mathematics anxiety include tension, nervousness, concern, worry, impatience, confusion, fear, and mental block (Rameau & Louime, 2007). More frequently, the symptoms of mathematics anxiety are physical including excessive sweating, nauseous, heart palpitations, paralysis of thought, and anxiety attacks (Rameau & Louime, 2007).

Student attitudes toward mathematics are directly related to student achievement in mathematics courses (Pucel & Stertz, 2005). A large percentage of college students have negative attitudes towards mathematics (Townsend, Moore, Tuck, & Wilton, 1998). Many students have had these negative attitudes for a very long time. Studies have found attitude to be a stumbling block towards progress in learning mathematics (Yushau, 2006). Students with positive attitudes toward mathematics will do well in the subject area while those with negative attitudes tend to perform poorly (Yushau, 2006). Negative attitudes often begin at a young age and refer back to some precipitating event or one particularly negative incidence in a student's elementary or secondary school experience (Pucel & Stertz, 2005). Mathematics anxiety progressively increases as a student moves toward college causing students to have negative attitudes towards mathematics (Pucel & Stertz, 2005).

Research on student attitudes towards mathematics examines both mathematics anxiety and students' self-concept in mathematics courses (Townsend et al., 1998). A student's self-concept of mathematics is defined as a perception of their ability to learn mathematics and to perform well in mathematics courses and on mathematics exams

(Townsend et al., 1998). Many students enrolled in mathematics courses lack the motivation or confidence to be successful in the mathematics classroom (Pucel & Stertz, 2005). Teachers may find it necessary to convince students that they can be successful in order to increase student achievement in mathematics (Pucel & Stertz, 2005). While negative attitudes and low self-efficacy are known to exist in mathematics classrooms, it is imperative that classroom environments be developed to overcome the factors that decrease student achievement in mathematics.

Literature suggests that the design of learning environments can substantially impact student learning (Tagg, 2003). Instructional designers and teachers need to incorporate behavioral theories of instruction into their course design framework, which suggests that student learning behaviors are predictable (Tagg, 2003). Behavioral theorists believe that when designing instruction, teachers must recognize that there is a link between stimulus and response (Qing & Edmonds, 2005). Gagne, a well-known behavioral theorist, believed that instructional design models should focus on mastering skills by first identifying subskills and then learning strategies to master each subskill (Qing & Edmonds, 2005). When students assimilate all of the knowledge, behavioral theorist believe they can then master the main skill (Qing & Edmonds, 2005).

Teachers need to understand the individualistic nature of students and must realize that what works for one does not work for all (Qing & Edmonds, 2005). Most students see and respond to stimuli differently. A second theory, cognitive theory, needs to be considered when designing instruction. Cognitive theorists believe that complex factors exist which affect the link between stimulus and response for students, including individual mental processes. By incorporating design strategies that are based on both theories, master learning can occur. Instruction that builds master skills and knowledge initially can move forward to more authentic learning (Qing & Edmonds, 2005).

Authentic learning can only take place when students are actively engaged in the learning process (Qing & Edmonds, 2005). Research shows that mastery learning can occur only if teachers are open to diverse learning styles and different student outcomes (Qing & Edmonds, 2005). Learning styles must be determined before instruction begins and differences such as personality, perception, ability, and intelligence should be considered (Kazu, 2009). Teachers must realize that students possess a variety of learning styles, but each learning style is present at different levels. Grasha and Yangarber-Hicks (2000) used the illustration of an artist's palette to describe learning style. All of the colors are present within students' personalities, but some blend more readily and some are more dominant than others.

Blended Learning Environments

Educators have a new understanding of the very nature of learning that affects the design, definition, and delivery of education (Pucel & Stertz, 2005). This new ideology offers students more choices than the traditionally based face-to-face classroom methodologies and approaches teaching and learning beyond the classroom walls (Pucel & Stertz, 2005). Research shows that the variety of teaching tools available in other formats such as online classrooms are at times superior to traditional classroom instruction (Pucel & Stertz, 2005). However, opponents of online learning claim that virtual classrooms are turning "postsecondary learning into an impersonal commodity that benefits educational producers and distributors but not its recipients, the students" (Tang & Byrne, 2007, p. 258). Studies suggest the most significant improvement to a strictly online course delivery would be to implement more frequent face-to-face contact between instructors and students (Harris & Parrish, 2006). Educators understand that access to information is an important part of learning, but research shows that intellectual development is largely achieved through active engagement and interaction with others (Aspden & Helm, 2004).

Many educators believe that education is best accomplished face to face, but blended learning is changing the accepted educational model by integrating the advantages of face-to-face classrooms with the positive characteristics of online learning (Davis & Fill, 2007). Blended learning is a modality mix that capitalizes on the strengths of each mode of delivery (Davis & Fill, 2007). The ideal learning environment takes advantage of the pedagogical strengths of traditional face-to-face courses and online teaching (Beard et al., 2004). The combination of both types of learning environments offers students the greatest opportunity to be successful in the classroom by discovering their academic strengths and weaknesses (Beard et al., 2004). Research indicates that students learn best through direct interaction with teachers and classmates, but online communications diminish student inhibitions and remove psychological and social communication barriers (Beard et al., 2004).

A combination of pedagogical practices should be used to produce optimal learning outcomes. Blended learning combines traditional teaching methods with authentic online learning activities to potentially transform student learning experiences and outcomes (Davis & Fill, 2007). A mixture of traditional and online modes of delivery reaches the educational goals of the teacher and the learning outcomes of the students (Tang & Byrne, 2007). Blended learning is any combined learning approach that uses technology as a supplement but does not completely replace face-to-face learning (Welker & Berardino, 2005-2006). A blended course design incorporates a mixture of learning and doing and includes any combination of instructional technology and instructor-led teaching.

A blended learning environment combines various event-based activities such as face-to-face learning, live e-learning, and self-paced learning. Teachers can mix traditional classroom lecture with synchronous online conferencing and asynchronous self-study (Yushau, 2006). A single mode of instructional delivery may not provide "sufficient choices, engagement, social contact, relevance, and context needed to facilitate successful learning and performance" (Yushau, 2006, p. 24). Research literature indicates that increased engagement in blended learning environments draws teachers and students together (Aspden & Helm, 2004). A blended learning environment facilitates connections and engagements and other aspects of the learning experience. The effectiveness of the blend relies on the active participation of students and the learning environment will only be effective if both teachers and students engage in the process (Aspden & Helm, 2004).

In 2001, approximately 21% of all college courses were delivered in a blended learning environment (Welker & Berardino, 2005-2006). The demand and popularity of blended courses originate from a need for institutions to accommodate learners who desire personal contact with instructors and the convenience and flexibility of online courses. In addition, higher education institutions must remain competitive for enrollment with other institutions, the workplace, and other fully online learning alternatives (Welker & Berardino, 2005-2006). Blended learning environments help higher education institutions face many challenges including the increasing size and diversity of student bodies and an increasing managerial approach to education that evaluates education against cost-effectiveness (Falconer & Littlejohn, 2007).

Blended learning environments are advantageous to teachers because they provide effective delivery of tutoring for students, increase the ability to share digital course materials and learning objects, develop effective virtual learning environments, increase facility in student assessment and feedback, and provide effective program management and student monitoring (Tang & Byrne, 2007). From the students' perspective, students appear to be more satisfied with the blended mode of delivery over strictly online and traditional modes of delivery (Tang & Byrne, 2007). At public universities, approximately 72% of teachers indicate that blended learning environments are more promising than strictly online learning environments (Tang & Byrne, 2007). More importantly, the literature implies that higher academic achievement is associated with modes of instructional delivery that use computer-assisted instruction such as blended learning environments (Aivazidis et al., 2006).

Students and teachers can use e-mail messaging, threaded discussion, online recitations, class materials, and other course management tools as well as traditional face-to-face activities to deliver and acquire course content (Tang & Byrne, 2007). These tools in the blended learning environment facilitate formal tracking of student progress, allow for modifications of lesson plans, speed the course development process, and provide flexibility to students with different learning styles (Tang & Byrne, 2007). Other advantages of the blended classroom are that it enhances teachers' ability to broadcast lectures synchronously and asynchronously, presents a virtual social presence, encourages self-study, increases interactions among students, and promotes collaborative learning (Tang & Byrne, 2007).

The results from action research suggest that a combination of well-designed and supported blended learning environments can improve course submissions and student retention. Online tracking techniques allow teachers to identify at-risk learners and apply early intervention programs for weak students. Blended learning joined with proactive learning support can be successfully applied in any discipline (Tang & Byrne, 2007). When used appropriately, blended learning environments enhance learning opportunities for students while meeting their educational needs (Aspden & Helm, 2004).

Technology

Focus on students' learning styles would be pointless without examining teaching styles concurrently. The integration of teaching styles and learning styles in a meaningful way defines instructional technology. Effective teachers need to analyze how technology fits into their philosophy of teaching and learning because research shows that student performance in classrooms using technology is tied directly to students' learning style preferences (Grasha & Yangarber-Hicks, 2000). A deep understanding of the pedagogy of technology integration is critical. Appropriate use of technology in the classroom will facilitate learning if technology becomes a part of the instructional process, and not used merely as an accessory during the course of instruction (Okojie et al., 2006). Technology integration is not a solitary concept that includes only software and hardware components, but teachers must interweave theories and application of research findings concerning technology in instruction to promote teaching and learning (Okojie et al., 2006). Technology integration should include strategies for selecting appropriate technologies, skills to demonstrate use with appropriate technologies, skills to evaluate the effectiveness of appropriate technologies, and skills to customize the use of appropriate technologies to address instructional problems (Okojie et al., 2006).

Technology integration has become a national priority in the U.S. and teachers are being encouraged to use computing technology as a tool for learning. The international, national, and local levels of education mandate the need to incorporate technology into the learning environment (Yuliang & Huang, 2005). To address the deficiencies in education with regard to technology, the U.S. Department of Education is investing more than $56 million to research the conditions and practices of using technology in the classroom and its impact on student performance (Bailey & Mageau, 2004). A portion of this investment will be used to improve the quality of instruction in technological classrooms (Bailey & Mageau, 2004). Quality instruction will include teachers who know how to make technology engaging and how to use appropriate technology to attain positive learning outcomes (Baule, 2007). One of the key components of technology in an educational setting is the transparency and ease of use of the technology. Teachers and administrators must understand that the appropriate use of technology in the classroom can be either a panacea for students' learning difficulties or a distraction from the learning environment (D'Angelo & Wooley, 2007).

Technology in the Mathematics Classroom. Evidence suggests that technology is an essential component in the learning process, but especially in the mathematics classroom (Machado, 2004). Qing (2007) explores the use of technology and concludes that technology can motivate students to learn mathematics and science. The use of technology to teach mathematics is a major influence in the classroom and enhances student learning (Machado, 2004). The proper integration of technology into mathematics courses fosters higher order thinking skills. Most students achieve more in mathematics classrooms that integrate technology appropriately, but research shows adult learners demonstrate an even greater achievement gain (Qing & Edmonds, 2005). Specific technologies yield a greater difference in community college mathematics classrooms (MacDonald & Caverly, 1999). The literature concludes that computers and calculators play a significant role in the teaching and learning of every mathematical topic (MacDonald & Caverly, 1999).

Computers in the classroom enable students to have direct access to mathematics and promote understanding of mathematics in a real world context (Provenzo, Brett, & McCloskey, 2005). In mathematics, the amount of information being made available through the use of computers allows teachers to bring concepts to the classroom earlier in their students' development and more frequently than in the past (Provenzo et al., 2005). However, using computers in the classroom significantly changes the learning environment for both students and teachers (Provenzo et al., 2005). For successful computer integration into the mathematics classroom, the following four characteristics must be true: (a) teachers must have the training and skills necessary to use technology effectively, (b) equipment and media must be affordable and in the budget, (c) equipment must be reliable and dependable, and (d) instructional materials must adequately fit the instructional needs of students (Provenzo et al., 2005). In summary, the components of successful integration include accessibility, professional development, reliability, and support (Baule, 2007).

Studies support the theory that technology can influence student learning outcomes in various learning environments (Allen, Bourhis, Burrell, & Mabry, 2002). Students' perceptions of technologies, personalities, and skill levels influence user reactions and satisfaction in particular learning environments (Allen et al., 2002). Computer-assisted instruction has made a tremendous impact on teaching and student learning at colleges and universities (Beard et al., 2004). Administrators and teachers view computer integration as a vital necessity because the use of technology leads to improved grades, improved pass rates, and lower per student costs (Skelly, 2007). Students are the direct beneficiaries of innovative technologies because technology increases efficiency, motivation, confidence, and prepares them for the future workforce (Qing, 2007). The literature provides evidence that students desire more frequent use of technology and the adoption of current technology in schools. Teachers are using a growing number of new technologies in the classroom to improve student learning (Skelly, 2007).

Tablet PCs. One specific type of new technology that has piqued the interest of educators and is beginning to be explored in the classroom today is the tablet PC (Godsall, Crescimano, & Blair, 2005). Because of tablet PCs' mobility, versatility, and convenient user-friendly access, many institutions have rendered standard computer labs obsolete (Barton & Collura, 2003). Tablet PCs are portable computing devices that are as powerful as a modern desktop but do not require a keyboard (Machado, 2004). They are similar to laptops because they provide portability similar to a PDA but have a larger screen size (Colwell, 2004). The two main categories of tablets are slates and convertibles/hybrids (Godsall et al., 2005). A slate tablet PC is one with no attached keyboard while a convertible tablet PC is essentially a laptop computer with a swivel screen that folds onto a keyboard to create a tablet computer (Machado, 2004).

Tablet PCs are powered by a special version of the Microsoft Windows operation system called Windows XP Professional Tablet PC Edition (Microsoft Corp, Redmond, WA). This operating system contains features that are standard to a traditional desktop and features that are designed specifically for tablet PCs (Colwell, 2004). The average cost of a tablet PC ranges from $1500-$2500 and includes wireless capability, a pen, the operating system and in most cases additional hardware and software. Though tablet PCs have the same software programs as regular laptops, it is the specialized software, including ink-enabled applications, which make tablet PCs a useful technology in the classroom (Godsall et al., 2005).

Tablet PCs allow users to interact and write on the screen using a stylus pen and digital ink technologies (Colwell, 2004). Digital ink technologies allow cursive or print handwriting to be converted into text using a screen digitizer (Machado, 2004). Surprisingly, tablet PCs are very good at handwriting recognition, especially cursive handwriting (Machado, 2004). Users can also input text into a tablet PC by using a block letter recognition system common to PDAs (Machado, 2004). Teachers can increase student learning, understanding, and ultimately retention by using digital ink technologies to clarify, emphasize, or visually expand what is present on a projection (Machado, 2004).

The capabilities of digital ink technologies are recognized as a major advantage of tablet PCs over other computer technologies (Colwell, 2004). A second advantage is the permanency of instructor comments and instructional files (Colwell, 2004). Teachers can use tablet PCs to write comments during lectures that can be saved to computer files for students to review. Research implies that instructors are more in touch with their own presentations when they use tablet PCs to electronically markup their presentation materials (Colwell, 2004). The literature states that students are more inclined to take notes when note-taking becomes more engaging and interesting (Barton & Collura, 2003). Tablet PCs provide teachers with many beneficial note-taking accessories including assorted highlighters and writing utensils of varying colors and widths, symbols and equations, cut and paste capabilities, and multiple viewing options (Barton & Collura, 2003). The interactivity and immediacy of tablet PCs allows students to see their own ideas, comments, and answers become a part of the lesson (Colwell, 2004).

Microsoft provides a comprehensive catalog of entertainment, business, education, and industry specific tablet PC applications including more than 7000 files in categories such as books, games, entertainment and product reviews which are available for download at tablet PC Post (Online resource, 2004). Currently, there exist over 100 software programs that have tablet function capabilities to assist instructors in the classroom. Microsoft Windows Journal (Microsoft Corp, Redmond, WA) is a note-taking program that allows students to type notes using a keyboard or handwrite notes on the screen using an electronic pen (Godsall et al., 2005). This program makes note-taking quicker, more comfortable, and more legible than pen and paper (Barton & Collura, 2003). A second program, Snippet Tool (Microsoft Corp, Redmond, WA) can be used in conjunction with the Internet and Microsoft Windows Journal to permit users to visit Web sites containing valuable information on a certain topic. Users circle relevant text or pictures and the Snippet Tool program transfers everything to the student's tablet PC Windows Journal notes. The program can also dictate spoken words and convert them to typewritten notes or e-mail messages (Barton & Collura, 2003).

As more software becomes available, tablet PCs will become indispensable in the educational setting. Educators need to realize that the implications for science and mathematics are significant (Godsall et al., 2005). Researchers claim that technology has a great impact in the mathematics classroom and enhances the quality of assessment (D'Angelo & Wooley, 2007; MacDonald & Caverly, 1999). Traditionally, mathematics teachers have experienced difficulty writing formulas on laptops. But with simple editing programs like Math Journal (XThink Inc., Round Rock, TX), the mathematics and science learning environment becomes interactive and intuitive (Godsall et al., 2005). Hoyles & Noss (1990) suggest that digital technologies such as the tablet PC are dynamic, interactive representational forms mediated by mathematical thinking and expression (Laborde, 2007). Research indicates that student learning and student participation increases dramatically when software is used appropriately (Laborde, 2007).

Even students report that tablet PCs and their software are engaging, interactive, and beneficial (Bonds-Raacke & Raacke, 2008). The more experience a student has with technology the more likely they are to perceive technology as beneficial (Allen et al., 2002). The tablet PC keeps students' attention more easily than more traditional, lecture-centered approaches. Students stay engaged by using a tablet PC to access assignments, worksheets and quizzes. During class, students can view files from computers while learning about content for the first time or can view missed lectures after class. An important function of a tablet PC is the ability to allow students to spend extra time reading notes or hearing directions multiple times. Conversely, teachers can dictate messages, monitor students' progress, collect assignments, grade exams, and give personalized feedback (DiGiorgio, 2003; Barton & Collura, 2003). The result is personal, effective, and diverse communication between students and teachers (Kynigos & Argyris, 2004).

Though the use of tablet PCs in the classroom offers many opportunities, there are a few disadvantages. One drawback is that convertible tablet PCs can easily be broken or pieces lost because of the many hardware accessories, slot covers, and pens associated with its use. The hinge on a convertible tablet PC that allows the screen to swivel is especially prone to wear and tear depending on how sturdily it is made. The screens on tablet PCs are difficult to see under certain lighting conditions due to the multiple layers of screen protection they require (Laborde, 2007). During use, tablet PC cursors have a tendency to drift when the pen is hovering near the edges and corners of the screen causing applications to accidentally close (Colwell, 2004). Tablet PCs are not inexpensive and keeping students and teachers on the cutting edge of the electronic revolution can be a costly proposition. In addition, as with all technology, hardware and software become obsolete rapidly and are expensive to replace (Grasha & Yangarber-Hicks, 2000). Finally, training teachers to use tablet PCs as an effective component of their curriculum is difficult (Vannatta & Fordham, 2004).

Robert Ohn, former Dean of Arts and Sciences at the University of Alabama, said the amalgamation of supportive learning environments and new learning technologies will enable students to close the achievement gap in higher education (Skelly, 2007). Students will be better prepared for college and have the confidence and motivation to succeed in future academic endeavors (Skelly, 2007). A recent National Conference of

State Legislatures report found that students today use technology frequently in their daily lives and educators must learn to integrate technology into their learning environment (Skelly, 2007). Researchers claim that the best applications and uses of technology are in the process of being realized (Skelly, 2007). It is the responsibility of educators to approach technologies and new approaches to teaching with vigor for the benefit of student learning (Skelly, 2007). The challenge is set before community colleges to establish trends nationwide by encouraging teachers and administrators to use the latest technologies to improve student achievement.

Definitions of Terms

Several words or phrases in this dissertation have specific meaning particular to this research. For the purpose of this study, the following terms were defined for clarification of the research:

Community College. Community colleges are two-year colleges whose central role is to provide access to higher education by having an open door admissions policy while still maintaining high academic standards (Perin, 2006). In comparison to four-year universities, community colleges have lower tuition rates, are more numerous, are more accessible, and thus provide students who normally would not have an opportunity to attend college a chance to obtain an advanced degree (Lucas, 1996).

Developmental Education. The National Association for Developmental Education defines developmental education as “a field of practice and research within higher education with a theoretical foundation in developmental psychology and learning theory” (“National Association for Developmental Education,” 2009, para. 3). The purpose of developmental education is to promote cognitive and affective growth for postsecondary students. Developmental education affects all levels of the learning continuum and is sensitive and responsive to student differences and special needs. Programs within developmental education provide the following academic services: "academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning" (Biegel, 2009, p. 10). This research considers developmental education and remedial education to be synonymous.

Remedial Education. Remedial education is defined as "a class or activity intended to meet the needs of students who initially do not have the skills, experience, or orientation necessary to perform at a level that the institutions or instructors recognize as 'regular' for those students" (Perin, 2006, p. 339). Many scholars use the terms remedial education, developmental education, and learning support interchangeably.

Learning Support Policies. The Georgia Board of Regents for all system institutions established Learning Support policies for students who have academic deficiencies in reading, writing, and mathematics. Students who fail to demonstrate academic competencies in these areas are placed in Learning Support courses. For the two-year college in this study the following indicate that deficiencies may exist and that further testing is needed: (a) reentered SAT scores of less than 430 verbal or 400 math (or American College Testing (ACT) equivalent scores) (b) a high school grade point average of less than 2.0 and (c) College Preparatory Curriculum deficiencies in English or math.

COMPASS. (Computer Adaptive Placement Assessment and Support System) COMPASS is a college placement exam in the University System of Georgia that community colleges use to measure a student's abilities in English, reading, and mathematics. If a student fails the COMPASS exam, the student must enroll into a Learning Support course in the area in which they did not demonstrate academic proficiency. In the area of mathematics, a student must earn a score of 37 or higher to proceed to a college level mathematics course.

Learning Support Mathematics Policies. Learning Support mathematics courses are non-credit courses. For Math 99, a student must earn at least a grade of 65 or higher to be eligible to attempt to pass the Exit COMPASS exam. A student must pass the Entrance COMPASS exam with a score of 37 or higher. Students who test into Learning Support Math 99 earn an S, IP, or U. A symbol of S indicates that a student has successfully completed the academic coursework and has passed the Exit COMPASS exam. A symbol of IP indicates that a student has completed all coursework but is not prepared to proceed to the next level and must repeat the course. A student will receive a U if they stop attending class or exceed the accepted amount of absences for the course. If a student fails to exit Learning Support mathematics after twelve semester hours or after three attempts, the student is suspended from college for three years. A student may appeal for a fourth or fifth attempt under special circumstances.

Learning Support Math 99. Math 99 is a four-hour Learning Support mathematics course taught at community colleges. This course is not a college-credit course. The catalog describes the course as Intermediate Algebra: A study of real and complex numbers with special emphasis on rational expressions, rational exponents, quadratic equations, radicals, graphing, compound inequalities, complete factorization and word problems. Mathematics 97, (Elementary Algebra) or a passing score on the Entrance COMPASS exam are prerequisites for the course.

Virtual Classroom. The virtual classroom is a Web-based classroom management software system used to help colleges offer online and hybrid courses and to provide online course materials to complement traditional face-to-face courses. The virtual classroom allows faculty to provide resources to students online such as discussion boards, virtual chat, online quizzes, grades, assignments, mail, and other course materials.

Blended Learning. Blended learning is any combined learning approach that uses technology as a supplement but does not completely replace face-to-face learning (Welker & Berardino, 2005-2006). A blended course design incorporates a mixture of learning and application and includes any combination of instructional technology and instructor led teaching. A blended learning environment combines various event-based activities such as face-to-face learning, live e-learning, and self-paced learning. For this research, a blended learning environment was created by blending a traditional face-to-face class with an online classroom.

Captured Class Content. Captured class content are narrated lectures which have been recorded using a tablet PC, Mimio (9.12, Mimio Studio, Cambridge, MA) and Camtasia (4.0, TechSmith, Okemos, MI). The face-to-face classroom has a wireless projector and projection screen in place. During the class, Mimio and Camtasia are used with a tablet PC to capture narrated class lectures. Later, the narrated lectures are converted to flash movies and placed online. The entire class is captured and referred to throughout the research as captured class content.

Student Achievement. Student achievement has multiple meanings from various perspectives. However, for this research, student achievement is the mastery of Learning Support Math 99 outcomes listed in the course syllabus. Student achievement is measured by examining grades on four chapter exams and Entrance and Exit COMPASS exam scores. Successful student achievement is evident by exam grades of 70% or higher and Exit COMPASS exam scores of 37 or higher.

Tablet PC. Tablet PCs are portable computing devices that are as powerful as a modern desktop computer but do not require a keyboard (Machado, 2004). Tablet PCs are similar to laptops because they give you the portability of a PDA but have a larger screen size (Colwell, 2004). The two main categories of tablets are slates and convertibles/hybrids (Godsall et al., 2005). A slate tablet PC is one with no attached keyboard, while a convertible tablet PC is essentially a laptop computer with a swivel screen that folds onto a keyboard to create a tablet computer (Machado, 2004). Tablet PCs are powered by a special version of the Microsoft Windows operation system called Windows XP Professional Tablet PC Edition. This operating system contains features that are standard to a traditional desktop computer but is designed specifically for tablet PCs (Colwell, 2004).

Camtasia. Camtasia Studio (4.0, TechSmith, Okemos, MI) is a software program used to capture images on computer screens. The software program acts as a video camera to record the computer screen. These are recorded directly to a digital video format with high quality audio. Users can customize Camtasia to capture the entire screen, a specific window, or a user-defined region. Screen captures can be recorded with or without voice narration and annotations can be made after recording. Common uses of Camtasia are for creating software tutorials, Web site tours, narrated PowerPoint (Microsoft Corp, Redmond, WA) presentations, narrated explanations of lecture notes and homework solutions, and video and audio podcast productions. For this research, Camtasia was used to capture narrated lecture notes in mathematics courses.

Mimio. Mimio (9.12, Mimio Studio, Cambridge, MA) is software that uses a pen-tracking system to capture what is written on a whiteboard or tablet PC and saves the text to a computer. In this study, a tablet PC and Mimio were used to capture lecture notes that were projected onto a screen in Learning Support mathematics courses.

Chapter III

METHODOLOGY

Introduction

The intent of this study is to assess pedagogical practices using captured class content in a learning support mathematics classroom. The study will involve five major procedures:

1. A blended classroom will be created using an online classroom management software system to allow students to view captured class content outside of class.
2. A qualitative survey will be administered to determine the impediments to students' use of technology to review captured class content.
3. Captured class content will be recorded each class period and placed online via the assessment feature in the classroom management software.
4. Students access to captured class content will be recorded weekly using tracking features within the online classroom management software.
5. Statistical analysis will be performed to either support or reject the research hypothesis.

Research Site

The research will be conducted at a rural community college located in the southeastern portion of the U.S. The college was established in the early 1900s and offers Southern Association of Colleges and Schools (SACS) accredited Associate of Art and Associate of Science degrees in various subject areas. The two-year community college is an access institution whose main mission is to prepare students to transfer to four-year universities. An emphasis is placed on teaching rather than research to provide students with more individualized attention necessitated by the specific needs of students at an open access institution. The faculty consists of approximately 64 full-time and 55 part-time professors. The majority of faculty have a doctoral degree with the remaining having at least a master's degree.

Population

The student population at the community college is diverse with students originating from 12 different countries. The ethnic make-up of the college is: 3.2% Hispanic/Latino, 0.2% American Indian/Alaskan Native, 0.8% Asian, 37% African American, 0.1% Native Hawaiian/Pacific Islander, 57.6% Caucasian, and 2.4% Race Undeclared/Unknown. The majority of students commute from surrounding areas. Approximately 2,000 students enroll each semester in the community college with 48% of these entering into at least one Learning Support course.

The target population of the study will be all students enrolled in two sections of Learning Support Math 99 courses offered during the spring 2010 semester that will take place January through May. The target population will not be randomly selected as students will voluntarily enroll into Learning Support Math 99 choosing both the instructor and time of the class. Each will be required to take Learning Support Math 99 since they scored below the passing rate of 37 on the Entrance COMPASS exam. The low Entrance COMPASS exam scores indicate these students failed to demonstrate the knowledge of basic mathematics skills and content. Students enrolled in the courses will be diverse, including traditional and non-traditional students, as well as students from various ethnic and socioeconomic backgrounds. Demographic data will be collected at the beginning of the semester. The target population will include students from various majors and with varying career goals.

Two sections of Math 99 will be included in the study. Each section will contain a maximum of 40 students. Therefore, approximately 80 students will participate in the study which will take place over a 16-week period. One Math 99 section will meet on Mondays and Wednesdays from 1:00-2:40 p.m. and the second section will meet on Tuesdays and Thursdays from 1:00-2:40 p.m. All classes will be taught in the same classroom by the researcher. The researcher is a tenured Associate Professor of Computers and Learning Support who has been employed by the community college for thirteen years. The researcher holds a Bachelor of Science degree in Computer Information Systems, a Master of Education degree in Curriculum and Instructional Technology, and has 18 graduate hours in mathematics content.

Instrumentation and Research Design

The research design uses quantitative techniques to explore the questions identified in the study. Numerical data from chapter exam scores, Learning Support mathematics attempts, time spent reviewing captured class content, Entrance COMPASS exam scores and Exit COMPASS exam scores will be used to determine student achievement. Quantitative methods will determine if these factors affect variability in Exit COMPASS exam scores and ultimately determine which factors have a greater influence on student achievement in Learning Support mathematics courses and what impediments are apparent in reviewing captured class content.

Data Collection

Data will be collected from students in two Learning Support Math 99 sections at a community college taught by the researcher. A blended learning environment will be created using traditional face-to-face lecture and voluntary participation in the community college's virtual classroom. The online classroom is a password protected site used by the community college to provide online and hybrid courses. The virtual classroom technology can also be used as a resource in traditional lecture courses. Each section will be taught in the same classroom using traditional face-to-face lecture methods by the same instructor. Participation in the virtual classroom will be encouraged but not required.

All classes will be taught in a model classroom that includes a computer for each student, a wireless projector, and a projection screen. On the first day of class, students will review the syllabus and student learning outcomes and participate in training for the online classroom. Students will be taught how to log into the virtual classroom and navigate through the course. A virtual classroom will be designed as an additional resource for students who are enrolled in the Learning Support Math 99 courses. Students will have access to e-mail, discussions, a syllabus, and captured class content. The main purpose of the virtual classroom is to provide students with access to captured class content recorded daily. The virtual classroom will provide students with a gateway to access the online course and serve as an instrument to collect tracking information to determine the amount of time students review captured class content. All students will be informed that they can access captured class content at any time and from any location with an internet-enabled computer.

The Monday and Wednesday session of Learning Support Math 99 will be recorded using Camtasia (4.0, TechSmith, Okemos, MI) and Mimio (9.12, Mimio Studio, Cambridge, MA). Mimio will provide the ability to write lecture notes on a notebook and project example problems on a screen instead of a marker board. Using Camtasia, each class will be recorded in its entirety including all visual and auditory examples. The recording will be available to all students in both sections of the course. All examples and lecture notes will be captured using a tablet PC and converted to a flash movie. The entire class including all teacher explanations will be recorded for students to review at any time. Each class recording will be stored in a virtual folder titled with the class date and topic. For example, students who wanted to access the Monday class on January 25 would click on the folder named Jan25_Section 5.1. Virtual folders will be created for students to review class material to gain a better understanding of the content presented in the face-to-face class and to present the material in a way that allows the researcher to track the amount of time students spend reviewing captured class content.

Several limitations of the online classroom management software have to be addressed in order to correctly track the amount of time students actually spend reviewing class content. The first limitation deals with a security feature standard within the software which causes the program to time-out after 20 minutes of inactivity. The online classroom management software only recognizes a student as being active if they are actually clicking on folders or tools located within the virtual classroom. Because of this feature, if a student watches the class recording for any amount of time over 20 minutes, the program will automatically time-out and the researcher would not be able to determine the amount of time the student actually spent reviewing captured class content.

To overcome this limitation, each class recording will be divided into approximately 15-minute segments to prevent the program from timing out. Therefore, a folder will be created for each day the class meets. Each folder will contain the contents of an entire class divided into approximately five, 15-minute sessions. A function within the online classroom management software requires that an assessment be provided after each 15-minute session is viewed. For this study, students will be asked an irrelevant multiple choice question in which they simply have to identify the class session in which they are enrolled, either a) M/W 1:00-2:40 p.m. or b) T/R 1:00-2:40 p.m. This allows students to comply with the requirements of the software without receiving any additional instruction or practice which may provide an unfair advantage to students who participate in the virtual classroom. Each assessment will be set up as a self-test which will not be graded and will not count toward a student's overall course grade. Students can view the assessment as many times as they choose.

Each student's performance report will be reviewed at the end of each week. Using Microsoft Excel (Microsoft Corp, Redmond, WA) each student's name will be entered into a spreadsheet. Two days after each class, tracking statistics will be recorded for each student. For each class, student information will be recorded including how much time the student spent reviewing each class and which assessments were completed, indicating which 15-minute sessions were observed. Additional information including Entrance and Exit COMPASS exam scores and chapter exam scores will be recorded.

On the first class day of every other week for the entire semester, both Learning Support Math 99 classes will be administered a survey (see Appendix B) to determine why they may have chosen not to participate in the virtual classroom. The purpose of the survey is to identify any impediments that may prevent students from reviewing the captured class content. Students will be allotted a couple of minutes at the beginning of each class to provide their responses. All absent students will be required to complete the survey when they return to class.

Several sets of exam scores will be collected to determine student achievement. Each student will complete four chapter exams in Math 99. For each exam, tracking statistics within the online classroom management software will be analyzed to determine if students who review captured class content achieve higher exam scores than students who do not review captured class content.

Each student enrolled into Learning Support Math 99 will be required to take an entry-level university system exam called COMPASS. At the end of the semester, students with a course average of 65 or higher will retake the COMPASS exam to attempt to exit Learning Support mathematics. Analyses will be conducted on students' Entrance and Exit COMPASS exam scores to determine achievement between students who reviewed captured class content and students who did not review any online content. Further examination will be conducted to determine if the amount of time spent reviewing captured class content affects student Exit COMPASS exam scores.

Data Analysis

Regression analysis will be used to identify the existence of causal relationships among variables in the study. Multivariate methods will be used to describe and test the existence of predictable relationships among the dependent and independent variables in the study. The dependent variable is identified as Exit COMPASS exam scores and the independent variables are Entrance COMPASS exam scores, chapter exam scores, Learning Support mathematics attempts, and time spent reviewing captured class content. The Statistical Package for the Social Sciences (SPSS) (18.0, IBM, Armonk, NY) software program will be used to analyze the research data.

Using SPSS, the regression equation will be determined to identify the intercept and regression coefficients. The Pearson Product Moment Correlation (Pearson r) will be used for the sample to reflect the degree to which the variables are related. A stepwise regression will be used to compute the level of contribution of the independent variables to the hypothesized prediction. This research process will determine which factors have the greatest impact on Exit COMPASS exam scores and ultimately student achievement. Because multiple regression methods can be adversely affected by outliers, all extreme cases will be removed from the study for validation. For this study an alpha level of .05 will be used for reporting statistically significant findings.

Ethical Considerations

An Institutional Review Board (IRB) application through Valdosta State University was completed, submitted, and approved prior to data collection (see Appendix C). An approval letter from the President of the two-year college involved in the study was included permitting the researcher to collect data during the spring 2010 semester (see Appendix D). A pilot course was set up in the fall 2009 semester to test the blended learning environment. Several students, faculty and Instructional Technology specialists were asked to explore the blended learning environment for availability, ease of use, and course content. Comments and suggestions to improve the blended learning environment were implemented into the course before the beginning of the spring 2010 semester. In this research, a normal educational setting was observed and not altered in any way to affect any subjects involved in the study.

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APPENDIX B: Math 99 Blended Learning Classroom Survey

Week _______

Math 99 Blended Learning Classroom Survey

Name: ___________________ Circle Your Class Days: M/W or T/R

1. Did you participate in the blended learning classroom by reviewing your class recordings online during the previous week?
   Circle : YES or NO

2. If you answered NO, please check all reasons that apply:
   _____ I am not comfortable with technology
   _____I do not have internet access at home
   _____I did not have enough free time
   _____I understood the concepts in class
   _____I have too many family or work responsibilities
   _____Other

   If you listed Other, please give specific reasons:
   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

APPENDIX C: Institutional Review Board Approval

Institutional Review Board (IRB)
for the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

PROTOCOL NUMBER: IRB-02443-2009 **INVESTIGATOR:** Cindi Kirkland

PROJECT TITLE: Does using technology to capture class content increase student achievement?

DETERMINATION:

☑ This research protocol is exempt from Institutional Review Board oversight under Exemption Category(ies) 1. You may begin your study immediately. If the nature of the research project changes such that exemption criteria may no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research.

☐ Exemption of this research protocol from Institutional Review Board oversight is pending. You may **not** begin your research until you have addressed the following concerns/questions and the IRB has formally notified you of exemption. You may send your responses to irb@valdosta.edu.

ADDITIONAL COMMENTS/SUGGESTIONS:

Although not a requirement for exemption, the following suggestions are offered by the IRB Administrator to enhance the protection of participants and/or strengthen the research proposal. If you make any of these suggested changes to your protocol, please submit revisions so that IRB has a complete protocol on file.

Barbara H. Gray Date:12/02/09 8/3/12 ***Thank you for submitting an IRB application.***

Barbara H. Gray, IRB Administrator ***Please direct questions to irb@valdosta.edu or 229-259-5045.***

cc: Dean – Dr. Phil Gunter
Advisor – Dr. Brian Gerber

Form Revised: 09.02.2009

APPENDIX D: Permission Letter

South Georgia College

A Degree of Difference

Office of Academic Affairs

COPY

November 20, 2009

Institutional Review Board
Valdosta State University
1500 North Patterson Street
Valdosta, GA 31698

To Whom It May Concern:

Ms. Cindi Kirkland, a graduate student in your Department of Curriculum and Instruction, has requested a letter of support for her doctoral project, "Does Using Technology to Capture Class Content Increase Achievement?" I have reviewed her Application for Use of Human Participants in Research, as well as her project draft chapter on methodology, and I have discussed her project with her. As a result, I offer my wholehearted support of her project.

If I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Carl B. McDonald, Ph.D.
Vice President for Academic Affairs

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