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The Impact of Technology on Community College Students' Success in Remedial/Developmental Mathematics

Mary M. Bendickson
University of South Florida

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The Impact of Technology on Community College Students'
Success in Remedial/Developmental Mathematics

by

Mary M. Bendickson

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Education
Department of Adult, Career, and Higher Education
College of Education
University of South Florida

Major Professor: Jan M. Ignash, Ph.D.
Jeffrey D. Kromrey, Ph.D.
Kathleen M. Moore, Ph.D.
William H. Young, Ed.D.

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pre-collegiate, post-secondary

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Dedication

I dedicate this work to my mother and father, Edwina and John Griffin, for instilling in me a love for learning; to my husband, Jim, for unwavering support; and to my children, Ginny, Julie and Philip, who have afforded me the time to pursue this endeavor as I spent countless hours as researcher instead of mother. To my grandsons, Jared and Jack, I challenge you to continue this legacy. I also dedicate this work to my friends, who have listened to me and encouraged my efforts.

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Table of Contents

List of Tables	iii
List of Figures	v
Abstract	vi
Chapter One Introduction and Background	1
Statement of the Problem	3
Significance of the Problem	5
Purpose	9
Research Questions	10
Hypotheses	11
Definition of Terms	12
Limitations and delimitations	18
Summary	21
Chapter Two Review of the Literature	23
Curriculum	24
Studies by the Center for the Study of Community Colleges	24
Florida Curriculum Study	27
Remedial/Developmental Education	30
Teaching Approaches	31
Student Success	33
Technology in Remedial/Developmental Courses	35
Instructional Technology	37
Summary and Synthesis of Literature Review	43
Chapter Three Method	45
Introduction	45
Research Design	48
Population	49
Instrumentation/Measures	49
Procedures	51
Data analysis	53
Summary	54

Chapter Four Results.....	55
Summary of Data Collection	55
Data Analysis: Quantitative design.....	62
Research Question 1	62
Research Question 2	76
Research Question 3	78
Research Question 4	88
Summary	90
Chapter Five Summary of Findings, Conclusions, and Implications for Practice and Research	92
Method summary	93
Summary of findings.....	93
Conclusions.....	98
Limitations	99
Implications for practice	99
State level implications.....	100
Institutional Implications	101
Implications for research.....	105
Summary	107
References.....	109
Appendices.....	117
Appendix A: Configuration of Remedial/Developmental Math Sequence	118
Appendix B: Mathematics Courses Offered in Fall 2002 in Florida Community Colleges	119
Appendix C. Coding Decision Rules	121
About the Author	End Page

List of Tables

Table 1	CSCC Curriculum studies	25
Table 2	Remedial/developmental course portion of all math courses in 2000	29
Table 3	Sections of all remedial/developmental math courses offered in each delivery format by institutional size	64
Table 4	Distribution of delivery formats in all remedial/ developmental math courses	65
Table 5	Proportion of all remedial/developmental math sections by delivery format	66
Table 6	Distribution of all remedial/developmental math sections by delivery format and course.....	67
Table 7	Proportion of gatekeeper courses compared to all remedial/ developmental math courses	71
Table 8	Percentages of all remedial/developmental math courses compared to gatekeeper remedial/developmental math courses by delivery format and institutional size.....	73
Table 9	Number of gatekeeper remedial/developmental math sections by institutional size	74
Table 10	Average class size of gatekeeper remedial/developmental math sections by delivery format.....	76
Table 11	Analysis of passing rates in gatekeeper sections of remedial/ developmental math by delivery format	77
Table 12	Analysis of variance summary table - Student success and delivery format in gatekeeper remedial/ developmental math sections	78

Table 13	Analysis of covariance summary table - delivery format while controlling for CPT score in gatekeeper remedial/developmental math sections	79
Table 14	Mean CPT score of gatekeeper remedial/developmental math by delivery method	80
Table 15	Mean placement test scores for each delivery format.....	84
Table 16	Pass rates in sections when faculty members taught in multiple delivery formats.....	89

List of Figures

Figure 1	Average class size in gatekeeper remedial/developmental math classes	75
Figure 2	Comparison between CPT score and pass rate by delivery method.....	81
Figure 3	CPT score and pass rates by delivery format for all gatekeeper remedial/developmental math sections.....	83
Figure 4	Distribution of passing rates in three delivery formats.....	84
Figure 5	Correlation between CPT score and pass rate for traditional delivery sections of all gatekeeper remedial/developmental math	85
Figure 6	Correlation between CPT score and pass rate for hybrid delivery sections of all gatekeeper remedial/developmental math	86
Figure 7	Correlation between CPT score and pass rate for computer-based delivery sections of all gatekeeper remedial/developmental math	87

The Impact of Technology on Community College Students'

Success in Remedial/Developmental Mathematics

Mary Bendickson

ABSTRACT

Increased institutional accountability and fiscal constraints coupled with most community college students being required to take at least one remedial/developmental course indicates a need to find the best way to deliver these classes. Institutions are expanding alternate delivery formats to meet student expectations. Is using technology best for students in remedial/developmental courses?

This study investigated effectiveness of technology-assisted instruction for remedial/developmental math in Florida community colleges. Technology has emerged as potentially enhancing student success; however, it is expensive. If research shows that students benefit from technology in remedial/developmental courses, then funds spent to provide instruction through technology are validated. However, if research does not show remedial/developmental courses with a technology component are more effective than courses delivered traditionally, then spending funds for technology in those courses becomes questionable.

The research questions for this study asked whether the delivery format of gatekeeper remedial/developmental math courses varied by institutional size. Was there a relationship between student success and technology-assisted delivery of "gatekeeper" remedial/developmental math classes? The study asked if such a relationship existed

when controlling for placement test scores. To answer these questions, the research compared student success rates in three delivery formats--traditional, hybrid, and computer-based.

Results showed that small institutions favored traditional delivery of remedial/developmental math. Medium institutions offered traditional and hybrid delivery in similar proportions while larger institutions favored hybrid delivery. Results also showed that students in traditional delivery sections were likely to be just as successful, or slightly more successful, than students in hybrid and computer-based delivery courses. Students with higher placement test scores in remedial/developmental math were clearly more successful in courses delivered via traditional instruction.

Implications from this study suggest that the introduction of a technology component to remedial/developmental math courses does not seem to be more effective in helping students successfully pass remedial/developmental math classes. If an institution does not have funds to invest in technology for remedial/developmental math students, which may be especially true for smaller institutions, no harm is done in delivering instruction in remedial/developmental math via traditional methods. Students may actually benefit from the traditional delivery format in remedial/developmental math courses.

Chapter One

Introduction and Background

Community colleges are unique institutions in the American system of higher education primarily because of the comprehensiveness of the curriculum. The community college curriculum must reflect the needs of students and prepare them for their goals. Students who attend community colleges have various goals including preparation for transfer to a four-year institution, education for employment, or improvement of skills not mastered in high school. The curriculum consists of transfer, general education, vocational, and developmental courses (Schuyler, 1999).

While Florida's community colleges have a large component of transfer courses, they also provide the first step into the college world for many students in *remedial/developmental* (defined on p. 17) courses. Students who score high enough on the *college level placement test* (defined on p. 12) may take courses at college level, but those who do not score high enough on the test may not take courses at the college level. Since almost 60% of community college students in Florida are required to take at least one remedial/developmental course (Windham, ¶ 4), Florida community colleges must provide effective remedial/developmental programs.

The Florida legislature has charged community colleges with sole responsibility for remediation: "Public postsecondary educational institution students who have been

identified as requiring additional preparation pursuant to subsection (1) shall enroll in college-preparatory or other adult education pursuant to s. 1004.93 in community colleges to develop needed college-entry skills” (Assessment and Accountability, 2002, Chapter 1008, 4a). Beyond the fact that Florida’s statutory directive places the responsibility for remediation directly on the community colleges in Florida, placement of remediation within community colleges throughout the United States is common. The 1995 National Center for Education Statistics (NCES) study found that state policies tend to name community colleges as the preferred providers of remediation (USDE, 1995).

The Florida statutory directive establishes postsecondary remediation as a core part of the community college mission with little prescriptive definition given to how remediation is to be provided. The lack of specific direction about the remedial/developmental program has produced a wide variety of course offerings in that portion of the curriculum. A study of the math courses offered at the 28 Florida community colleges shows the extent of math remediation needed. A quarter of the Fall 2000 Florida community college math course sections (Bendickson, 2000) were remedial/developmental math classes offered in several formats. The community colleges must accommodate a large portion of students in remedial/developmental courses while operating with diminishing resources. In the academic year 2000-01, the state funded \$4752 per FTE compared to \$4340 per FTE in 2003-04 (Shugart, 2004). This is but one example of the diminishing resources. The combination of decreased funding and responsibility for remediation in the community colleges creates a necessity to maximize cost-effectiveness while still providing the needed remediation with maximum student success.

Technology has emerged as one possibility to enhance student success; however, technology is expensive. If research shows that students benefit from *technology* (defined on p. 17) in remedial/developmental courses, then the funds spent to provide instruction through technology will be well spent. However, if research does not show remedial/developmental courses delivered with a technology component more effective than courses delivered through traditional instruction, then spending funds for technology in remedial/developmental courses becomes questionable. Although there are multiple factors that influence the effectiveness of any instructional method, technology in instruction is one factor that can be controlled. The purpose of this research is to examine the effectiveness, as measured by student success, of technology-assisted instruction for remedial/developmental math courses in Florida community colleges.

Statement of the Problem

In addition to the fact that community colleges bear the responsibility of remediation in Florida, most Floridians believe that high school graduates are not academically prepared to enter college. The public expects the community colleges to resolve this problem (Immerwahr, 2000). The public's expectation that remediation should be offered in the community colleges matches the legislature's assignment of remediation to the community colleges. Because Florida's community colleges are responsible for providing remediation at the college level, remedial/developmental math courses are offered at each of the state's 28 community colleges.

Two particular developments have occurred in Florida recently that make it necessary for community colleges to pay attention to remedial/developmental programs --

one legislative and the other fiscal. The first development is a legislative development and has far-reaching effects on the entire Florida public education system. The implementation of a seamless K-20 education system in Florida with the passage of the Florida Education Governance Reorganization Act of 2000 (House Bill 2263, 2000) changed the educational governance structure in Florida. The Act has focused attention on the missions of each segment of education in the state. While the K-12 schools and four-year colleges and universities have clarity of mission (at least in the public's mind), the community colleges must carve a unique and secure niche in the educational landscape. The Florida Reorganization Act of 2000 established the newly created Florida Board of Education as the sole governing body for public education in Florida. The new K-20 structure also empowered the Board of Education to set standards and to coordinate with private education in the state. The Board of Regents and the State Board of Community Colleges were dissolved under the Florida Reorganization Act of 2000, placing university and community college governance at the local institutional level with Boards of Trustees. Although Florida statute broadly assigns guidelines delineating the missions for universities, community colleges, and K-12 schools, each level now has more latitude in providing instruction and services previously governed at the state agency level. This freedom has led to a perception of "mission squeeze" in community colleges. However, one area remains inviolate for community colleges. By statute (FL Stat. 1008) the responsibility for remedial instruction and services is assigned to the community colleges.

The second development is a fiscal development concerning fiscal implications as a reduction in state dollars per student. Although the total state budget for community

colleges has recently shown an increase, the effect of enrollment growth actually produced a drop in dollars funded per student. The current state funding levels would require more than \$100 million to restore funding levels to the levels of two years ago (E. Cisek, Vice Chancellor of the Florida Department of Education, Community College Office of Information and Finance, personal communication, March 31, 2003). The apparent increase in dollars decreased the sense of urgency in state funding. Newman (2003) painted a different picture. "The cuts in state appropriations are likely to do real harm to higher education." Attention must be given to providing cost-effective delivery for remediation because funding for higher education has not consistently kept pace with enrollment growth.

This study will explore various ways that remedial/developmental math is offered in Florida's community colleges and analyze one factor that may be a realistic predictor of student success -- delivery format. The researcher expects to find courses delivered completely through technology; traditional in-class, lecture-based courses; and a hybrid of the two delivery methods. What delivery method for remedial/developmental math courses provides the best opportunity for success to the students who enroll in the courses?

Significance of the Problem

A central mission of the community college is to provide remediation for students who are not prepared for college level courses. All expenditures in higher education must be justified because of the focus on quality, increased accountability, and funding constraints. Declining funding and an assignment to provide remedial/developmental

courses make it critical to know how the courses should be structured to best serve both the institution and the student.

Due to Florida's legislative directive, there are significant portions of the community college curriculum dedicated to remedial/developmental courses. In Fall 2000, more than 10% of the total community college credit curriculum in Florida was remedial/developmental course sections. Since the state does not prescribe how remedial/developmental math is to be offered, there is no common structure of those courses within the 28 Florida community colleges.

Each of the 28 community colleges has its variation of the full remedial/developmental track. A typical track for remedial/developmental courses in Florida community colleges includes MAT 0002, commonly called College Preparatory Math, and MAT 0024, commonly called College Preparatory Algebra. The MAT 0002 course is also offered as MAT 0002C and MAT 0024 as MAT 0024C; the C indicates that it is a combination course -- part lecture and part laboratory formats. Without the C designation, MAT 0024 is a lecture course. There are some sections identified in the printed schedules as C courses without any specification about how the laboratory portion of the class would be conducted. There are also combinations of these two courses in which arithmetic and algebra are in one course often called Integrated Math and typically identified as MAT 0012, although other numbers may be used. MAT 0024, College Preparatory Algebra, is often the *gatekeeper* (defined on p. 14) remedial/developmental course because it concludes with the student taking the state exit exam. Regardless of the remedial/developmental track at a given institution, passing the state exit exam is the

single common requirement for a student to progress from remedial/developmental courses into *college level math* (defined on p. 12) courses.

A question that flows from the extent to which technology is used in remedial/developmental math relates to the size of the institution. Is it accurate to assume that larger colleges offer more sections in a greater variety of formats? Does the size of the institution affect the variety of remedial/developmental courses that it offers? Examination of the curriculum will likely reflect lecture-based, technology-assisted, and hybrid courses. It appears logical to assume that a larger institution will offer more sections, but do more sections translate to greater variety in format or simply more instances of a course in the same delivery format? Does greater variety of delivery formats translate into improved student success? These results are important only if the delivery formats are found to be good predictors of student success. If delivery formats are good predictors of student success and the research shows that the larger institutions offer more sections in greater variety, does the conclusion follow that students in smaller colleges are at a disadvantage? The results may be informative to smaller colleges in their spending decisions and may also provide leverage for the smaller institutions to pursue increased funding.

To know if particular students seem to be disadvantaged, it is important to provide measurable data, rather than anecdotal comments, when faculty and administrators are making decisions about the delivery format for remedial/developmental classes. While knowledge of any advantage or disadvantage due to institutional size does not provide clear or easy answers, that knowledge may be valuable in choosing how to present particular classes at institutions of different sizes.

Once taught in traditional classroom lecture format, remedial/developmental math courses began to change with the increase of technology in the classroom. *Computer-assisted courses, hybrid courses, modular format courses, and online courses* (defined on pp. 12-15) have added to the element of change. Active promotion of academic software to community colleges by vendors has produced a plethora of remedial/developmental math courses being taught in a computer-aided format. Colleges might not question the assertions of the vendors or seek out research that shows whether or not the academic software formats are successful and beneficial to the students. Colleges may also assume that such research has been done without taking the time to investigate a particular program. Developmental education programs must be evaluated to correctly assess the effectiveness of the program. Do the community colleges in Florida weigh the student outcomes in making the choices to use technology in remedial/developmental math classes?

Although many educators have expected a transformation in education with the available burgeoning technology, there is not sufficient information readily available to support the difficult decisions that institutions face in choosing between delivery formats (Gilbert, 1996, pp. 412-413). Boylan (1999) describes the need for teachers in good remedial/developmental programs to emphasize outcomes. Each institution must rely on recommendations from faculty and administrators within its own community to choose whether or not to incorporate technology and if so, how to best incorporate technology into its classrooms.

Each of these reasons (size, cost, or lack of research on effectiveness) is sufficient alone to require a serious look at the various formats in which remedial/developmental

math is offered to community college students. It is imperative that community college administrators and math faculty members have a firm understanding of expected success rates among the different instructional delivery formats for remedial/developmental math courses when making decisions on the delivery format to be used. Since there is such variety in the delivery of remedial/developmental math courses offered in Florida community colleges, this study will focus on one of the facets of those course offerings: What is the most effective delivery format in which to offer remedial/developmental courses? Questions driving this study center on assessing the effectiveness of remedial/developmental math courses offered through technology-assisted delivery formats.

Purpose

The purposes of this study are (1) to explore the range of remedial/developmental math in Florida's community colleges and any relationship that may exist between community college size and the variety of remedial/developmental math classes offered, (2) to explore the relationship that may exist between student success and the delivery format of gatekeeper remedial/developmental courses, (3) to explore the relationship that may exist between student success and the delivery format of gatekeeper remedial/developmental courses while controlling for initial placement test scores, and (4) to explore the relationship that may exist between student success and the delivery format of the gatekeeper remedial/developmental courses while controlling for instructor influence. The variables of initial placement test score and instructor influence will be included in this study because they may influence the chances of student success and can be isolated to eliminate any influence on student success.

The reductions in state funding coupled with an increased focus on student retention and success provide the impetus for pursuing these questions. It is important from a student services perspective to have information on student success and retention in remedial/developmental courses. It is also important for academic administrators and instructors to have information on which delivery formats provide the best combination of cost effectiveness with the highest possible student success. This is not to say that selection of the delivery format is totally a financial question, but the academic administrator should be aware of comparative data when choosing the delivery formats for classes. While online and computer-based courses may seem to be at the cutting edge of technology, they should not be employed for that reason alone. Any format should be used only if it is effective for students and within the fiscal constraints of the college.

Research questions. To support this research, the specific research questions are:

- 1) What remedial/developmental math courses are offered in Florida's 28 community colleges? Does the instructional delivery format of the remedial/developmental courses offered in Florida's 28 community colleges vary by institutional size?
- 2) Is there a relationship between *student success* (defined on p. 17) and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges?
- 3) Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in

Florida community colleges while controlling for initial placement test scores?

- 4) Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges while controlling for instructor influence?

Hypotheses. The researcher expects to find the following results to the research questions in this study:

- 1) There is greater variety in the instructional delivery formats of remedial/developmental math offered by institution size in Florida community colleges.
- 2) There is a significant difference at the .05 level in the student success rate relative to the variety of formats of remedial/developmental math.
- 3) There is a significant difference at the .05 level in the student success rate relative to the variety of formats of remedial/developmental math while controlling for initial placement test scores.
- 4) There is a significant difference at the .05 level in the student success rate relative to the variety of formats of remedial/developmental math while controlling for instructor influence.

Definition of terms. Definitions for terms used throughout this study are as follow:

- 1) *Academic software* -- Any computer software program designed to support and/or deliver academic instruction is included in the academic software category. The variety of academic software includes programs that are designed for use with college level classes as well as remedial/developmental math, reading, and writing.
- 2) *Accuplacer* -- ACCUPLACER is a set of eight multiple-choice computerized placement tests in a range of English and math subjects designed to determine whether or not a student has the skills to be successful in college level courses (Accuplacer, 2003). The tests were developed with the help of faculty committees and are produced by The College Entrance Examination Board.
- 3) *College level mathematics* -- College level mathematics includes any math course that is designed to be transferable to other institutions and exists in the statewide list of transferable courses. Transferability is verified by the statewide common course numbering list. Common course names and prefixes for these math courses are shown in Appendix B.
- 4) *College level placement test* -- A common placement test has been used at all 28 community colleges since July 1995 and is required by Florida State Statute 240.117 (4)(a). The Florida College Entry-Level Placement Test (FCELPT) is the Computerized Placement Test (CPT) that is part of the ACCUPLACER system. Written versions are available for institutions that do not have computer

testing laboratories available. There is a scale for conversion of scores from other standardized tests that are sometimes used for college placement.

- 5) *Computer-based instruction* -- A course that is coded as computer-based instruction meets in a computer lab or other classroom equipped with computers and utilizes a commercial software package with a tutorial format that students may use in a self-paced timetable. Individual instructors may incorporate mini-lectures to the class as needed, or provide one-on-one instruction to students as needed, but the main mode of instructional delivery is via the computer. The primary distinction in a computer-based course is the role of the faculty member. The role of the faculty member assigned to a computer-assisted course is one of management rather than whole class instruction. A course considered to be in the category of computer-assisted instruction is not the same course as one offered as independent study. Independent study sections are not included in this study.
- 6) *Credit courses* -- Credit courses are those that award credit, including both courses that are designed to be transferable and courses that carry only institutional credit and are not designed to be transferable.
- 7) *Developmental courses* -- Based upon a holistic approach that includes all forms of learning assistance, counseling, academic advisement and coursework, developmental courses provide instruction in the discipline as well as motivational and attitudinal aspects to enhance student success in college. These courses include traditional academic disciplines such as reading, writing, and math as well as courses in life skills -- college success or study skills.

- 8) *Gatekeeper course* -- A gatekeeper course is the most advanced remedial/developmental course in each community college. The gatekeeper course contains the state exit exam.
- 9) *Hybrid integrated course* -- A hybrid course is one that combines traditional lecture-based instruction with computer-assisted instruction. The student may have choices of how and when to complete the assignments or the instructor may prescribe the parameters of acceptable methods and/or timetables for completion of assignments. Additionally, a course will be coded as hybrid if lecture and lab components are listed as co-requisite. The lecture and lab may be listed in the printed schedule as separate sections. These separate sections will not be coded separately, but as a hybrid course since both portions are required in the same semester.
- 10) *Independent study* -- An independent study course is one in which the instructor allows the student to choose from options to complete course requirements. These options are designed by the instructor. Independent study courses do not have specific meeting times or places.
- 11) *MAT 0002* -- The Florida statewide common course numbering office lists the course content for MAT 0002 as including “addition, subtraction, multiplication and division of whole numbers; fractions; decimals; and percents” (Florida DOE, Statewide Course Numbering System section).
- 12) *MAT 0024* -- The content of this course includes “language and operation on sets, operations on signed numbers, solving linear equations and inequalities in one variable, adding, subtracting, and multiplying polynomials, factoring: greatest

common factor, differences of squares, trinomials, and by grouping, applications of factoring: solving equations and reducing algebraic fractions, integer exponents: definitions, properties, and simplifying expressions with negative and zero exponents, simplifying, multiplying, adding and subtracting square roots of monomial expressions, graphing ordered pairs and lines; determining intercepts of lines and applications of the above topics” (Florida DOE, Statewide Course Numbering System section).

- 13) *Modular course* -- A modular course is one that allows a student to progress through the complete remedial/developmental math sequence without obstacles created by time-on-task demands or separate course levels. The instruction is likely organized into self-paced units or modules that students complete at their own pace during designated class days, times, and meeting rooms. Time constraints may require that one semester is completed before advancing to the next step in the remedial/developmental math sequence.
- 14) *Online course* -- An online course is one that may be completed solely through use of the worldwide Web. These courses may be based on a variety of distance learning packages or may be instructor-designed courses.
- 15) *Preparatory math courses* -- Preparatory math courses are those math courses that are remedial or developmental. These courses are not generally transferable between institutions. The terms remedial, developmental, and preparatory math are often used interchangeably although there are distinctions between the terms. All remedial/developmental math courses taught in Florida community colleges are identified in Appendix B.

- 16) *Remedial courses* -- Using the medical paradigm, the term remedial implies a need to improve basic skills due to a deficit or lacking from prior educational experiences.
- 17) *Remedial/developmental courses* -- Often used interchangeably, the many terms describing pre-collegiate courses are distinctive. Recognizing philosophical differences and elements of validity that exist between the terms remedial and developmental (Ignash, 1997, p. 3), this study will use the hybrid term remedial/developmental to represent those pre-collegiate courses. Remedial is a term often used in academic circles to describe student deficiencies, implying that something needs to be fixed (Cazarra, 1999). Remedial education only focuses on one facet of the individual student. Conversely, a holistic approach identifies these same courses as developmental. Developmental education addresses academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning. “Developmental education includes, but is not limited to all forms of learning assistance . . . counseling . . . academic advisement . . . and coursework (National Association for Developmental Education, Definition section, ¶3). These distinctions highlight the one-dimensional approach to remedial education compared to the holistic approach to developmental education.
- 18) *Statewide exit exam* -- The statewide exit exam is written by a statewide group of instructors. Two forms of the test are written and each institution has the freedom to create its own test from within the items provided. The institutions are given

the number of items to be tested from each skill area and the two forms have about 30% overlap. This test is rewritten annually, but the tests used in any particular year are made from the same bank of questions. The state exit exam is test is not normed (K. Fearon, Office of Assessment and School Performance, Florida Board of Education, personal communication, March 31, 2003).

- 19) *Student success (defined for this study)* -- Although many other factors can be used to define student success, for this study, completion of the remedial/developmental math sequence and passing the statewide exit exam constitutes student success. It is important to use percentages of students passing the exit exam as the measure of student success, rather than measuring student success by section because all sections are not the same size. Although there are differences in the 28 community colleges, students often must have a certain grade at the time of the final exam in order to take the exam. Each institution sets its required score for the student to be eligible to take the state exit exam. The statewide exit exam is often given as the final exam for the gatekeeper course, typically MAT 0024. A student must be successful in two steps in order to achieve success. The student must be eligible to take the state exit exam by the standards set by the institution and must pass then the exam in order to enroll in college level courses.
- 20) *Technology* --Any computer-assisted instruction is considered to have a technology component. The technology component is often based on a particular academic software program.

- 21) *Traditional course* -- Any course offered at regularly scheduled times including an instructor and students without containing a significant technology component is considered a traditional course.

Limitations and delimitations

A common measure of student success is a necessary limitation in this study. The only common thread among all 28 community colleges is the state exit exam because the Florida community colleges vary in both the number of courses required to exit the remedial/developmental sequence and in the nomenclature of the final course in the sequence.

A second limitation of this study is the exclusion of non-credit remedial/developmental courses. Non-credit refresher math courses may be available in continuing education departments of the colleges and may also be available through private enterprise. The materials covered by each of these other providers may duplicate the math presented in remedial/developmental math courses and thus may also have an effect on student success.

A delimitation that may affect the results of the exam revolves around the administration of the exit exam. Each institution determines its own policies of administering, grading, and requiring a certain score in order to pass the exam. The state requires that each student earns a passing score on the exit exam, but does not define that passing score (K. Fearon, personal communication, March 31, 2003).

In the memorandum dated May 25th of 2002 and issued from the Division of Community Colleges, the specifications for passing the state exit exam are described.

Thomas Fisher, administrator of Assessment and Evaluation Services and Theresa Klebacha, Executive Vice Chancellor for Student and Academic Success, describe the requirements:

According to law, students must pass both the college remedial/developmental course and an Exit Test. As determined by the Council on Instructional Affairs, all Florida community colleges and Florida A & M University are required to administer the Florida College Basic Skills Exit Test as of the fall semester of 1999. The Exit Test is to be administered following the completion of the highest level of remedial/developmental coursework and prior to enrollment in college credit English or mathematics courses that apply toward degree requirements. (Fisher & Klebacha, 2002)

Further, the memorandum allows for institutions to use the test forms provided by the state or to develop their own tests following a blueprint provided by the state using items from the state test bank. For instance, the blueprint calls for a quantity of items of a given type, but does not provide specific items to be used on the exam (Fisher & Klebacha, 2002).

A delimitation to be acknowledged is a caveat to the definition of student success. Each institution has the responsibility to set the standard to determine student eligibility to take the state exit exam. For instance, College A might require that a student have a class average of at least 60 to qualify to take the state exit exam while College B requires that a student's class average be at least 70 to take the same test. This is relevant information as it relates to student retention rates in remedial/developmental courses. For example, a student in College A with a class average of 65 could pass the exam and

progress to college-level math by passing the state exit exam, while a student at College B with the same class average would not be able to take the exit exam. Simply being ineligible to take the state exit exam does not necessarily mean that the student at College B would not be able to pass the state exit exam. If a student in College B could pass the state exit exam and is denied the opportunity to take it, that institutional standard could be the only insurmountable obstacle for that student. In this example, the student in College B might not return to try again while the student in College A could progress through a full degree program.

Another delimitation relates to the length of time that a particular software product is used at an institution and the method in which it is used. If College A has been using a particular product for several years and College B is using the same product for the first year, there might be differences in the degree of success that relate primarily to simply knowing the product. Also, if College A uses the product as the vendor intends for it to be used and if College B devises an alternate use of the same product, there might be differences in the effectiveness that relate to the differences in implementation. Either example could appear to produce greater success in College A when the reality is that the increased success is actually due to one of these factors instead.

The fact that students do not always have a free choice in the delivery format of their section is a delimitation that would be difficult to measure. While it may be true that students tend to self-select the format that best suits their individual strengths, true free choice would require that all institutions offer each delivery format and have unlimited seats in each delivery format. The large number of remedial/developmental math sections

reviewed will minimize the effect of the moderating variables, instructor influence and initial placement test scores.

Another major delimitation is geographic and situational. Each student's available course choices are a factor of which institution serves his or her home district. Beyond the geographic delimitation, the only students at each institution who truly have a free selection in the formats that an institution offers are those who register early enough that all delivery formats are available. Students may choose a class by the time/day it is offered or may even choose on the basis of a friend's selection rather than making choices based upon delivery format. Additionally, the students are limited by the scope of choices offered.

Summary

The purposes of this study are (1) to explore the remedial/developmental math offered in Florida's 28 community colleges with particular attention given to comparisons of institutional size and available instructional delivery formats, (2) to explore the relationship that may exist between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges and student success, (3) to explore the relationship that may exist between student success and the delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges while controlling for initial placement test scores and (4) to explore the relationship that may exist between student success and the delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges while controlling for instructor influence.

Chapter II reviews the literature relevant to this study and focuses on three areas: curriculum theory, theoretical background for remedial/developmental education in colleges and universities, and instructional delivery formats. The research focusing on each of these areas will be examined and compared.

Chapter III discusses the research questions and hypotheses, target population, participants, appropriate measures and procedures, and methods of data analyses of the study.

Chapter Two

Review of the Literature

In order to effectively study the remedial/developmental mathematics education at the community college level with examination of the differences between delivery formats, the researcher must explore the literature in three areas: curriculum, remedial/developmental education, and instructional technology. Research on the first area, curriculum, is valuable for comparison between the curriculum of an institution and how well remedial/developmental classes provide the needed skill enhancements for students. Research on the literature in the second area, remedial/developmental education, describes the underlying philosophy that affects the delivery of effective remedial/developmental education to meet the needs of under-prepared students (Payne & Lyman, n.d., ¶3), which raises questions about what particular factors are part of effective remedial/developmental courses. If students do complete remediation in a reasonable period of time, what factors contribute to that success? Literature in the third area, instructional technology, offers a variety of ways to incorporate technology into the classroom. If there are ways to improve the percentage of students who complete remedial/developmental courses by investigating classroom support through technology while maintaining the proven practices of remedial/developmental education, then

exploration of the combination of developmental education with a technology component is worth consideration.

Curriculum

Research on community college curricula can be used to provide either a snapshot view or a longitudinal view when several studies are combined. Due to the number of studies on the curriculum in community colleges that have been conducted, both views are available for further study. The community college curriculum has remained fairly consistent over time. Looking specifically at the math portion, which is the focus of this study, Schuyler (1999) reports that the math portion of the total credit curriculum was consistently about 10% of the total curriculum since the 1930s (p. 4).

Studies by Center for the Study of Community Colleges. The studies of community college curriculum that have been conducted by the Center for the Study of Community Colleges (CSCC) at the University of California at Los Angeles under the direction of Arthur M. Cohen have provided the foundation for further analytical studies on the community college curriculum. In addition to a snapshot of the community college curriculum at a given point in time, the seven different national studies have provided a slightly different area of primary focus depending on the specific priorities of the grants that funded the various projects: sciences, non-liberal arts, transfer vs. non-transfer, or an overview of the total curriculum.

The national studies began in 1975 with a grant from the National Endowment for the Humanities (Cohen & Ignash, 1994, p. 13). Additional studies of the community college curriculum were conducted during the years following as cited in Table 1.

Table 1

CSCC Curriculum Studies

Date	Sponsor	No. of colleges in the sample	Curricula reviewed
1975	NEH	156	Humanities
1977	NEH	178	Humanities
1978	NSF	175	Sciences and Social Sciences
1983	Ford	38	All liberal arts
1986	Carnegie	95	All liberal arts
1987	Ford	109	Fine and Performing Arts
1991	NCAAT	164	All liberal arts

Note. From “The total community college curriculum,” by A.M. Cohen & J.M. Ignash, 1993, *Probing the community college transfer function*, p. 10. Reprinted with permission from the American Council on Education.

In 1998, a comprehensive study examined the total curriculum of community colleges (Schuyler, p. 11). For the 1975 study and each subsequent national study, catalogs and schedules were gathered from a sample of colleges, a sample that was balanced by geographic region and institutional size. Course sections were coded and tallied according to a consistent coding scheme that “divides the liberal arts curriculum into six major disciplines: humanities, English, fine and performing arts, social sciences,

sciences, mathematics and computer sciences” (Cohen & Ignash, 1992, p. 51). Each discipline was divided into 55 subject areas that were further divided into 245 sub-subject areas. For example, any sub-subject section of French was part of the subject area of Foreign Languages that was part of the broad discipline of Humanities (Cohen & Ignash, 1992, p. 51).

In each of these national curriculum studies, course sections were coded and tallied with this coding scheme to examine the curricular offerings and trends across the nation using a sampling of colleges. To maximize consistency in the coding, each coding sheet was reviewed and random sections recoded by a second researcher. All coders met on a weekly basis to discuss anomalies and ensure consistency across all coding.

Brawer (1999) noted that 63% of the math courses in the 164 community colleges in the 1991 study were introductory and intermediate courses (p. 22), while all math courses accounted for 12% of the liberal arts courses. In the CSCC studies, the category of introductory and intermediate math includes courses at the remedial/developmental level and other math courses that are at college level but do not fit into the category of advanced math or math for other majors. In the 1998 study, 59% of all math courses were introductory or intermediate and still accounted for 12% of the total liberal arts portion of the curriculum.

In their 1991 national study, Cohen and Ignash (1994) found that 16% of the math courses offered were remedial/developmental courses, 62% standard math courses, and 22% advanced math courses. Remedial/developmental math, those courses that are basic and “below college-level proficiency and which do not typically carry college transfer credits” (p. 14), were found at almost all institutions, regardless of size.

Florida curriculum study. In 2000-01, a team of seven Florida researchers conducted a study of the state's community college curriculum similar to the CSCC national studies described above, with specific comparison to the national studies in 1991 and 1998. Following the pattern of the previous national studies, catalogs and Fall 2000 credit course schedules were collected from each of Florida's 28 public community colleges. Each of more than 43,000 sections was coded by discipline, subject and sub-subject area, following the coding scheme developed by CSCC and modified by the 1998 researchers. Each coding sheet was reviewed by a second coder and random sections were recoded to maximize the consistency of the coding process and to maintain consistency with the previous studies. The integrity of the original CSCC coding system was maintained for accurate comparison between the Florida results and the national results.

There is not a consistent pattern in the ways that the 28 Florida colleges show the remedial/developmental math courses in their schedules. Some of the schedules show the lecture course sections separate from corresponding lab sections while others show the lecture and lab as one section with two components. Some schedules show one section of a single course that covers the entire spectrum of remedial/developmental math while other colleges show the remedial/developmental math sequence as multiple sections of two or three courses, or any combination of these elements. Any section that was identified as a lab, self-paced, or independent study -- that is without a definite time and meeting place or designated instructor -- was not counted for consistency with the previous CSCC national studies.

The results of the Florida study differed considerably in the proportion of remedial/developmental math from the two previous national community college studies largely because of the difference in how the laboratory sections were counted. In 1986, 32% of the math courses were reported as remedial. The 1991 CSCC study shows that 16% of the math courses were remedial, reflecting a dip from the previous studies. Cohen and Ignash (1994) attribute the dip in the 1991 study to the fact that more remedial courses were being offered in the laboratory format and were not counted in the 1991 study. "Self-paced, individualized, and lab courses were not counted. A large number of remedial math courses were self-paced, individualized, and lab courses; this would explain the low remedial math percentage" (Cohen & Ignash, p. 17). If lab sections had been counted in the 1991 study, the percentage would have been higher. In the CSCC 1998 study, lab sections and tutorials were counted for remedial courses, showing that the remedial/developmental courses accounted for 32% of all math courses (Schuyler, 1999, p. 8). The Fall 2000 Florida study showed only 25% of all math courses were remedial/developmental (Bendickson, 2002). This percentage does not seem unusual compared to the percentage of math courses reported as remedial/developmental in the 1998 national study until one considers the legislative mandate that all remediation in the state will be in the community colleges. Since all of Florida's remediation is assigned to the community colleges, the researchers working on the study expected that there would be a larger proportion of remedial/developmental courses than the 32% in the national study.

Table 2

Remedial/Developmental Course Portion of All Math Courses in 2000

	CSCC			FL
	1986	1991	1998	2000
Remedial/developmental percentage of all math courses	32%	16%	32%	25%

A comparison of the percentages of the remedial/developmental courses as a portion of the total curriculum is presented in Table 2. Possible explanations for the discrepancy between 32% when all math courses were coded as remedial/developmental were reported in the 1998 national study and 25% reported in the Fall 2000 Florida study include an increase in the number of computer-assisted classes for remedial/developmental math. The many ways that remedial/developmental math courses were presented in the Fall 2000 course schedules may explain the apparent dip to 25% from 32% reported in the 1998 national study, since some sections were not counted to maintain consistency with the coding of the 1998 study. To preserve this consistency, there are a number of remedial/developmental math courses offered in formats that were not coded in the Florida study that were counted in the national study. Also, the number of hybrid sections may be greater in the Florida study than those in studies cited here due to inconsistencies in the ways that the courses are shown in the schedules. This lack of clarity in the actual number of sections of remedial/developmental math that are technology-based or technology-assisted highlights the rationale to further examine this anomaly.

Remedial/Developmental Education

Remedial/developmental courses have been part of the collegiate curriculum since the 17th century (Casazza, 1999). The National Center for Developmental Education (NCDE) at Appalachian State University has been a leader in studying remedial/developmental education in college. There is extensive research by the NCDE and the National Association of Developmental Educators (NADE) on what constitutes effective developmental education. The NADE definition of developmental education is “a field of practice and research within higher education with a theoretical foundation in developmental psychology and learning theory. The NADE definition promotes the cognitive and affective growth of all postsecondary learners, at all levels of the learning continuum” (NADE website, definition page). To broaden knowledge, the effective remedial/developmental instructor must meet the needs of students who have “deficiencies in content knowledge and about the learning process” (Stahl, Simpson, & Hayes, 1992, pg 4).

Controversies surrounding the remedial/developmental programs often show a lack of understanding of the programs. Outside the academic community, there is a prevalent mindset that remedial/developmental courses are a case of paying for the same training twice. It is not necessarily the same training when the student takes remedial/developmental courses in the community college. Secondary schools often allow students to graduate without the coursework needed to prepare them for college. In this case, students may have received a high school diploma, but without Algebra and sufficient writing skills to place into college level reading, writing, and math when they come to the community college. McCabe (2003) believes that we, as educators, must forget placing

blame for a student's needing remediation and accept that it has become an essential part of higher education (p. 23).

In response to some of the controversies surrounding remedial/developmental education, Colby & Opp (1987) called for entrance and exit exams as well as integrated tutorial and lab experiences to maximize support for students while maintaining the integrity of the institution. Mandated entrance and exit exams provide response to some concerns as researchers seek additional predictors of success in remedial/developmental courses. With declining numbers of students passing the required exit exam, the Texas legislature considered eliminating the exit exam as a requirement. A team led by Hunter Boylan reviewed the exit exam and found the test to be valid and reliable (Boylan & Saxon as cited in McCabe, p. 139). Florida's exit exam is mandatory, but has not been examined for validity and reliability.

Teaching approaches. While courses for under-prepared students may have been largely remedial in nature in the beginning, a gradual shift occurred to modify the theoretical focus from remedial to developmental. Developmental educators began to look to psychological theories of Jerome Bruner and Jean Piaget to link developmental education theory to cognitive and affective personality (McGrath & Spear, 1994). Following the humanistic views of Carl Rogers and Abraham Maslow, developmental educators identified a need for teachers to nurture each student's individuality.

In contrast, college remedial/developmental programs often focus on the deficit model for instruction, implying that the student is lacking knowledge. The skill and drill format, often a part of the remedial approach, has been a primary teaching style in math

classes and tends to focus on fixing a problem. Grubb (2001) reports that computer programs in remedial/developmental courses tend to involve drills to teach a topic. Following the diagnostic test, discipline-based remediation is often used. Students are allowed to progress to a new topic only when they pass a test. Grubb (2001) suggests that the approach to remedial/developmental education should be multi-faceted rather than just a collection of skills and drills. Grubb's suggestion points to an approach that involves more than skills and drills in order for a technology-based approach to provide the best support for those students, such as student-centered teaching, learning communities, and coherent philosophies across departments.

Learning theories that address how we learn include progressivist thinking as well as a continual struggle between a developmental whole learner approach and a remedial discipline-based approach. The progressivist view identifies the natural stages that children encounter and responds with a student-centered and problem-based approach. The progressivist educator supports the stages of cognitive development (Cazarra, 1999).

Programmed instruction based on individual student need is one such approach. Programmed instruction is often utilized in remedial/developmental education following yet another model, the behaviorist model, with a basic assumption that learners respond to external variables and can be expected to react in a certain way. Programmed instruction may be built on expected responses. Remedial/developmental instruction that follows the behaviorist model usually is self-paced or computer-assisted instruction and often has an open-entry open-exit format (McMillan, Parke, & Lanning, 1997, p. 25). Remedial courses in the open entry-open exit format may draw attention to a student's

lack of the self-discipline necessary to successfully complete any course that has no structured timetable.

Student success. While the developmental weaknesses of the students who place into remedial/developmental courses may seem to be the reason for their weakness, Ley & Young (1998) report that a core deficit may be a lack of the ability to self-regulate in order to be successful in college. They report that the students who place into remedial/developmental classes are not likely to have the self-discipline needed for success in college courses, which adds to the individual student's apparent developmental weakness. The need for self-regulation highlights a potential misfit if a student who lacks this self-regulation skill enrolls in a section that is totally technology-based and requires that the individual student regulates his/her own study needs.

Another factor that may be a significant feature of a student's chance of success is the degree to which the student has control over the instruction. Computer-assisted instruction has characteristics that may be indicators of the potential effectiveness of a given program. Programs are either geared toward the learner having control over the program or the program controlling the learning process. There is research (Lawless & Brown, 1997, as cited in Lunts, 2003) to indicate that these controls may produce very different results. Learner control is seen if the student has the ability to change the program to match individual preferences or skill levels. Program control refers to a situation in which the student has no control over the program or its presentation (Lunts, 2003, p.1).

Williams (1996) points out that learning complex knowledge is made possible when the learner has the opportunity to participate in the construction of how that knowledge is presented. Learners are more likely to influence the way that computer-based instruction affects them if they are given interactive activities. College students, particularly remedial/developmental students, may not make good use of this ability to interact. If college students are allowed to have choice in the amount of instruction they need, the least prepared students are the most likely to underestimate the amount of instruction that they really need (Williams, 1996, p. 959). Learner control in computer-based instruction may not be a positive factor in student success for all remedial/developmental students.

Recent research (as cited in Boylan & Saxon, n.d.) has identified several factors that contribute to successful remedial courses. Classroom and laboratory integration stimulate instructional and laboratory personnel to work together in collaboration. An institution-wide commitment and consistency of academic standards were found to strengthen remedial education programs. Learning communities, supplemental instruction, strategic learning, professional training, student orientation, and training in critical thinking are other factors that contribute to student success. Student success may increase when students have open access to developmental instruction. “Surveys indicate that 75 percent of developmental students enroll because of the flexible times for learning through the open lab” (McCabe, 2003, p.109).

Other factors that contribute to success of developmental programs are identified by Weissman (1995): remediation should be required of students who are deficient in skills and should be required upon entering college. Weissman recommends that students

who need some remediation should be allowed to take college-level courses simultaneously only if they continue the needed remediation. But, any student who needs remediation in multiple areas such as reading, writing, or math, should focus on the remediation needed before beginning college-level work (Weissman, 1995, p. 18).

Some of the initial research on effective methods for providing remediation was in the work of John Roueche. Roueche's early studies (as cited in Boylan & Saxon, n.d.) show that successful techniques in remedial instruction include mastery learning and a degree of structure with a variety of teaching methods. Courses should have a strong theory base, a clearly defined philosophy, and mandatory assessment and placement. Remedial/developmental programs that are centralized with counseling components, tutoring, and computer-based instruction were found to be the most successful (Boylan & Saxon, n.d., p.4). While much research exists to examine the effectiveness of given programs, there is no single answer that surfaces as the best way to provide effective remedial/developmental instruction.

Technology in remedial/developmental courses. McGrath & Spear (1992) suggest that the solution for remedial students lies in using appropriate educational technology. Cartwright identifies two primary types of software that reflect the many beliefs about how technology might best fit into remedial/developmental courses: those that improve generic basic skills and those that improve discipline-related skills. The generic basic skills approach is reported to be successful with moderately or highly motivated students (Cartwright, 1996, January/February). However, there are those "who argue that a basic skills approach cheats capable, if underprepared, students of the

opportunity to develop higher-order thinking skills” (Cartwright, 1996, January/February, ¶12). Due to this dichotomy of philosophies, there are software packages that present skills taught in remedial/developmental courses in each way, providing choices in approach to institutions. The programs that present generic basic skills often use tutorials and exercises to strengthen a student’s skills. The programs that are discipline-specific tend to be more interactive and allow more individualization based on student preferences (Cartwright, January/February 1996). One difference between the basic skills approach and the discipline-specific approach to the technology-assisted remedial/developmental courses is that the generic basic skills courses are most often housed in general computer labs, while the discipline-based courses are most often housed in a computer lab that is specific to the discipline. Discipline-based computer labs may be open to a more restrictive student population than are general computer labs, and therefore, the cost per student could be higher in a discipline-based computer lab.

Additionally, there are a growing number of programs that utilize technology in multiple ways. Cartwright (1996, May/June) introduces programs that allow students to utilize email and the Internet to do active writing, collaborating on assignments and posting assignments for peer review. Another program at Indiana University-Purdue University at Indianapolis emphasizes technology to stress active learning and to get the faculty highly involved with the students. Using technology allows the faculty member to act as facilitator rather than instructor. Increased class sizes are feasible in this model.

Instructional Technology

As new technologies increase on the educational landscape, institutions must explore benefits to students and financial impacts of technology to survive. One dominant effect of the explosion of technology into education relates to instructional delivery methods. Higher education is becoming more individualized, to the extent that students will set their own educational agenda instead of conforming to the institutional agenda (Levine, 2000). Institutions are faced with the task of determining the method and extent of technology in the educational opportunities offered.

Instructional delivery methods may have begun as rudimentary electronic worksheets, but current technology takes these delivery variations to new heights so that instructional delivery sometimes merges entertainment into education. MacDonald and Caverly (1999) cite an example in which an algebra software program is presented in a game format with animated video clips so that the students become involved and forget to be nervous about the math or the technology. The boundary between education and entertainment has become somewhat blurred.

Although there are other potential uses of technology in education, the media often considered when discussing technology in education is computer-based. Brothen (1998) suggests that technology must function at the level of the student in order to facilitate student independence, self-regulation, and self confidence (Brothen, b, Goals, section). Brothen (1992) reports that computers can be of assistance with developmental students who may need more individual attention than an instructor can provide.

When expressing his prediction of the future of college mathematics, Maurer (1984) did not question at all the need for math in future college curricula. Instead, he

questioned the extent to which computers might replace math instructors. In the 2000 review of his earlier predictions, Maurer (2000) indicates that instead of replacing instructors, computers have provided an alternate mode of instruction often used to enhance the human instructor.

Technology, if used very carefully, can be helpful to students in remedial/developmental classes. Students must see many correct examples in order to develop a number and symbol sense. Technology allows students to see many more examples in the same amount of time. The question is do they pay attention to the answers? Examples done with technology should be graded in difficulty of technology use or students will learn to hate buttons as much as they hate pencils. (Maurer, personal communication, May 22, 2003).

Keup (1998) reports two positive factors that surface in the use of technology in remedial/developmental education in community colleges. The use of technology may change the role of instructor to that of facilitator, but technology does not replace the need for the instructor. Secondly, the use of technology in remedial/developmental education seems to increase the need for collaborative learning. Since student-to-student communication may be integrated into the software program, this need for collaborative learning may be met by the software program (Keup, 1998).

Previous technological innovations of the time were predicted to revolutionize education. For example, educators predicted some 50 years ago that radio technology would cause tremendous changes in the classroom. However, the impact of radio on education never reached the level predicted. Subsequently, television came onto the scene with a similar prediction and result. Both these forms of technology are part of education

and have become integrated into classrooms as appropriate, rather than taking over the classrooms. Only time will show the extent to which current technology will impact the classroom.

An example of high technology in the classroom can be found at California Polytechnic State University at San Luis Obispo (Cal Poly). Much of the remedial/developmental math at Cal Poly is offered through an interactive multi-media format. Even with as many as 50 students enrolled in the online mathematics courses, instructors are able to keep close tabs on each student's individual progress by using the reporting functions built into the program. The coordinator of the entry-level math and math placement exams at Cal Poly reports that students learn and are able to move on to higher level math when beginning their college math track in an online format (Olsen, 2000). Teachers have a very different role in a course of this type: facilitation, rather than direct instruction.

In considering the expected affect of computers on education, what expectations are realistic? Hershfield (1980) identifies the individual faculty member as the most crucial facet in the acceptance of current technology into the classroom. (p. 402). Accepting the idea that it is crucial to have buy-in from the faculty member, perhaps the faculty member should be the one to select a delivery method. Widespread acceptance of any technological implementation into the classroom will depend on many people making individual choices for a particular format for their own classroom. Hershfield contends that both faculty and students must recognize the advantages to be gained from using technology in order to fully implement high technology in the classroom (p. 403). In considering the adoption of new technologies, Johnson and Johnson (1996) note that

the educational community is often slow to adopt and quick to discontinue the use of technology in classrooms.

Contrary to the Hershfield idea that widespread acceptance will require many individual decisions, Kozma and Johnston (1991) believe that instructional innovations can be adopted collaboratively (p. 411). In reviewing more than 700 academic software packages, Kozma & Johnston have identified six ways in which the software and innovations are making positive differences in higher education.

- 1) Rather than the student absorbing knowledge through a passive process, technology encourages active engagement on the part of the student.
- 2) Technology enables the institution to take the learning environment out of the brick-and-mortar classroom.
- 3) Technology allows for the use of multiple dimensions rather than simply relying on text to transmit knowledge.
- 4) Technology has the capacity to individualize the depth and breadth of drill on a particular skill to meet the individual student needs.
- 5) Technology has the ability through networking to connect individual students who may or may not be co-located.
- 6) Technology incorporates the ability to reproduce conditions that are often costly or cumbersome in a physical classroom. For instance, chemistry experiments may be dangerous and expensive in the classroom while interactive modeling allows the student to experiment without consuming costly chemicals or causing damage (pp. 409-410).

Kulik (1994) reports major implications for administrators in a meta-analysis of the effectiveness of computer-based instruction. In summarizing the results of 97 studies, he reports that students learn more and learn faster in courses which involve computer-based instruction. Additionally, students have more positive attitudes toward instruction and toward computers in courses which involve computer-based instruction. While these ideas seem to suggest that computer-based instruction has positive effects of student success, Kulik, however, also suggests that the results should be treated as exploratory in nature.

Technology has the capacity to present materials to students in a variety of ways. The effects of learning styles and abilities with computers are complex and varied. Regardless of the capacity to present materials in various ways, the instructor must ensure that the technology-assisted course grows to its fullest potential rather than merely serving as a repository for electronic worksheets. There must be clearly defined objectives identified in order for the individual instructor to maximize the positive effect of the technology. “Educators must take a stand against the mass introduction of online courses without clearly defined objectives” (Bothel, 2002).

Mass introduction of online courses only increases the steep learning curve that some remedial/developmental students face, a factor that has great potential to affect the effectiveness of technology in remedial/developmental courses. Mehlenbacher (2002) reports “On-line learning environments are still very much in their infancy, and despite enthusiastic claims that such teaching and learning environments readily exist, instructors and students are still faced with a significant learning curve” (p. 96). In presenting

courses in an online format, attention needs to be given to computer familiarity as well as the discipline-based skill set.

Early math software simply presented electronic worksheets. MacDonald and Caverly (1999) reported that academic software on the market has become more coordinated with learning styles of each student. An experiment called Project Synergy at Miami-Dade Community College produced reports from the faculty that computer-assisted instruction encouraged students to stay in college (Watkins, p. 2). However, if decisions are based primarily on the expectation that student retention will increase while technology is used in classes, more information is needed. Using technology simply to increase student retention creates a nebulous, hard to measure factor in the decision process (Watkins, 1991).

Several concerns have been raised concerning effectiveness and cost in choosing to present remedial/developmental courses through computer-assisted instruction. The founder of one software company responded to concerns over the use of computer-assisted instruction by insisting that the advantage of technology in a math classroom is not increasing enrollment to reduce the number of faculty. Instead, the advantage comes in the form of increased student success, reducing the need for repeats. "Greater learning productivity, more so than lower teaching cost, is the great promise of information technology" (Finkelstein & Scholz, 2000, p. 23). Another concern over technology in the classroom beyond that of effectiveness in student success is simply who will pay for the technology costs. DeLoughry (1996) reports that the software needed to support technology in math classrooms may be paid for in different ways. The institution may

charge a course fee, similar to a lab fee, to cover the cost. The institution also has the option to pass the costs on to the student (p. 4).

Another financial concern surfaces in the implementation of academic software into remedial/developmental courses. The direct cost of offering instruction with a technology component in remedial/developmental classes exceeds the costs of offering the instruction to students in a classroom. The costs are greater because of fixed costs associated with the technology support: hardware and annual software licensing fees (Jewett, 2000, p.169). Although the decision to offer classes in a technology-based format is not purely a fiscal decision, the budgetary impact cannot be ignored.

Relating literature on instructional technology to this study, the goal of effective instructional technology in remedial/developmental classes may be a matter of the right combination of controllable factors, one of which is the delivery mode chosen for a particular class. Pumerantz and Frances (2000) conclude that the decision is not whether to use the conventional mode of delivery or a technology-based mode, but rather what is “the most effective combination of human and technological resources” (p. 253)?

Summary and Synthesis of Literature Review

This study will build upon existing knowledge to investigate the effectiveness of the various formats of remedial/developmental math in community colleges in Florida. A review of the literature on curriculum reveals that there is no common general education curriculum which makes it even more difficult to find the most effective way to deliver remedial/developmental education to students who lack basic skills necessary to succeed in subsequent general education courses. A review of the literature on instructional

technology highlights the impact of technology on higher education as institutions now have the ability to offer instruction to students when, where, and how they want it. Instructional technology will have an impact on all aspects of higher education, including remedial/developmental education in community colleges, and, as Newman (2000, p.7) points out “No institution, no matter how great its prestige in the traditional mode, will be able to escape the need to compete effectively through the skilled use of technology to enhance learning”.

Although some of the existing literature suggests that students participating in remedial courses are very much like other community college students (Saxon & Boylan, 1999), some educators believe that these students are not only under prepared in terms of basic skills, but have had little or no access to technology and are intimidated and alienated by it. (McCabe, 103)

A review of the literature on curriculum and instructional technology raises more questions that it answers. Do students enrolled in remedial/developmental courses in Florida community colleges readily accept technology? Should the lack of familiarity with technology and the possible apprehension toward technology change the way that remedial/developmental courses are presented?

The findings of this study, by addressing these questions, will provide a basis for colleges to make decisions for the directions and delivery formats of their remedial/developmental math courses. If there is so significant difference found, institutions might re-examine spending limited funds on technology. Conversely, if there is a significant difference found, institutions might seek out additional sources of funding to support technology in the remedial/developmental math courses.

Chapter Three

Method

Introduction

Remedial/developmental math formats and nomenclature vary across the state, with a single common element that exists in all 28 community colleges: the state exit exam. Among the 28 Florida community colleges, the remedial/developmental math sequence may be offered in several ways, including two 5-semester hour courses and two or three 3-semester hour courses. Regardless of the numbering of the course or the number of remedial/developmental math courses that are offered in a particular college's curriculum, all students must pass the state exit exam to be classified at college level, enabling those students to go into higher level math courses. The four research questions in this study addressed the overall search for the most effective delivery format for remedial/developmental math courses in the state's community colleges.

- 1) What remedial/developmental math courses are offered in Florida's 28 community colleges? Does the instructional delivery format of the remedial/developmental courses offered in Florida's 28 community colleges vary by institutional size?

- 2) Is there a relationship between *student success* (defined on p. 16) and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges?
- 3) Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges while controlling for initial placement test scores?
- 4) Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges while controlling for instructor influence?

The first question was intended to capture the scope of current remedial/developmental math offerings in the state and to provide a foundation for investigating the other three questions. Information on institutional size was noted in the event that a significant difference was found. The second question was the primary focus of the study and addressed the question of effectiveness of the delivery of remedial/developmental math programs across the state. In other words, do technology-assisted courses help students or not? The third and fourth questions controlled for the intervening variables of initial student ability and again, instructor influence. Until the full coding process took place, it was not known if there would be cases of the same instructor teaching sections in more than one delivery format, the focus of the fourth question.

The delivery format for gatekeeper remedial/developmental math courses was the independent variable. The dependent variable was student success. The researcher expected several different formats to be found in the Fall 2002 schedules of all

community colleges in the state during the coding process. A small pilot examination was conducted and 30 sections were coded by two outside veteran coders who worked on the Florida Fall 2000 curriculum study to ensure clearly defined parameters of definitions and consistency in the coding. The expected formats were traditional lecture, hybrid classes that included a technology component, and totally computer-based formats. Any section that appeared with a specific meeting place and time without any additional information was coded as traditional. A computer-based section was listed in the schedule as one in which the students took the course in a computer lab for the entire class period. A hybrid class was listed in the schedule as one in which the course contained both classroom and computer lab components. In any instance where there were identifiable instances of varying types of technology -- synchronous or asynchronous, they were coded independently of each other. Until the full coding took place, it was not known how many of these or to what extent these formats would be found.

Regarding question 1, the researcher expected to find no discernable pattern in the variety of remedial/developmental courses offered in community colleges across the state when compared with institutional size. For questions 2,3, and 4, the researcher expected to find no evidence that delivery formats are a valid predictor of student success, even when the possible effects of either initial placement test scores or instructor influence were removed.

Research design

The overall structure of this research was a quantitative design. Question #1 was largely descriptive in nature while the other three questions were more analytical. There were several factors that might have been chosen to measure student success. Some of the other possibilities included mastery of course content, enrollment in subsequent math courses, or successful completion of subsequent math courses. However, with no clear prescription from the State of Florida of the remedial/developmental classes to provide a consistent framework, data to investigate some of the factors that might have been seen to be effective measures of student success may not readily available. The only common thread in the remedial/developmental class offerings in Florida were the courses that served as gatekeeper and contained the exit exam. The gatekeeper course numbers and titles were not consistent across the state, since it exists with several different titles and several different course numbers.

The degree of variation in the course offerings focused attention on the gatekeeper course and exam to measure student success because so much leeway was given in the state's loosely defined prescription for remediation. Because of the variety of ways in which the remedial/developmental courses were offered in Florida community colleges, it was important to simplify the questions into a consistent and measurable definition. The only consistent item measuring student success in remediation was the state exit exam, so that became the variable used for measuring student success.

Population

All credit-bearing sections of remedial/developmental math in the 28 community colleges in Florida provided the population for this study. Each section of remedial/developmental math in the state was coded by its delivery format, sorting each section of the gatekeeper course in the remedial/developmental track into the three delivery formats: traditional lecture, hybrid combination of lecture and computer-assisted, and completely computer based. The delivery format was determined by the entry in the printed course schedule. To verify the consistency and validate the coding of the researcher, two experienced coders coded a sampling of 30 sections of the schedules. The second research question used the full student population figures from the state. The researcher obtained data that included the students' enrollment by section, placement test scores, and final course grades from the Florida Division of Community Colleges. The total population of students who were enrolled in a gatekeeper remedial/developmental math course in any Florida community college in the Fall 2002 semester was examined for focused study. The researcher collected pretest scores and final grades in the gatekeeper math courses by section from the Florida Division of Community Colleges and controlled statistically for the student's initial placement test score to remove that potential impact on apparent effectiveness. A subsequent statistical test controlled for instructor variability isolating any case in which one instructor taught in multiple delivery format.

Instrumentation/measures

In the first hypothesis, the independent variable required information regarding institutional size from the Florida Division of Community Colleges February 2002 Fact

Book. The size was measured by unduplicated headcount figures from Fall 2002. The different formats and the number of sections of each format found in each college's credit schedule were the dependent variables. The researcher gathered this information by coding and counting each section of all remedial/developmental math courses in the Florida community colleges. The researcher expected to find (1) traditional lecture, (2) hybrid sections that include a technology component, and (3) totally computer-based formats.

The second hypothesis required additional information to measure student success. To maintain consistency, the researcher ensured that the course used for this study was the one that includes the state's exit exam as the requirement before a student exits the remedial/developmental math sequence and is eligible to enroll in college level math courses, previously defined as the gatekeeper course. The course selected for this study is often listed as MAT 0024 or MAT 0024C, College Preparatory Algebra. Some of the 28 Florida community colleges listed the gatekeeper course as MAT 0020, Basic Algebra II. Since MAT 0024(C) may not be the only course that contains the state exit exam, the course used for this research was the course(s) in each of the 28 community colleges that contained the exit exam as a requirement to pass the course. The state exit exam was provided to community colleges to ensure consistent standards across the state. Data was gathered statewide regarding the passing rates of students in the remedial/developmental gatekeeper math course.

The pretest used for the third hypotheses was the statewide college placement test (CPT). Controlling for initial student ability, as demonstrated in the placement test score, removed an additional confounding factor. Information on faculty members assigned to

the remedial/developmental math classes to support the fourth hypothesis was obtained from the printed schedule, from the institution's research office, or appropriate department chair.

Procedures

The first hypothesis was analyzed by size and proportion of sections that were traditional, hybrid, and totally computer-based. The variety was sorted by delivery format and course. For instance, curriculum planners would be interested to know if medium College A offers only its remedial/developmental math courses in a hybrid delivery format and medium College B offers half its total math courses in a hybrid delivery format. This is particularly important if the hybrid format (as defined in this study) is found to be the most successful delivery format.

The second hypothesis tested was an analysis of variance (ANOVA) using statewide data to examine any relationship that may exist between delivery formats of remedial/developmental math courses in the 28 community colleges in Florida and student success. Student success was measured against the delivery format by using the statewide exit exam.

The third hypothesis was tested with an analysis of covariance (ANCOVA) to seek and identify interaction between student success in different delivery formats of remedial/developmental math classes while controlling for a student's incoming score on the state placement test. The fourth hypothesis would have been tested with an analysis of covariance (ANCOVA) to seek and identify interaction between student success in different delivery formats of remedial/developmental math classes while controlling for

instructor influences. The fourth hypothesis was not tested due to the limited occurrence of an individual faculty member teaching sections of the gatekeeper remedial/developmental math course in multiple delivery formats. Focusing on those cases in which one instructor at a single institution taught multiple sections using multiple methods, the researcher again used the delivery format as an independent variable and student success as the dependent variable.

The element of instructor influence was of interest because of the potential that students in class with Professor A would always perform better (and have a higher success rate as defined in this study) than the students in class with Professor B simply because Professor A was a more effective teacher. In isolating the cases in which the same instructor taught the gatekeeper class in two or more different formats, the element of teacher performance was removed. This question was to be addressed only if there were sufficient cases in which an instructor could be identified as teaching at least two sections in more than one delivery format.

The researcher categorized each section of remedial/developmental math for the Fall 2002 semester and sorted the count by college size as reported in the Fall 2002 unduplicated headcount enrollment figures. The researcher collected data on the percentages of students who earned the right to advance to college level. After identifying all sections of remedial/developmental math and coding them by delivery format, the researcher gathered faculty assignment information from the printed schedules, institutional research offices, or other appropriate office in each college to match those sections in which the same faculty member taught in more than one delivery format. There was not a large enough group to produce anything valuable. The total of 1,121

sections of gatekeeper remedial/developmental math produced only 12 instances of an individual faculty member teaching in more than one delivery format. Although the researcher did not expect to find many instances in which the same faculty member taught in multiple delivery formats, the question regarding instructor influence was an important one and would have been investigated if the frequency warranted investigation.

The researcher identified formats for remedial/developmental math courses by examining the Fall 2002 credit course schedules and college catalogs from each of the 28 community colleges in Florida. Once the formats were identified and sorted by college and format, the researcher gathered specific information for all students in each format to identify any relationships that existed. A positive relationship between pass rates and instruction delivered via technology might have illustrated a need for increased funding to smaller institutions or level statewide funding for technology-delivered remediation.

Data Analysis

Descriptive statistics were computed for the first hypothesis to provide foundation for the remaining three hypotheses. Sections of remedial/developmental math were counted and an analysis of variance on the coding was conducted to test the second hypothesis. Two analyses of covariance were run to analyze the initial effects of initial placement test scores before comparing the between group variance and instructor difference.

Summary

In summary, the effectiveness of the delivery method of remedial/developmental mathematics courses in the Fall 2002 semester of Florida's 28 community colleges was the focus of this study. The complete printed schedules were studied closely to identify relationships that might exist between a student's pass rate and the delivery format of the section. The sections were coded by an extension of the coding taxonomy developed by the Council for the Study of Community Colleges. Sections were identified as traditional, hybrid, or computer-based delivery formats. After coding each section, the researcher compared the pass rates of students enrolled in each delivery. Again, the pass rates were compared to delivery format while controlling for the student's incoming placement test score. The final research question would have controlled for instructor variability if there had been a sufficient number of cases in which the same faculty member taught in more than one delivery format.

Chapter 4

Results

The purpose of this research was to examine the effectiveness, as measured by student success, of technology-assisted instruction for remedial/developmental math courses in Florida community colleges. This chapter presents results of the quantitative analysis used to investigate each of the four research questions. Specifically, this chapter includes a summary of the data collection process and the subsequent analyses as they relate to each question.

Summary of the Data Collection

The initial step necessary to complete a full assessment of the curriculum of remedial/developmental mathematics courses in all Florida community colleges was the collection of a complete set of college catalogs and printed schedules applicable to the Fall 2002 semester for each of Florida's 28 community colleges. The catalogs and schedules provided the foundation for the remainder of the research. Appendix A provides a clear description of the remedial/developmental mathematics curriculum. Appendix B also provides a listing of all math courses in the state's common course numbering system, highlighting the remedial/developmental courses.

The second step, one that had to precede the actual coding of the 28 printed community college schedules from the Fall 2002 semester, was a pilot coding completed

by two veteran coders from the 2000 Florida curriculum study described in Chapter Two. The pilot coding of 30 sections was conducted and highlighted the need to more clearly define the terms in order to ensure consistency in the full coding of all remedial/developmental mathematics sections. The next step involved detailed definitions of the coding terms (shown in Appendix C). This was an important step in validating the consistency of the full schedule coding that followed. These criteria were used to code all remedial/developmental math sections in the entire printed schedules of the 28 community colleges in Florida.

The third step involved examination of the remedial/developmental mathematics curriculum at each college as presented in the college catalog. The variety of curricula in the 28 community colleges showed five different remedial/developmental math courses across the state, despite the fact that the mix of five courses varied quite a bit from one institution to the next. Although the titles of the courses were inconsistent, Florida's common course numbering did provide a framework that produced some continuity since the numbering schemes were found to be consistent throughout the state. The course titles often included terms like College Preparatory or Elementary, Developmental or Introductory. The gatekeeper course titles were listed as Basic Algebra, Elementary Algebra, Fundamentals of Algebra, College Preparatory Algebra, Introduction to Algebra, or Introductory Algebra, with similar variations in lab section titles as well in the lecture portions of course titles.

The fourth step in the data collection process involved compilation of the data provided from the Division of Community Colleges. The state data selected for the detailed investigation included all students enrolled in a gatekeeper remedial/

developmental math course in the 28 Florida community colleges during the Fall 2002 semester. There was no individually identifiable information included in the state data, only individual student records with a counter instead of a traceable identification number. To provide data and respond to question three, the incoming placement test score was included when available. All student records did not include a placement test score since there are other means of placing students into remedial/developmental courses, including prior scores on national college entrance exams or transfer from another institution.

To support question four, the final step in the data collection process involved analysis of the delivery formats offered at each institution to identify the institutions that offered the gatekeeper course in multiple formats. This step produced a list of 12 of the 28 community colleges that offered the gatekeeper course in more than one delivery format. The remainder of the 28 institutions offered the gatekeeper course in only one format. Some of these 12 institutions provided faculty information in the printed schedule so it was easy to determine the cases of faculty members teaching in multiple formats. The remaining institutions were contacted to request faculty information for each of the applicable sections. Again, no individual identifying information was collected. The information on faculty assigned to particular courses only answered the question: “Did the same faculty member teach the gatekeeper course in more than one delivery format?”

Once the institutional remedial/developmental math curriculum was defined for each institution, all sections of remedial/developmental math in the printed Fall 2002 schedules were coded according to an expansion of the coding taxonomy described in previous chapters that divides the liberal arts curriculum into six major disciplines. The

original coding taxonomy divided the liberal arts into six major disciplines. This coding was specifically focused on the remedial/developmental math portions of the printed schedules. The framework for the coding taxonomy was consistent with the taxonomy used in the CSCC coding taxonomy with the addition of coding all remedial/developmental math sections by delivery format for this study. All remedial/developmental math sections were coded in this manner to provide a clear method to identify those sections that were sections of gatekeeper courses.

Prior to any coding, the researcher wrote definitions to describe the delivery formats expected. With the assistance of the veteran coders, and before beginning the full coding process, the definitions were discussed and points of vagueness were clarified. The reason that this step had to be completed before beginning the coding process using the printed schedules was to remove any tendency to write definitions to fit the schedule listings. The definitions needed to be clear enough that the veteran coders who participated in the pilot coding would be able to code consistently and without questioning the coding decisions. With these clear definitions in hand, it was simple to code the printed schedules with confidence. The definitions that provided the foundation for the coding process were concluded with a consensus of the parameters of each delivery format definition and the coding of the sections selected for the pilot coding project with the veteran coders.

The formats were traditional lecture, hybrid classes that included a technology component, and totally computer-based formats. Any section that appeared with a specific meeting place and time, without any additional information to specify a laboratory component, was coded as traditional. Sections that were coded as traditional

were listed in the printed schedule with a specific meeting place and time and with no indication of any use of technology during the delivery of the course. Additionally, the researcher conducted a validation check by comparing the section listing in the printed schedule with the course listing in the college catalog. There were cases of the course descriptions providing the only indication of the use of technology in the course. For instance, if a section was presented in the printed schedule with a specific meeting place and time and no mention of a computer lab, but the course listing in the college catalog indicated a co-requisite lab, the section was not coded as traditional. The only element that excluded the traditional coding for that section was the catalog description that showed the required lab to be taken with the lecture-based course.

A hybrid class was listed in the schedule as one in which the course listing in the printed schedule contains both classroom and computer lab components. Sections that were coded as hybrid were those that clearly contained elements of traditional lecture-based and technology. For instance, the co-requisite lab presented in the example above would provide justification to code those sections as hybrid rather than traditional. In order to be excluded from being coded as computer-based delivery, there must be an element of traditional delivery. This might be shown through two different meeting places, one classroom and one computer lab.

A computer-based section was listed in the schedule as one in which the students took the course in a computer lab for the entire class period. Sections that were coded as computer-based were those without any indication of lecture-based traditional classroom. These sections might be listed in the printed schedules as online or distance learning. Other sections were coded as computer-based if the printed schedule listing showed only

a computer lab as the meeting place or if there was a printed comment that the course was based on a specific software package as the primary focus.

The researcher also separated fully computer-based sections from online sections during the coding process as described in the original method section of this study, but the total number of online sections was so small that those sections were combined with the computer-based sections for the analysis in this study. The state data was then sorted by institution to facilitate a careful cross-check of section numbers to validate the consistency of the coding and verify that all sections were counted. There were a total of 111 sections that appeared in the state data that were not in the printed schedules. This was not a surprise as institutions often modify existing sections and create additional sections as needed to meet student demand.

The printed schedules provided the full list of sections that was used in this study. Any section that was not in the printed schedule and might have been added later was not included in this study because of the unavailability of consistent information regarding delivery formats for those sections that might have been added later. To maintain the integrity of the research, any section that was included in the state data but was not reflected on the printed schedule was eliminated from the study. The researcher considered the idea of contacting each institution to ask for information on delivery format. However, the researcher decided against pursuing these additional sections because:

- a) Many of the “added” sections were likely not really additional sections but re-worked presentations of sections that appeared to be cancelled sections. For instance, if there is some reason to change the days that a class meets from

Monday/Wednesday to Tuesday/Thursday after the schedule has gone to print, the section might be cancelled and resubmitted in the system with only a change of days. One reason that it might be better to cancel an existing section and create a new section with only minor modification would be to ensure that the students enrolled in the course would have the correct schedule. Simply making the change in an existing section instead of canceling it opens the possibility that some students register early enough to see the incorrect schedule and build their schedule accordingly. This would appear to be one cancelled section and one added section, but it is actually a cosmetic modification of the section with the only course offering information changed.

- b) Information on these added sections would have been obtained from an individual at each institution. That individual's perception of the delivery format of the added sections might not have been consistent with this researcher's definition of each delivery format. If the definitions and perceptions are inconsistent with the sections already coded from the information available in the printed schedules, the institutional representative's assessment of a hybrid section might not have been consistent with the researcher's assessment and had the potential to skew the data by reporting a section differently than it would have been coded from the entry in the printed schedule.

Therefore, the elimination of these added sections does not affect the results of the study, particularly in light of the small number of added sections compared to the large number of sections that were presented in all sections of remedial/developmental math as shown in the printed schedules. Eliminating these sections removed less than 9% of the

sections reported by the state. The total number of sections added was less than 10% of the total number of sections in the printed schedules. The few sections in the printed schedules that were not reported in the state data accounted for less than 2% of the total number of sections in the printed schedules and were likely the sections that were cancelled after the schedule went to print.

Data Analysis: Quantitative Design

Research question 1. The first research question was: “What remedial/developmental math courses are offered in Florida’s 28 community colleges? Does the instructional delivery format of the remedial/developmental courses offered in Florida’s 28 community colleges vary by institutional size?”

The catalog course descriptions collectively provided the full scope of the remedial/developmental math courses across the state. While the mixture of courses and the structure of the remedial/developmental math curricula were quite varied in the 28 institutions across the state, each of the 28 community colleges showed MAT 0020 and/or MAT 0024 as the gatekeeper course(s) containing the state exit exam. The catalog course descriptions provided sufficient information to identify the sequence of courses that comprise the remedial/developmental math curriculum and clearly pinpoint the gatekeeper courses, that is, those courses that contain the mandatory exit exam. A two-course sequence comprised this remedial/developmental math curriculum at 25 of the 28 community colleges. These courses were listed at zero to five semester hours of credit, with 82% of the institutions listing either three or four semester hours per course in the college catalogs and in the remedial/developmental math portion of the printed schedules.

Only three community colleges offered 5-semester hour remedial/developmental courses and one offered 6-semester hour remedial/developmental courses. In the seven schedules offering both MAT 0020 and MAT 0024 as gatekeeper courses, these two courses were a combination of the entire remedial/developmental math sequence into one integrated course and were sometimes offered in different delivery formats, or showed other distinctions. The proportion of gatekeeper sections offered in the various delivery formats was similar to the overall proportions of remedial/developmental math offered in hybrid and computer-based delivery formats.

The researcher had originally expected to find sections presented in several delivery formats; including traditional, computer-based, hybrid, and online delivery formats. Once the printed schedules were reviewed, the remedial/developmental math sections were presented in each delivery format as expected with one exception. The researcher had expected to find more online sections in the remedial/developmental math portion of the schedules. Casual scanning of the remainder of the schedules showed that there seemed to be more online courses offered throughout the state in a variety of disciplines other than math. Additionally, there also appeared to be more online courses offered throughout the state in college level math than were found in the remedial/developmental math portion of the schedules. Half of the 28 institutions offered the gatekeeper course in only one delivery format, although that single delivery format was not the same in each of these institutions across the state. Additionally, 11 institutions offered students two choices of delivery format and only three of the 28 institutions offered remedial/developmental math to students in all delivery format configurations.

The infrequent occurrence of fully online remedial/developmental math courses was the basis of the decision to include those into the computer-based numbers.

Table 3 combines the information for each institutional size and indicates both the number of sections and percentages of all remedial/developmental math courses offered in each delivery format. The small institutions seem to favor the traditional delivery method as reflected in the 72.67% of the 150 total sections offered in that delivery format. Medium institutions offer similar proportions in traditional and hybrid delivery, both approximately 42%. The large institutions clearly favor the hybrid delivery format with almost two-thirds of the total 1,271 sections offered in that delivery format. It is interesting to note that no small institution offered a section of remedial/developmental math in the computer-based delivery format. The size of an institution does seem to be associated with the delivery format offered in gatekeeper remedial/developmental math courses.

Table 3

Sections of all remedial/developmental math courses offered in each delivery format by institutional size

	Traditional		Hybrid		Computer based	
	n	%	n	%	n	%
Small	109	72.67%	41	27.33%	0	0.00%
Medium	228	42.93%	217	40.87%	86	16.20%
Large	282	22.19%	831	65.38%	158	12.43%

Table 4

Distribution of delivery formats in all remedial/developmental math courses

College	Traditional	Hybrid	Computer based
Small A	6	0	0
Small B	0	5	0
Small C	0	14	0
Small D	0	20	0
Small E	8	0	0
Small F	33	0	0
Small G	46	0	0
Small H	7	0	0
Small I	9	2	0
Medium A	73	0	22
Medium B	0	23	2
Medium C	0	52	1
Medium D	0	39	0
Medium E	0	43	4
Medium F	22	0	1
Medium G	65	0	0
Medium H	31	20	19
Medium I	3	40	0
Medium J	34	0	37
Large A	0	175	5
Large B	47	47	0
Large C	95	3	2
Large D	62	8	6
Large E	0	47	0
Large F	0	210	0
Large G	0	120	0
Large H	78	0	132
Large I	0	221	13
Totals	619	1089	244

The data in Table 4 represent the distribution of delivery formats of all levels of remedial/developmental math by institutional size. For the purposes of this study, small institutions are those with full-time enrollment of 3,000 or less. Medium institutions are those with full-time enrollment greater than 3,000 and smaller than 9,000. Large institutions are those with full-time enrollment greater than 9,000. All figures are taken from the Florida Community College 2002 Fact Book. Table 4 also illustrates the combination of delivery formats that are offered at each of the 28 institutions. It is interesting to note that only one medium institution and two large institutions offered sections in all three delivery formats.

Table 5

Proportion of all remedial/developmental math sections by delivery format

Delivery format	# of sections	% of all remedial/developmental math
Traditional	619	31.7%
Hybrid	1,089	55.8%
Computer-based	244	12.5%
Total	1,952	58.4% of all math courses

According to the data in Table 5, the sections of all remedial/developmental math courses offered in a traditional delivery format account for almost one-third of the total number of sections. Hybrid sections comprise more than half the total remedial/developmental math sections in the 28 community colleges in the state. Only one-eighth

of all remedial/ developmental math sections in the state were offered in a wholly computer-based delivery format. The gatekeeper sections reflect almost 60% of all remedial/ developmental math sections. Sections of all levels of remedial/developmental math taught in a traditional delivery format account for 31.7% of the total remedial/ developmental math curriculum. The hybrid delivery sections are 55.8% of all levels of remedial/ developmental math. The computer-based sections account for 12.5% of all levels of remedial/developmental math in the state.

Table 6

Distribution of all remedial/developmental math sections by delivery format and course

	MAT 0001	MAT 0002	MAT 0012	Gatekeeper courses		Totals
				MAT 0020	MAT 0024	
Traditional	0	153	115	10	341	619
Hybrid	2	135	293	203	456	1,089
Computer- based	0	38	67	4	112	221
Online	0	2	7	0	14	23
Totals	2	328	482	217	923	

Table 6 represents the number of sections of all levels of remedial/developmental math courses in each delivery format, with particular focus on the number of sections of gatekeeper courses. Once the MAT 0020 and MAT 0024 courses were identified as the

gatekeeper courses, clear parameters were established to identify the 1,140 of the total sections that were sections of the two gatekeeper courses and therefore, included in the research analysis in this study. The 1,140 sections of the gatekeeper courses account for 58% of all remedial/developmental math courses in the state. The total number of sections of all levels of remedial/developmental math is 1,952. Although the 812 sections of non-gatekeeper remedial/developmental math courses were not included in further research analysis, it is interesting to note the proportions of gatekeeper and non-gatekeeper sections across the state, particularly when sorted by delivery format. Gatekeeper sections account for 58.4% of all remedial/developmental math sections in the state.

The fully online sections were only 1% of the total 1,952 remedial/developmental math sections shown in the printed schedules. When focusing on all courses of remedial/developmental math in the state, only 23 sections were identified as fully online sections. The fully online gatekeeper sections were only 14 of the 23 fully online sections at all levels and only 1% of the total number of gatekeeper courses. For the purposes of this study, and since the incidence of the fully online sections of gatekeeper remedial/developmental math was so small, these 14 sections were combined with the other computer-based sections for analysis.

There was considerable inconsistency in the course descriptions provided to students regarding the remedial/developmental math track shown in the college catalogs throughout the state. Additional inconsistencies exist in the ways that sections are presented in the printed schedules, details that may be confusing as students try to determine the delivery format of the section they chose. It is not always clear if a section

was offered in a traditional, hybrid, or computer-based delivery format. The catalog descriptions were sometimes so clear that a student selecting a course would not have difficulty in knowing which of the courses to take and what options of delivery formats were available. However, in other cases, the catalog descriptions and printed schedules were either contradictory or not very clear and left room for uncertainty regarding whether or not the course would be offered in traditional, hybrid, and/or computer-based delivery formats. In these instances, the student might not have sufficient information to be able to make the most appropriate selection very easily. Individual sections in some printed schedules were very clearly identified as based on a specific software program, while others were less clearly identifiable in the printed schedules, leaving the student with insufficient information to make the most informed decision about section selection. If the technology component was not clearly listed in the schedule, the student might have been surprised to find the first day of class in a computer lab or a student who would really prefer the technology component might not register for that section since the technology element was not stated clearly. While many students may not be concerned about the delivery format of the section that they select, the delivery format might be an important factor for a student whose computer literacy is limited. One schedule showed that all students who placed into remedial/developmental math were to be initially registered into the gatekeeper course and then would be placed downward into a lower level remedial/developmental class, depending on the placement test score.

One alternative that provides more options for students found in the schedules of seven institutions is the combination of two courses that allows students the opportunity to complete all requirements for the full remedial/developmental track in a single course.

The seven community colleges that offered an option to take one integrated course instead of multiple courses sometimes offered that course with a lower number of credit hours than the total of the two course sequence. For instance, if the two-step sequence was two 3-credit hour courses, the integrated course might have been one 5-semester hour course. There are several details that do not appear in either college catalogs or in the printed schedules. For instance, if there are additional criteria that restrict a student's eligibility to take these integrated sections, there is no explanation given in either the college catalog or in the printed schedule to provide that information. Another detail that might be missing is any indication whether or not the student might have been restricted from registering for the integrated course without being placed directly into it by meeting specific criteria. For instance, there might be a restriction that a student cannot register into the integrated section without an authorizing signature, a certain score on a diagnostic instrument given after the initial placement test, and/or an initial placement test score above a certain cut-off score. Four institutions created classes that were coded as the hybrid format by offering a separate lecture section with co-requisite lab. As defined earlier, the separate lab sections were not counted if required as co-requisite with a lecture section. While the state definition of a course with a C suffix is a combination course, there was no indication that this was consistently enforced in the way that sections were offered and presented in the printed schedules. Other suffixes were used throughout the state without clear explanations of their meaning. These details are the types of information that the student might want to know prior to registering for a particular section.

The data in Table 7 indicates the comparison between the proportions of all levels of remedial/developmental math sections with particular focus on the sections of gatekeeper remedial/developmental math in all 28 institutions. This comparison indicates that the percentage of the gatekeeper sections of remedial/developmental math delivered in the traditional delivery format of courses is 1.7% less than the percentage of the remedial/developmental math courses at all levels that are delivered in the traditional delivery format. The percentage of gatekeeper sections of remedial/developmental math delivered in the hybrid delivery format is 3% greater than the percentage of the remedial/developmental math courses at all levels that are delivered in the hybrid delivery format. The percentage of gatekeeper sections of remedial/developmental math delivered in the computer-based delivery format is 1.4% less than the percentage of the remedial/developmental math courses at all levels that are delivered in the computer-based delivery format.

Table 7

Proportion of gatekeeper courses compared to all remedial/developmental math courses

Delivery format	Portion of all remedial/ developmental math n=1,952	Portion of only gatekeeper sections n=1,121
Traditional	31.7%	30.0%
Hybrid	55.8%	58.8%
Computer-based	12.5%	11.1%
Totals	100%	100%

Table 8 provides percentages to compare the proportion of all levels of remedial/developmental math sections offered in each delivery format and by institutional size compared with only gatekeeper sections of remedial/developmental math courses in each delivery format and by institutional size. The proportion of gatekeeper sections of remedial/developmental courses offered in each delivery format does not mirror the proportion of all remedial/developmental math courses offered in each delivery format. In the small and medium institutions, the percentage of gatekeeper sections offered in the traditional delivery format is greater than the number of sections offered in the traditional delivery format in all levels of remedial/developmental math courses. The number of sections offered in each delivery format at the large institutions is just the opposite. Large institutions offered less of their gatekeeper sections of remedial/developmental math sections in a traditional delivery format than they offered in all levels of remedial/developmental math courses. In the small and medium institutions, the percentage of gatekeeper sections offered in the hybrid delivery format is less than the number of sections offered in the traditional delivery format in all levels of remedial/developmental math courses. The number of computer-based sections of all levels of remedial/developmental math is greater than found when focusing on only the gatekeeper sections in institutions across the state without regard to institutional size. In summation, the small and medium institutions offer a larger percentage of traditional delivery gatekeeper sections and less in the hybrid delivery format than the percentage of all traditional delivery sections. The percentage found in large institutions is just the opposite. The percentage of traditional delivery sections comparing all remedial/developmental math

sections with only the gatekeeper sections reveals a larger percentage in the hybrid delivery format and less in the traditional delivery format.

Table 8

Percentages of all remedial/developmental math courses compared to gatekeeper

remedial/developmental math courses by delivery format and institutional size

	Small < 3,000 FTE		Medium 3,000-9,000 FTE		Large >9,000 FTE	
	All	Gatekeeper	All	Gatekeeper	All	Gatekeeper
Traditional	72.2%	78.2%	42.9%	48.4%	22.2%	19.7%
Hybrid	27.2%	21.8%	40.9%	36.1%	65.4%	69.6%
Computer-based	0.06%	0.0%	16.2%	15.4%	12.4%	10.7%
	100%		100%		100%	

Table 9 represents the number of gatekeeper sections offered in each format by institutional size and the percentage of sections of gatekeeper remedial/developmental math by institutional size. It is not surprising to find that the majority of all remedial/developmental math offered in the state is found in the larger institutions. No institution in the small category was found to offer a section in the computer-based delivery format. As reported earlier, this matters a great deal if the delivery format is shown to affect student success. A summary of the remedial/developmental math offered compared with the size of the institution revealed that all 12 of the institutions that offered the gatekeeper course in multiple delivery formats had full-time enrollments of at least 3,000 and were

categorized as medium or large. For the purposes of this study, small institutions are those with less than 3,000 full-time enrollments reported in the Florida Community College 2002 Fact Book. Medium institutions are institutions that reported full-time enrollments between 3,000 and 9,000. Large institutions reported more than 9,000 full-time enrollments. No institution with full-time enrollment less than 3,000 offered its gatekeeper remedial/developmental math course in more than one delivery format.

Table 9

Number of gatekeeper remedial/developmental math sections by institutional size

	Traditional n = 337	Hybrid n = 659	Computer- based n = 125	Percentage of all remedial/developmental math that are gatekeeper sections
Small	67	18	0	56.7%
Medium	124	96	42	49.3%
Large	146	545	83	60.9%

An unexpected item of note relates to the average class size in gatekeeper sections of remedial/developmental math. Since the non-gatekeeper sections were previously excluded from this study, it is unknown if the average class sizes are similar in non-gatekeeper remedial/developmental math. Figure 1 represents the range of class sizes of all gatekeeper sections of remedial/developmental math, from 5 to 60 students. Six sections with enrollments less than 5 were excluded from this study since the passing rate would be so easily influenced by the performance of a single student. The most frequent occurrence in class size was 29 students, with a definite clustering between 24 and 33

students and few sections with a larger than 36 average class size. The overall average class size in gatekeeper remedial/developmental math sections was 25.811.

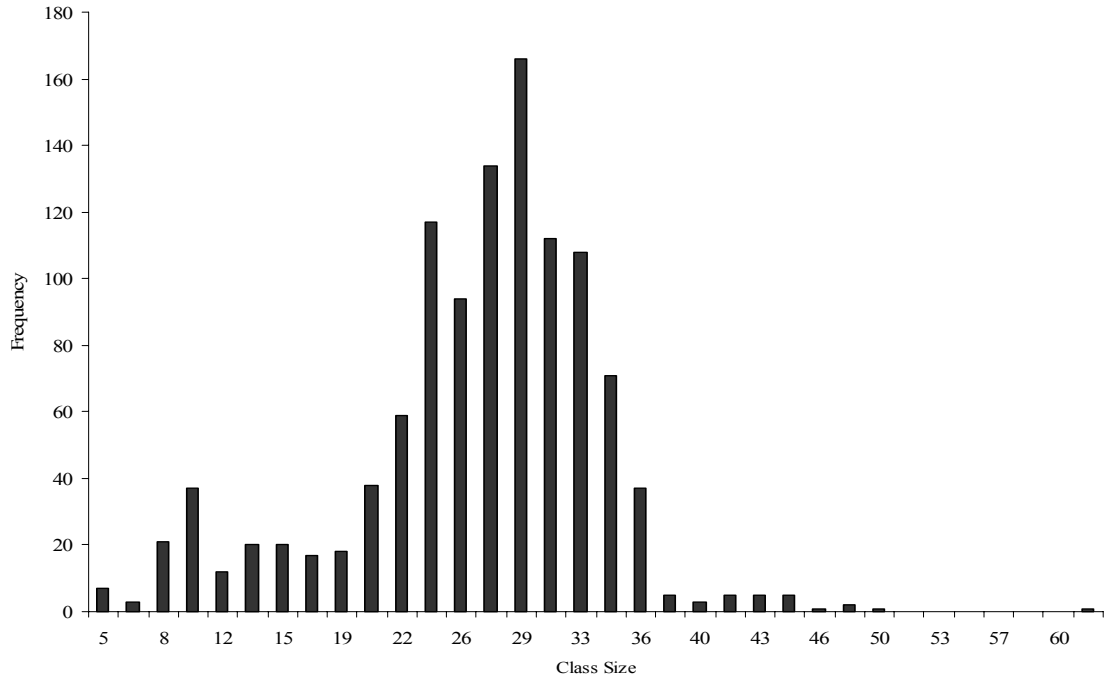


Figure 1 Average class size in gatekeeper remedial/developmental math classes

Table 10 represents the average class by delivery format. The class sizes in gatekeeper remedial/developmental math classes showed a wide range. The average class size is sometimes presented in state data as 25 students in all remedial/developmental math classes. The average class size in all gatekeeper sections in these data is consistent with the class size from the state. It is interesting to note that the smaller average class size is found in computer-based sections. One might expect that the computer-based sections could accommodate a larger number of students.

Table 10.

Average class size of gatekeeper remedial/developmental math sections by delivery format

	n	Average class size
Traditional	337	25.298
Hybrid	659	27.771
Computer-based	125	16.864

Research question 2. The second research question was “Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math sections (usually MAT 0024C) in Florida community colleges?”

The data in Table 11 indicate that the passing rates do reflect a significant difference in student success between sections in the different delivery formats and provides the justification to support the suggestion that the traditional delivery format might contribute to increased student success in remedial/developmental math. The initial analysis only shows that there is a difference, but does not indicate which delivery method appears to be more successful than another. A Tukey test of honestly significant difference (HSD) revealed that the student pass rate for sections in the traditional delivery method is significantly higher than are found in sections in the other two delivery methods at the $\alpha = 0.05$ level. Recognizing that the mean passing rates of each group do differ, the researcher examined the pass rates of sections in each delivery method

more closely. This comparison supports the conclusion that the traditional delivery method appears to be associated with student success more than the other two delivery methods contribute to student success. The pass rate for sections of remedial/developmental math in the traditional delivery format was 53.5%. The pass rate for sections of remedial/developmental math in the hybrid delivery format was 48.6%. The pass rate for sections of remedial/developmental math in the computer-based delivery format was 45.9%. The overall passing rate of all gatekeeper sections of remedial/developmental math is 49.6%.

Table 11

Analysis of passing rates in gatekeeper sections of remedial/developmental math sections by delivery format

Delivery method	Total # of sections	Passing rate
Traditional	337	53.5%
Hybrid	659	48.6%
Computer-based	125	45.9%
All	1,121	49.6%

A three-level one-way analysis of variance presented in Table 12 demonstrates that the mean passing rates of the sections using the three delivery formats are significantly different from each other ($p = <0.0001$). The F value and p value rejected

the null hypothesis indicating that differences do exist in the means among the three groups. The researcher conducted Levene's test of homogeneity of variance to test the ANOVA assumption that the variance in each group is the same. Since the Levene statistic was not significant at the .05 level, the researcher failed to reject the null hypothesis, concluding that the groups are homogenous in variances. Although this analysis shows that there is a difference between delivery methods, further analysis is necessary to draw any conclusions about which delivery method is more successful.

Table 12

Analysis of variance summary table - Student success and delivery format in gatekeeper remedial/developmental math sections

Source	df	Sum of Squares	Mean Square	F value	Pr > F
Between groups	2	0.7630	0.3815	15.24	<.0001
Within groups	1117	27.9709	0.0250		
Total	1119	27.7339			

Research question 3. Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math sections (usually MAT 0024C) in Florida community colleges while controlling for initial placement test scores?

The results of the analysis of covariance listed in Table 13 indicate that the interaction between the placement test score and the delivery format variables is significant. Furthermore, the statistically significant F value (alpha =.05) for the covariate indicates that the analysis of covariance is not the most appropriate test to assess the relationship between delivery format and outcomes.

Table 13

Analysis of covariance summary table - delivery format while controlling for CPT score in gatekeeper remedial/developmental math sections

Source	DF	SS	Mean Square	F value	Pr > F
CPT score (C)	1	0.0067	0.0067	0.27	0.6013
Delivery format (D)	2	0.1816	0.0909	3.67	0.0258
C x D interaction	2	0.3057	0.1528	6.18	0.0022
Residual	1092	27.0208	0.0247		

Following the inconclusive results of the analysis of covariance, the researcher pursued another avenue to assess the interactions between the CPT score and delivery method with an investigation of possible correlations between the CPT placement test score and pass rate compared to each delivery method. Regression supports a comparison between the possible interactions between CPT score and delivery formats and the relationships between the pass rates and delivery formats.

Table 14

Mean CPT scores of gatekeeper remedial/developmental math by delivery method

	n	Mean	SD
Traditional	337	46.242	8.9058
Hybrid	659	48.093	5.0998
Computer-based	125	44.501	6.6600

Table 14 lists the mean CPT scores and standard deviations for students enrolled in sections offered in each delivery format. The sections that are offered in a hybrid delivery format list a higher average section mean and a lower standard deviation than do the other two delivery formats. These data show that traditional delivery sections have the greatest variety in CPT scores. The effect size for traditional delivery is small for both combinations involving the traditional delivery sections. Cohen's d for traditional and hybrid is -0.255 and 0.221 for traditional and computer-based. The effect size in comparing the means of the hybrid and computer-based delivery formats is medium with Cohen's d 0.605.

The interactions between pass rates and delivery formats are presented in Figures 2 and 3 in two different layouts. Figure 2 represents the scatter plots and lines of regression of each delivery method while Figure 3 removes the scatter to focus on the lines of regression. The scatter points are important because they show that there is huge variety in the test scores for all delivery methods. Figure 2 reveals the clustering around the middle of both axes with a considerable amount of scatter. The first glance at this

scatter plot and regression lines might leave the general impression that there is no significant difference in the relationship between CPT score and pass rate.

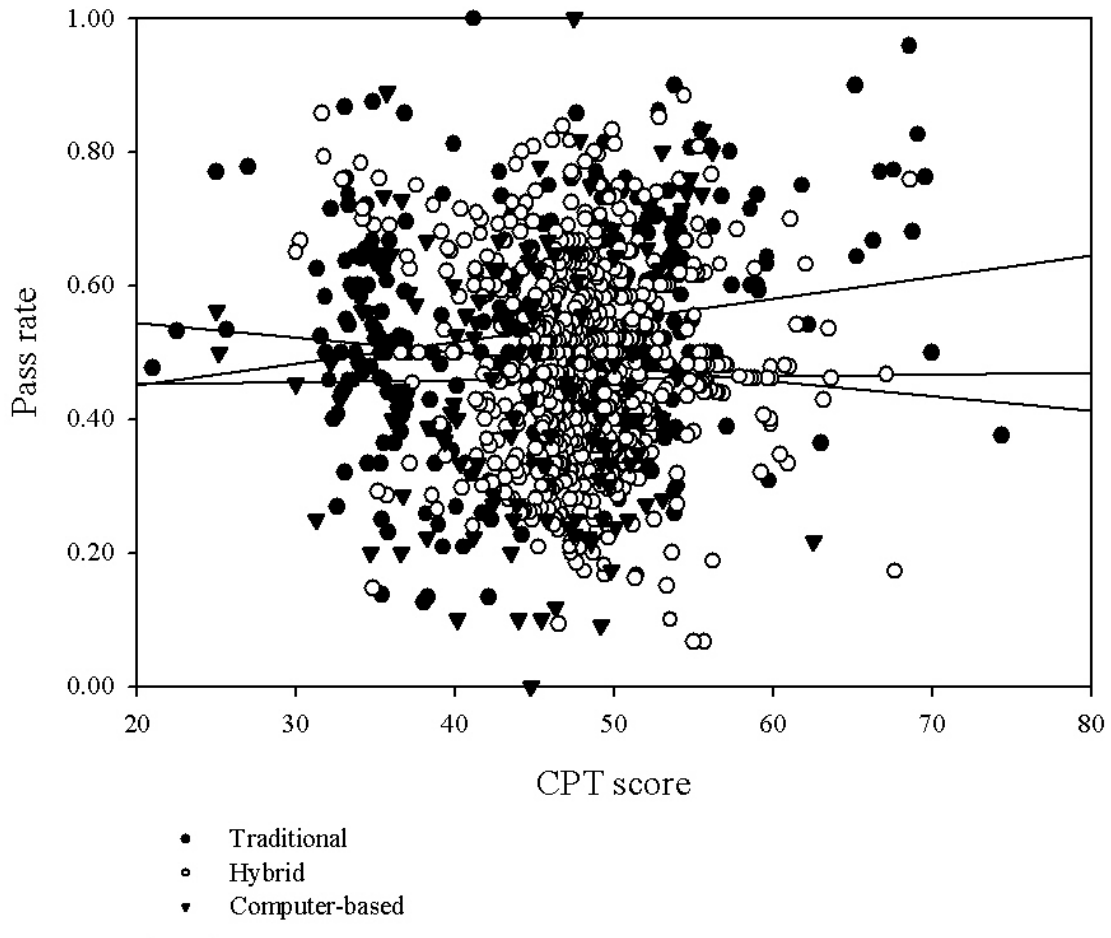


Figure 2. Comparison between CPT score and pass rate by delivery method

Upon closer examination of each delivery format viewed in Figure 3 with the scatter points removed, however, differences do emerge. The data seem to suggest that the student with higher CPT scores may have a greater likelihood of success in a traditional delivery course than in sections either the hybrid or computer-based delivery

methods. This is consistent with the finding in the second research question but delves deeper into the interaction between the placement test score and pass rate for a student enrolled in a section delivered in the traditional delivery format.

In the traditional delivery sections, a student with a CPT score of 20, at the lower end of the 60-point range, might expect a 45% chance of success in the course while the student whose CPT score is near 80, at the upper end of the range, might expect a 65% chance of success in the course. Conversely, the range of expected success for the hybrid delivery sections decreases from 54% to 41% as the student's CPT score increases. In the computer-based sections, the range of expected success is relatively stable, with a 45% chance of success at the lower end of the CPT score range and 46% chance of success at the upper end of the range. A student's CPT score seems to increase the expectation of passing the course as the CPT score increases when the student is enrolled in a traditional delivery format and decrease the expectation of passing the course as the CPT score increases when the student is enrolled in a section offered in the hybrid delivery format. A student's CPT score does not seem to increase or decrease the expectation of passing the course for computer-based delivery format. Figure 2 highlights the apparent interaction between CPT score and pass rate for traditional delivery.

Removing the scatter points that were presented in Figure 2, Figure 3 illustrates the interaction between CPT score and passing rate when focusing on the regression lines while allowing comparison between lines of regression by delivery format. This view indicates that the pass rate for sections offered in the traditional delivery format increases as the average CPT scores in those section increases. Conversely, the pass rate for sections offered in the hybrid delivery format decreases as the average CPT scores in

those section increases. This seems to contradict the findings from question 2 and calls for further investigation before any conclusions are drawn.

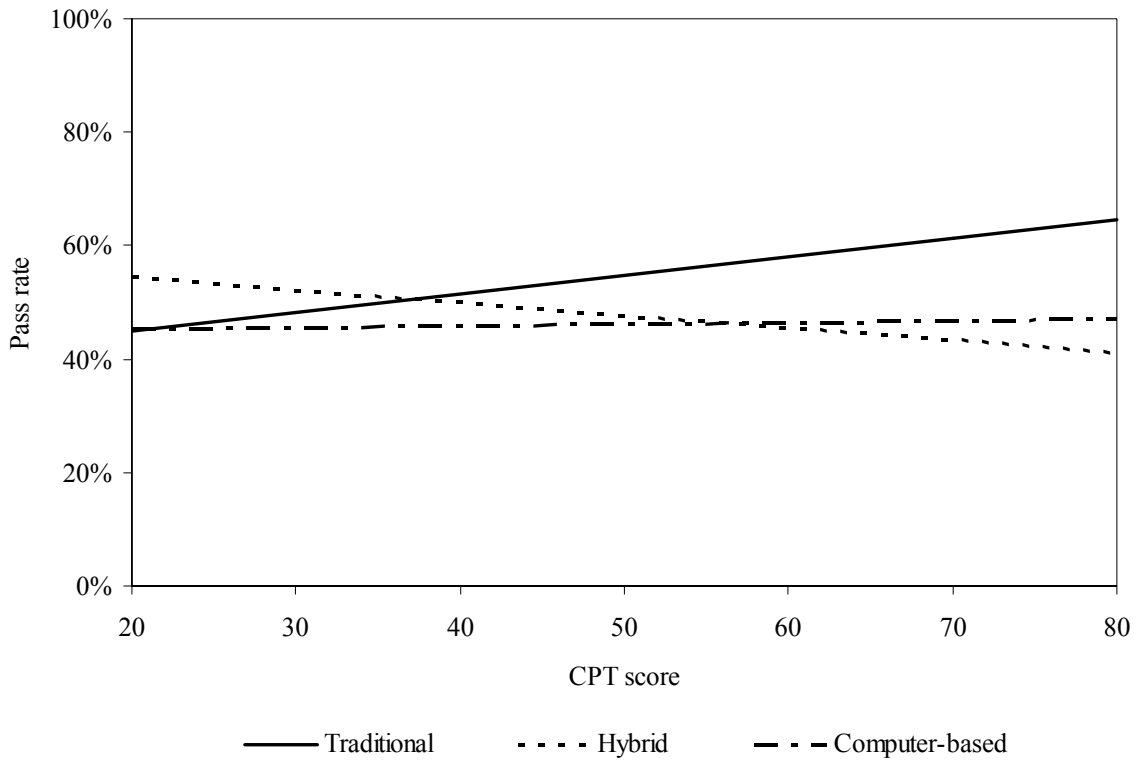


Figure 3. CPT score and pass rates by delivery format for all gatekeeper remedial/developmental math sections

To provide the foundational comparison for examining each delivery format individually, Table 15 presents the mean placement test scores for each delivery format. Sections presented in the traditional delivery format reflect the lowest mean and sections presented in the hybrid delivery reflect the highest mean in hybrid delivery format.

Table 15. Mean placement test scores for each delivery format

Delivery format	Mean
Traditional	46.242
Hybrid	48.093
Computer-based	44.501

To expand this line of thinking further, it is relevant to compare the proportions in each delivery format compared to the means reported in Table 15. Figure 4 represents the mean placement test scores for each delivery format ranged from a low mean CPT score of 44.501 in the computer-based delivery sections to a high mean CPT score of 48.093. The mean CPT score for sections in the traditional delivery format was 46.242.

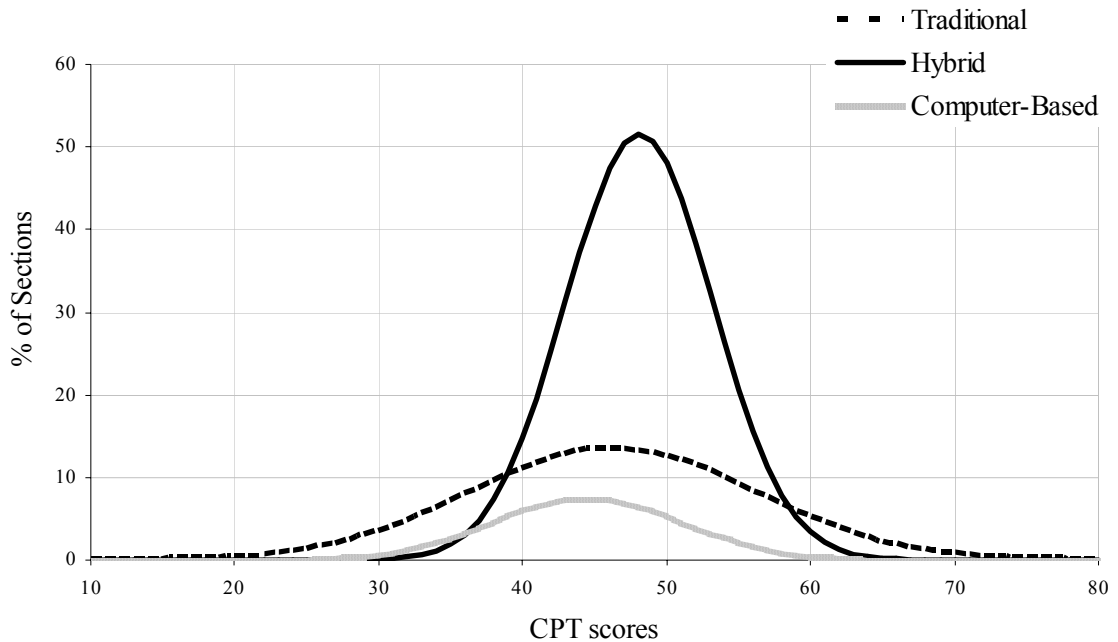
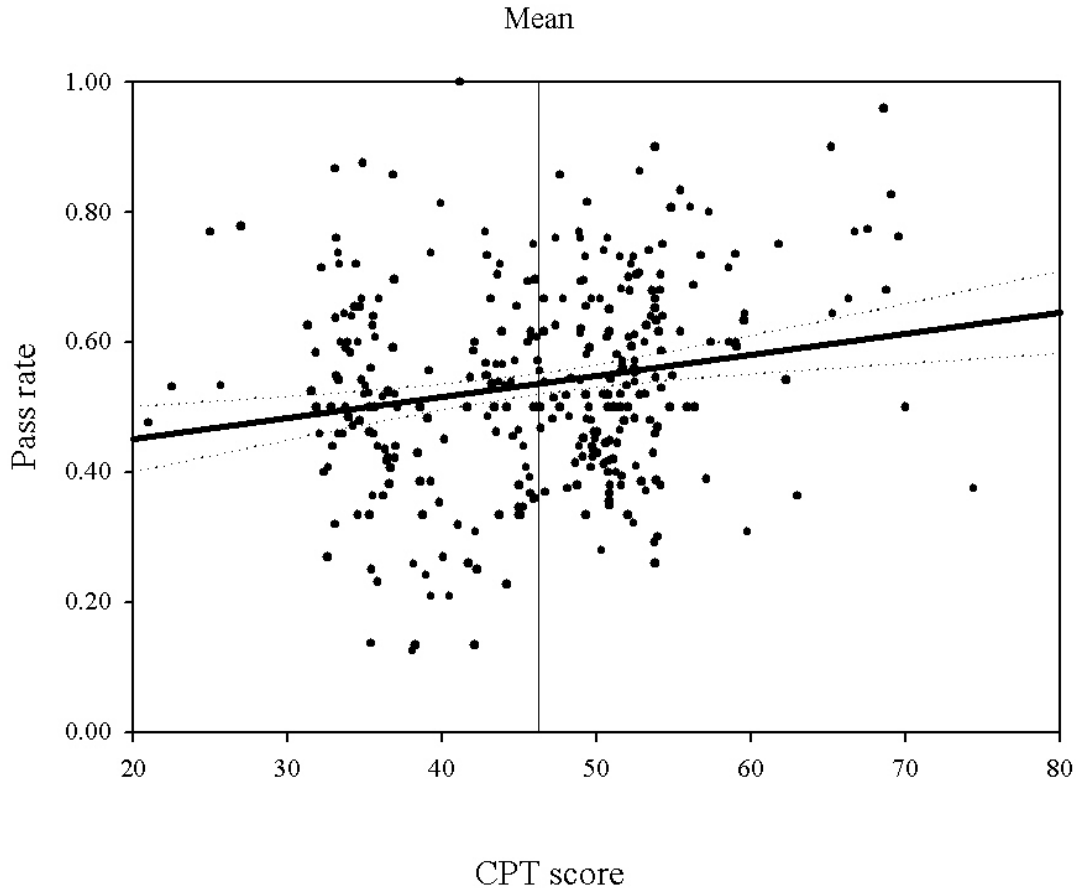


Figure 4. Distribution of mean placement test scores in three delivery formats

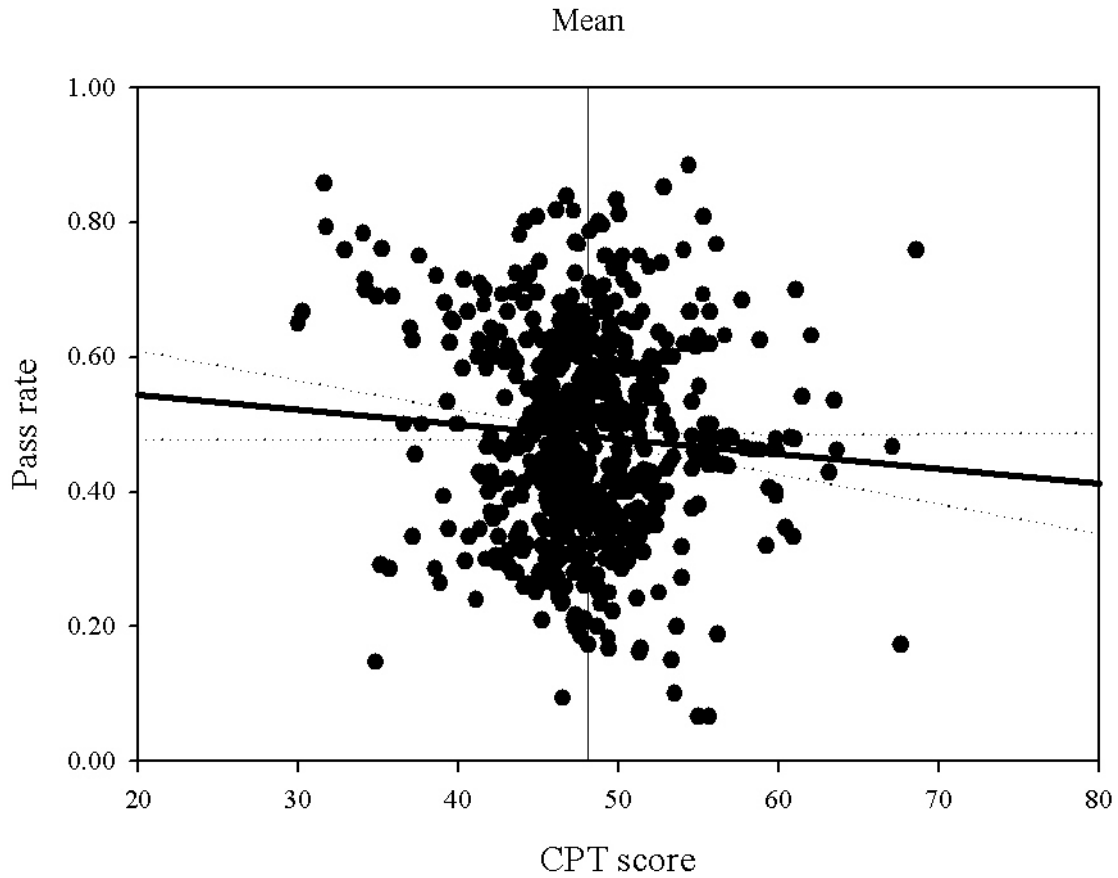
Figure 4 represents a proportional distribution of placement test scores by delivery format while controlling for CPT score. This view of the same data represents a visual comparison between the passing rates while controlling for the incoming placement test score – particularly showing the relative size of each group and the centering of each delivery format mean.



n = 337	mean	SD
Pass rate	0.5357	0.1529
CPT score	46.2422	8.9058

Figure 5. Correlation between CPT score and pass rate for traditional delivery sections of all gatekeeper remedial/developmental math

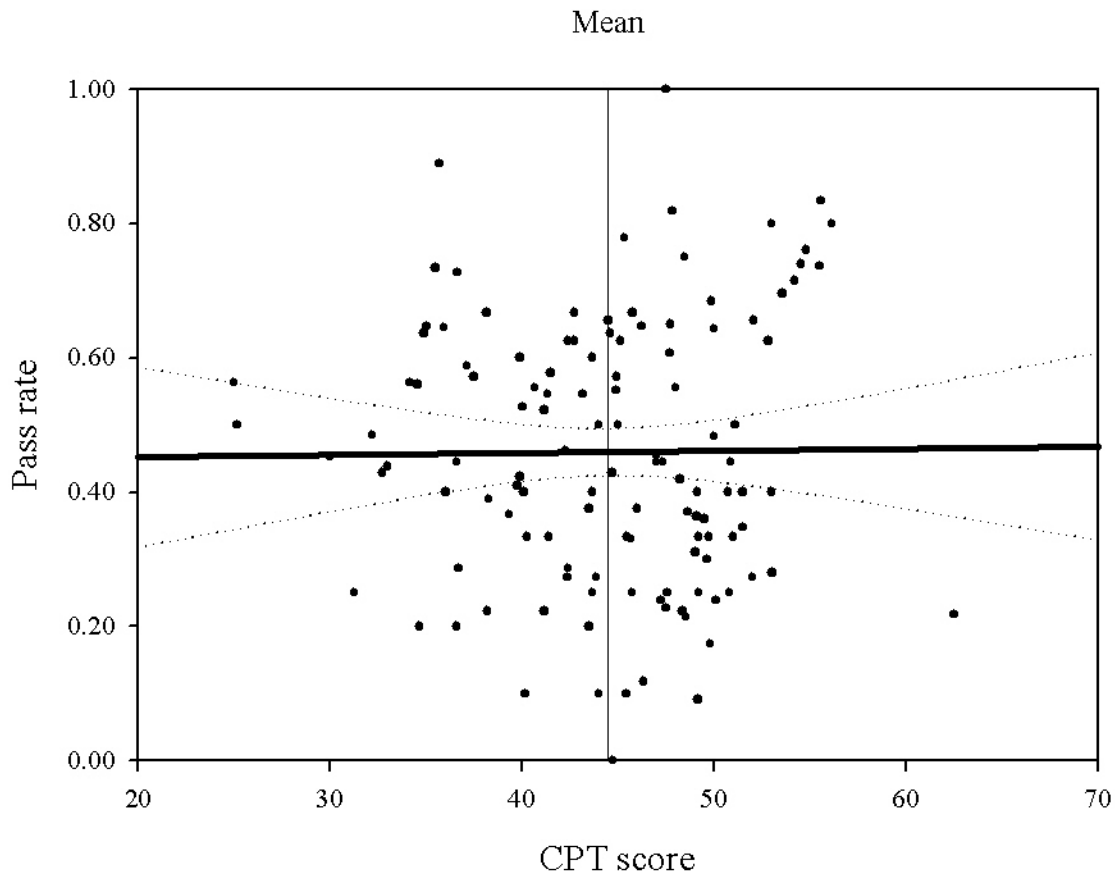
Focusing on the regression lines of each delivery format, it is easier to identify patterns in each delivery format. Figure 5 presents the scatter plot with 95% confidence intervals for sections in traditional delivery. With an increase of 20% in expected student success from the low end to the high end of the CPT range, the data suggest that there is a positive relationship between CPT score and student success in traditional delivery.



n = 659	mean	SD
Pass rate	0.4817	0.1521
CPT score	48.0926	5.0998

Figure 6. Correlation between CPT score and pass rate for hybrid delivery sections of all gatekeeper remedial/developmental math

The scatter plot with 95% confidence intervals for sections with hybrid delivery format is presented in Figure 6. A decrease of 13% in the rate of success from the low end of the CPT range to the upper end suggests that there is a slightly negative relationship between CPT score and student success in the hybrid delivery format.



n = 125	mean	SD
Pass rate	0.4597	0.1978
CPT score	44.5005	6.6600

Figure 7. Correlation between CPT score and pass rate for computer-based delivery sections of all gatekeeper remedial/developmental math

As shown in Figure 7, the line of regression and scatter plot for sections with computer-based delivery format seems to be truly scattered without any apparent clustering. With a relatively stable pass rate, less than 1% variation from the low end to the upper end of the range, the data suggest that there is no relationship between CPT score and student success in the computer-based delivery.

Research Question 4

Is there a relationship between student success and the technology-assisted delivery format of remedial/developmental math classes in community colleges in Florida while controlling for instructor influence?

The occurrence of an individual faculty member teaching in multiple formats was not found to be sufficient to research this question with confidence. Of the 28 community colleges in the state, only 12 were found to offer the gatekeeper remedial/developmental math course in multiple delivery formats. Furthermore, of the institutions that did offer the gatekeeper remedial/developmental math course in multiple delivery formats, the faculty assignments were most often limited to one delivery format or another. Of the 12 potential institutions that do offer the gatekeeper remedial/developmental math course in multiple delivery formats, only five institutions of those institutions actually reported a single faculty member teaching the gatekeeper remedial/developmental math course in more than one delivery format. As shown in Table 16, there were a total of 41 sections taught by 15 different faculty members. No individual faculty member taught in all three delivery formats.

Table 16

Pass rates in sections when faculty members taught in multiple delivery formats

	Traditional	Hybrid	Computer-based
Faculty A		46.7%	33.3% ¹
		42.3%	
Faculty B	45.3%		45.4%
Faculty C		78.3%	34.8%
		61.9%	
Faculty D	58.1%		37.0%
	37.5%		22.2%
Faculty E	62.5%		65.5%
			55.2%
Faculty F		63.0%	17.4%
Faculty G		72.0%	36.0%
Faculty H	69.2%		62.5%
Faculty I		80.8%	52.2%
		80.0%	
Faculty J		52.0%	33.3%
Faculty K	43.3%		31.0%
Faculty L	34.6%		57.1%
	76.0%		55.6%
Faculty M	86.7%		66.7%
Faculty N		48.1%	36.4%
		46.2%	
Faculty O	68.2%		65.0%
	54.5%		
Average	57.8%	61.03%	44.79%

Eight different faculty members taught a combination of traditional and computer-based delivery formats and seven faculty members taught in hybrid and computer-based delivery. There was no combination of a single faculty member teaching in traditional and hybrid delivery. Although the numbers of instances in which a single faculty member taught in multiple formats is limited, it is interesting to note that the passing rates seem to be higher in traditional or hybrid delivery sections compared to the computer-based sections.

Summary

The purpose of this research was to examine the effectiveness, as measured by student success, of technology-assisted instruction for remedial/developmental math courses in Florida community colleges. For question 1, this study shows that 55.8% of all remedial/developmental math courses in Florida community colleges are offered in a hybrid delivery format -- that is, with at least some technology component. Gatekeeper sections -- those that contain the state exit exam -- comprise 58% of all remedial/developmental math sections in Florida community colleges. Half of the Florida community colleges offer their remedial/developmental math in only one delivery format. Ninety-six percent of the 1,089 total sections of the gatekeeper course that were offered in the hybrid delivery format were offered in either medium or large community colleges. All of the 244 total sections that were offered in the computer-based delivery format were offered in medium and large community colleges.

There is little consistency in the ways that remedial/developmental math is offered in the 28 community colleges in Florida. More than half the remedial/

developmental math in Florida is offered in a hybrid delivery format. Results of this study suggest that sections of remedial/developmental math offered in the traditional delivery format might contribute to student success more often than in comparable sections offered in either hybrid or computer-based delivery.

For question 2, there is a difference in the passing rates by delivery format in Florida community colleges. The mean passing rates for each delivery format suggest that there is an increased likelihood that a student will be successful in a traditional classroom setting for the gatekeeper remedial/developmental math course in a Florida community college. Additionally, question 3 reveals that a student's likelihood of being successful in the gatekeeper remedial/developmental math course increases as the student's corresponding CPT score increases in a traditional delivery format and decreases as the student's corresponding CPT score increases in a hybrid delivery format. Results also suggest that as a student's placement test score increases, the incidence of student success in gatekeeper remedial/developmental math increases only in the traditional delivery format. In the hybrid delivery format, a student's likelihood actually decreases as the placement test score increases. There is no change in the student's likelihood of success when enrolled in a computer-based delivery format section of gatekeeper remedial/developmental math.

Question 4 reveals that there is little incidence of a single faculty member teaching remedial/developmental math in more than one delivery format. This phenomenon might suggest that a single course offered in different delivery formats would require additional work for the faculty member.

This chapter presented the resulting data analysis following the procedures described in Chapter 3. The findings show that there is much variety in the remedial/developmental math in the Florida community colleges. The data suggest that there is a significant difference in the pass rates of the gatekeeper courses in Florida community college in different delivery formats. Furthermore, the data suggest that the traditional delivery format might contribute to student success in remedial/developmental math courses in Florida community colleges.

Chapter Five

Summary of Findings, Conclusions, and Implications for Practice and Research

The purpose of this study was to investigate the effectiveness, as measured by student success, of technology-assisted instruction for remedial/developmental math courses in Florida community colleges. Furthermore, this study isolated two variables that might have been relevant as predictors of student success in these courses: placement test score and faculty variance.

For the purposes of this study, *student success* was defined as completion of the remedial/developmental math sequence and passing the statewide exit exam. The sections of remedial/developmental courses identified as *gatekeeper* sections were sorted in *traditional*, *hybrid*, and *computer-based*. *Traditional* sections are those in which a specific meeting time and place are identified and the instructor provides most of the instruction without a significant computer segment. *Computer-based* sections are those that take place in a computer lab and are completely based on computer software packages. *Hybrid* sections are those that have clearly identifiable components of lecture and computer support. Hybrid sections are a combination of the other two formats. For the purposes of this study, only the gatekeeper courses were analyzed. Gatekeeper courses are those that contain the mandatory statewide exit exam.

Method Summary

To isolate the gatekeeper sections of the remedial/developmental math courses offered in the 28 Florida community colleges, the 2002 catalogs and Fall 2002 printed schedules of each institution were analyzed to provide a concise list of the applicable courses. Each section of remedial/developmental math was coded by a taxonomy developed by the Center for the Study of Community Colleges and used in seven previous national curriculum studies. The coding revealed 1,121 sections of gatekeeper remedial/developmental courses in the Fall 2002 semester, a sufficient number of sections to analyze for statistical purposes.

Summary of Findings

Using quantitative analysis techniques, this study explored four research questions, each of which is presented below with a summary of the findings for each question.

1. What remedial/developmental math courses are offered in Florida's 28 community colleges? Does the instructional delivery format of the remedial/developmental courses offered in Florida's 28 community colleges vary by institutional size?

There were a total of 1,952 sections of all remedial/developmental math courses in the 28 community colleges in Florida in the Fall 2002 semester. More than half of these sections (1,140 of 1,952) were gatekeeper courses, that is, the courses that

contained the single common measure of student success -- passing the statewide exit exam. The gatekeeper sections comprised 58.4% of all remedial/developmental math courses. Half of the 28 institutions offered their gatekeeper remedial/developmental math course in only one delivery format. Two choices of delivery format for sections of remedial/developmental math courses were offered at eleven institutions and only three of the 28 institutions offered the remedial/developmental math courses all three delivery formats. All of the institutions that offered a choice of delivery format in remedial/developmental math courses to students were institutions with at least 3,000 FTE as reported in the *2002 Fact Book of the Florida Community College System*.

The sections offered in the traditional instructor-based lecture delivery format were 31.7% of all remedial/developmental math sections. Hybrid delivery format sections (those that include clearly identifiable segments in a traditional and computer-based laboratory format) made up 55.8% of all remedial/developmental math sections. Sections of remedial/developmental math courses that were wholly computer-based sections were only 12.5% of all remedial/developmental math sections. Of the 28 community colleges in the state, 12 institutions offered remedial/developmental math in more than one delivery format. The hybrid gatekeeper remedial/developmental courses comprised 59.3% of all remedial/developmental sections.

In summary, there is a considerable variety in the choices offered to students in remedial/developmental math classes in Florida community colleges. More variety in delivery format is offered to students in the medium and large community colleges than is offered to students in small community colleges. Students in institutions with less than 3,000 full-time enrollments are not offered any option in the delivery format of remedial/

developmental math courses. More than half of all remedial/developmental math in Florida community colleges is offered in a hybrid delivery format.

2. Is there a relationship between student success and the delivery format of the gatekeeper remedial/developmental math sections (usually MAT 0024C) in Florida community colleges?

The initial hypothesis stated earlier that the researcher expected to find a significant difference at the .05 level in the student success rate relative to the variety of formats of remedial/developmental math. An analysis of variance supports the initial hypothesis and shows that there is a significant difference ($p=.05$) in the passing rates of students who were enrolled in a traditional delivery format of the gatekeeper remedial/developmental math course. The overall passing rate of all gatekeeper sections of remedial/developmental math is 49.6%. Isolating traditional delivery format sections of gatekeeper remedial/developmental math produces 53.5% passing rate in the sections offered in a traditional delivery format, a 3.7% increase in the passing over all gatekeeper sections. In comparison, the passing rate for gatekeeper sections of remedial/developmental math in the hybrid delivery format is 48.6% and 45.9% for computer-based delivery format gatekeeper sections of remedial/developmental math. Both the hybrid and computer-based delivery format sections reflect lower pass rates than the overall pass rate of all gatekeeper remedial/developmental math sections.

While it appears that the traditional delivery format is more successful than the other two delivery formats for remedial/developmental math courses, further research is

needed to make a categorical statement to that effect. Items that should be considered in further research include a student's registration and success in subsequent math courses. Student satisfaction and faculty satisfaction are other elements to consider with delivery format and class size. Further research is also needed before this statement could be expanded to include other remedial/developmental areas, such as reading and writing. In summary, there is a significant increase in student success in sections of gatekeeper remedial/developmental math offered in traditional delivery formats, particularly as compared to the success rates in hybrid and computer-based delivery formats of gatekeeper remedial/developmental math.

3. Is there a relationship between student success and the technology-assisted delivery format of the gatekeeper remedial/developmental math classes in Florida community colleges while controlling for initial placement test scores?

The hypothesis stated earlier indicated that the researcher expected to find a significant difference at the .05 level in the student success rate relative to the variety of formats of remedial/developmental math while controlling for initial placement test scores. Conventional wisdom suggests that a technology component in remedial/developmental courses will improve student success rates. Kulik's (1994) meta-analysis that reviewed the use of computers in instruction reports that students learn more and faster in computer-based courses. Perhaps the reason for the apparent contradiction that surfaces in this study relates to the role of the instructor in computer-based instruction.

Also, the literature reported earlier points to differences in the students who are enrolled in remedial/developmental courses as compared to the whole student population.

The analysis of covariance reveals no discernable pattern of student success in gatekeeper sections of remedial/developmental math when controlling for placement test scores. However, when isolating the lines of regression and confidence intervals at the 95% level, there is a significant interaction between placement test score and student success in the traditional delivery format. This finding is consistent with the finding from the second research question. There is not a similar interaction for the hybrid or the computer-based delivery format.

Contrary to the finding related to traditional delivery format sections of remedial/developmental math, the hybrid and computer-based delivery formats do not mirror the interaction of the traditional delivery format sections. The impact of this finding suggests that students who have higher placement test scores have an increased incidence of success in the gatekeeper remedial/developmental math classes in Florida community college in a section offered in a traditional delivery format than in either hybrid or computer-based delivery formats. The sections of gatekeeper remedial/developmental math offered in a hybrid delivery format reflect a decrease in the rate of student success as their placement test scores increases. In the sections of gatekeeper remedial/developmental math offered in a computer-based delivery format, there is no interaction between placement test scores and student success. These data only partially support the initial hypothesis as the analysis of covariance was not conclusive justification of the initial hypothesis. Upon closer scrutiny, the initial hypothesis actually has differing results for the three delivery methods: traditional, hybrid, and computer-based.

4. Is there a relationship between student success and the delivery format of remedial/developmental math classes in community colleges in Florida while controlling for instructor influence?

The remedial/developmental math in Florida community colleges is most often offered in a single delivery format. In the institutions that do offer the gatekeeper remedial/developmental math course in multiple delivery formats, it is most often with an individual instructor being assigned to sections of a single delivery format. Even in the institutions that do offer gatekeeper remedial/developmental math in multiple delivery formats, the instructor assignments are usually linked to only one of the delivery formats. There were only 12 occurrences of the same instructor teaching sections of gatekeeper remedial/developmental math in Florida community colleges in more than one delivery format in the Fall 2002 semester out of the 1,121 gatekeeper sections in this study. These data reject the null hypothesis since there is insufficient evidence to validate the relationship as described in the initial hypothesis.

Conclusions

The findings of this study support the conclusion that gatekeeper sections of remedial/developmental math seem to be more successful in a traditional delivery format than in hybrid or computer-based delivery formats. Furthermore, controlling for the variable of incoming placement test scores, the data support the conclusion that students in traditional delivery format sections with higher CPT average scores have an increased likelihood of success. This study seems to show that technology assistance in remedial/

developmental math courses does not provide the help that a teacher in a traditional classroom delivery provides.

Limitations

This study has several limitations. The first and most obvious limitation is the lack of consistency throughout the state with regard to the placement test scores that place a student into remedial/developmental math courses. There is lack of reliability and validity data surrounding the mandated statewide exit exam and exact specifications as to how it will be offered and interpreted. Additionally, there is the possibility that remedial/developmental math might be offered in a non-credit schedule or by a third-party vendor. The non-credit sections offered at Florida community colleges and the remedial/developmental math offered by third-party vendors were not included in this study because of the initial parameters of the study and lack of accessibility to corresponding data on the non-credit portion of the curricula or from third-party vendors.

Implications for Practice

The results of this study lead to several implications for decision-making about remedial/developmental math in Florida community colleges. The results of this study provide several notes of encouragement for institutions that may not be able to offer as much variety in the delivery of remedial/developmental math courses as other institutions offer. There is also encouraging news in the findings for community colleges that do elect to offer remedial/developmental math in an online or wholly computer-based delivery

format. These implications and recommendations include implications and recommendations at both the state level and at the institutional level.

State level implications. At the state level, policy implications include a call for consistency across in the state in the criteria that place students into remedial/developmental math courses and definition of the avenues for students to exit the remedial/developmental math program. Changes at the state level should begin with reliability and validity norming for the statewide mandated placement test score. Texas faced this issue and chose to test their placement test for reliability and validity rather than abandon their placement test. Increased standardization throughout the state would provide more consistent data that would enhance in-depth statewide assessment and analyses of best practices.

Also at the statewide level, there are administrative implications. Two particular inconsistencies in the ways that remedial/developmental math is administered across the state contribute to a disparate implementation across the legislative assignment to the community colleges. (1) A statewide standard score for the placement test that places a student into remedial/developmental math in Florida community colleges would provide the consistency needed to accurately assess the implementation of the legislative mandate that the community colleges are responsible for remediation. (2) Additionally, a statewide standard for the criteria that allow a student to take the exit exam as well as a statewide standard for the score that is required to pass the exit exam before proceeding into college level math courses would only strengthen the program. Similarly, a consistent standard

that applies in all community colleges in the state to determine how student are placed into remedial/developmental math classes would provide a level playing ground.

Institutional implications. At the institutional level, there are identifiable bright spots in the findings of this study. The first good news is a suggestion that each delivery method may be successful, but in different ways. One item will be of interest for those institutions that may face fiscal constraints that might inhibit the purchase and the continued expense needed to support offering remedial/developmental math courses in a computer-based delivery format. These data suggest that the institution that offers remedial/developmental math in only one delivery format may not be limiting student success. The reasons for offering only one delivery format in remedial/developmental math may include limited funding, but may also be tied to a myriad of other reasons. While the possibility of fiscal constraints exists in all institutions, the problem may particularly acute at the small community colleges. The findings of this study suggest that the institutions that do not offer remedial/developmental math courses in multiple delivery formats may not restrict students by providing only one delivery format, particularly since the least expensive delivery format is the traditional delivery format. In fact, the pass rate seems to increase for students enrolled in a traditional delivery format. This may be good news from the financial perspective because the traditional delivery format is likely the most cost-effective delivery method, cost effective because the only per term cost for the institution is compensation for an instructor. This may also be good news for the student who is looking at the cost per course since the textbook in a traditional delivery format can often be reused from one term to the next and therefore,

may be available at a used book price. This study also suggests that an institution that may encounter difficulty in securing funding to support the more expensive delivery formats may not be limiting student success by not offering more options of delivery formats. The bottom line is that the data suggest that traditional chalk-and-talk approach in which an instructor teaches in a lecture-based format may be as at least as successful as the other varieties of delivery formats, if not more successful than other delivery formats.

The results of this study provide a bright spot for institutions that might have invested funds into technology to support remedial/developmental labs or courses or may have faculty members who especially want to teach in the hybrid delivery format. While there are a multitude of factors that contribute to student success, the data suggest that sections delivery in a hybrid delivery format may contribute to student success. Any institution that chooses to offer these courses in several delivery formats may certainly want to provide an option for hybrid delivery. The data suggest that the hybrid delivery format may be particularly successful with students whose placement test scores are at the lower end of the range of placement test scores.

Also at the institutional level, there is encouraging news for the institutions that have reason to offer remedial/developmental math through fully computer-based and/or online delivery formats. This may also apply to the students who have a need to find a section of remedial/developmental math course at a time or location other than the traditional class allows. The finding is simply that the pass rate seems to be about the same for students in the fully computer-based and online sections, regardless of the student's placement test score. While there may be concerns about student retention in an online section, the data suggest that any student who does complete the remedial/

developmental math course in an online delivery format will likely be as successful without regard to placement test score.

Inconsistencies in the presentation of remedial/developmental math courses in the college catalogs and printed schedules could very well lead to confusion and negative reinforcement. One institution identified two levels of remedial/developmental math in the college catalog but only one level was listed in the schedule. There was a schedule note that students should enroll in the gatekeeper level of remedial/developmental math as was listed in the printed schedule. Students would subsequently be placed into an appropriate level of math based on a cut-off score. If this is a way to allow students the opportunity to test out of the remedial/developmental math into college level math and bypass remedial/developmental math, the wording should be clearer. However, if this is a way to administratively place students into the lower level remedial/developmental math course, this student will likely perceive this as backward placement. This backward placement will surely foster a negative attitude toward remedial/developmental math and could have a negative correlation with student retention.

Several community colleges specify the lecture and lab components of the class separately but require them as co-requisites while other institutions show the courses as integrated without specifying the lab component. Some course descriptions make it very clear that there is an integrated lab component. There should be clear descriptions so that the student reading the printed schedule with section descriptions would be able to clearly identify the delivery format prior to the first day of class. While delivery format may not be a top priority in the mind of some individual students, the suggestion that there is a

difference in the likelihood of student success indicates that it may actually matter which delivery format the student chooses.

The decision-makers in each institution may want to consider the pass rates for the different delivery formats as they choose the delivery format for remedial/developmental math sections. One consideration in making these decisions might be the expense involved in each delivery format. The expenses considered might include the impact on the financial resources of (a) the institution and (b) each student who enrolls for the semester.

(a) The impact on financial resources for the institutions is largely centered on the cost of the initial hardware for a computer lab and then the ongoing expense of maintaining the hardware and personnel to staff the computer lab. Additionally, the software to support the remedial/developmental math classes might be charged as an annual license that must be constantly upgraded or calculated on a per student basis. Either way, the software costs are most likely not a one-time expenditure. If the software is purchased without the limitation of an annual license, the institution still faces the fact the newer and improved software will constantly be promoted.

(b) A student who enrolls in a remedial/developmental math course will not necessarily think about any cost differential between the different delivery formats available since the tuition charge will be calculated by the credit hours associated with the course. The student may not even realize that a cost differential might exist in the course requirements for sections offered in different delivery formats. A student who selects a section offered in a traditional delivery

format may likely have the opportunity to purchase a book that might be available as a used book at a lower cost than purchasing a new book. In contrast, the student in a computer-based section will not understand why there is no used textbook available. The computer-based delivery section may utilize a text that is actually a license that the student must purchase for a semester with a book that supports the software. In this case, the book is not one that the student will be able to sell back as a used book. The student may become confused about the book that is purchased with the software license for the semester and may not understand why it cannot be sold back to the bookstore. The book used in hybrid delivery format sections may be a combination of the other delivery formats or only a textbook. Either way, the selection of delivery format for each section should include consideration of the financial impact on each student with regard to the textbook requirement.

Implications for Research

The results of this study suggest several areas for future research:

1. *Expand this study to include remedial/developmental reading and writing.*

This study only scratches the surface in providing needed information to decision-makers who select delivery formats for remedial/developmental math courses. These findings may apply to other remedial/developmental disciplines but cannot be expanded to other areas without appropriate research to explore their applicability to other areas. Further research should be done to investigate these same questions in other remedial/developmental areas, specifically remedial/developmental reading and remedial/

developmental writing. Similarly, further study is needed to investigate these same questions using the individual student as the unit of analysis rather than the section.

2. *Compare student success in the integrated remedial/developmental course with the two or three course sequence of remedial/developmental math courses.* Since the integrated remedial/developmental math course (often MAT 0020) is not offered at all community colleges in Florida, further research is needed to analyze any difference in student success in the integrated course. If there is a significant difference in student success in the integrated course, more institutions might want to include this course in their curriculum perhaps in addition to the two-step sequence. The institutions that offer the two-course sequence in addition to an integrated course seem to offer more sections of the two-course sequence than of the integrated courses. Since this option does offer choices to the student, further research might investigate and compare the student success rates in both formats.

3. *Compare student success in computer-based remedial/developmental math courses with computer-based college level math courses.* Further research is needed to analyze some of the other factors that affect the success rate of remedial/developmental math students in computer-based classes as compared to students who are enrolled in college level math courses in a computer-based delivery format. There is research to indicate that technology in the classroom enhances the learning process. However, there are suggestions in the literature that the very factors that have led to students' placement in remedial/developmental math classes - such as inadequate preparation for college level math or lack of the self-discipline needed for college success - suggest that technology is not necessarily the most successful format for that student population. The focus of this

study did not concentrate on class size, age, or gender. One observer suggested that perhaps the student who chooses to enroll in a computer-based section feels comfortable doing so because of an increased computer literacy that is more common with younger students. On campus, an increase in computer-based classes might relate to a desire to maintain cutting edge technology in the classroom.

Summary

In summary, the implications for practice provide suggestions at the state level and at the institutional level. The first requirement might be the development of consistent standards to be applied to all remedial/developmental math courses across the state. The community college's responsibility for remedial/developmental math might include statewide tests that have been normed and validated, including both a placement test and an exit exam. Secondly, at the institutional level, decision-makers might consider the pass rates for students in all remedial/developmental math courses, particularly in the gatekeeper courses when selecting a delivery format for the course.

Implications for research should begin with similar studies in reading and writing. Further research should be done to investigate the success rate of the integrated remedial/developmental math course as compared to the two or three course sequence. Additionally, further research should to compare the success rates of students in remedial/developmental math courses and students in college level math courses. The area of remedial/developmental courses is rich with other possibilities for further study.

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Appendices

Appendix A:

Configuration of Remedial/Developmental Math Sequence

Community College	001	002	012	020	024
Small A		MAT 002			MAT 024
Small B		MAT 002			MAT 024
Small C		MAT 002			MAT 024
Small D			MAT 012		MAT 024
Small E		MAT 002			MAT 024
Small F			MAT 012		MAT 024
Small G			MAT 012		MAT 024
Small H			MAT 012		MAT 024
Small I	MAT 001	MAT 002			MAT 024
Medium A			MAT 012	MAT 020	MAT 024
Medium B			MAT 012		MAT 024
Medium C		MAT 002	MAT 012	MAT 020	MAT 024
Medium D		MAT 002			MAT 024
Medium E			MAT 012		MAT 024
Medium F		MAT 002			MAT 024
Medium G		MAT 002			MAT 024
Medium H		MAT 002		MAT 020	MAT 024
Medium I			MAT 012	MAT 020	MAT 024
Medium J		MAT 002			MAT 024
Large A			MAT 012	MAT 020	MAT 024
Large B		MAT 002			MAT 024
Large C		MAT 002			MAT 024
Large D		MAT 002			MAT 024
Large E			MAT 012	MAT 020	MAT 024
Large F		MAT 002		MAT 020	MAT 024
Large G			MAT 012	MAT 020	
Large H			MAT 012		MAT 024
Large I			MAT 012	MAT 020	MAT 024

Appendix B:

Mathematics courses offered in Fall 2002 in Florida community colleges

Course number	Course title
MAC 1105	College Algebra
MAC 1114	College Trigonometry
MAC 1140	Pre-calculus Algebra
MAC 1147	Pre-calculus Algebra/Trigonometry
MAC 1154	Analytic Geometry
MAC 1233	Essentials of Calculus
MAC 1930	Special Topics in Calculus
MAC 1932	Special Topics in Mathematics
MAC 2233	Business Calculus
MAC 2234	Applied Calculus II
MAC 2253	Calculus for Engineering Technology
MAC 2311	Calculus and Analytic Geometry I
MAC 2312	Calculus and Analytic Geometry III
MAC 2313	Calculus and Analytic Geometry III
MAD 2104	Discrete Mathematics
MAE 2801	Elementary School Mathematics
MAP 2302	Differential Equations
MAS 2103	Linear Algebra
* MAT 0002	Basic Mathematics
* MAT 0012	Basic Algebra
* MAT 0020	Integrated Arithmetic and Algebra
* MAT 0024	College Preparatory Algebra
MAT 1033	Intermediate Algebra
MAT 1325	Engineering Technology Math I
MAT 1326	Engineering Technology Math II
MGF 1106	Math for Liberal Arts I
MGF 1107	Math for Liberal Arts II
MGF 1112	Logic
MTB 1101	Business Math
MTB 1103	Business Mathematics

Appendix B (continued)

Course number	Course title
MTB 1310	Applied Mathematics
MTB 1321	Technical Algebra and Trigonometry I
MTB 1322	Technical Algebra and Trigonometry II
MTB 1327	Math for Electronics I
MTB 1328	Math for Electronics II
MTB 1348	Technical Mathematics
MTB 1370	Math Topics for Health Professionals
MTG 2204	Geometry for Teachers
MTG 2206	College Geometry
QMB 1001	College Business Mathematics
QMB 2100	Business and Economics Statistics

* indicates remedial/developmental mathematics course

Appendix C

Coding Decision Rules

Delivery format	Decision rules
Traditional delivery	Any section that appeared with a specific meeting place and time, without any additional information to specify a laboratory component, was coded as traditional. Sections that were coded as traditional were listed in the printed schedule with a specific meeting place and time and with no indication of any use of technology during the delivery of the course. The section listing in the printed schedule was compared with the course listing in the college catalog. There were cases of the course descriptions providing the only indication of the use of technology in the course. For instance, if a section was presented in the printed schedule with a specific meeting place and time and no mention of a computer lab, but the course listing in the college catalog indicated a co-requisite lab, the section was not coded as traditional.
Hybrid delivery	A hybrid class was listed in the schedule as one in which the course listing in the printed schedule contains both classroom and computer lab components. Hybrid sections were those that clearly contained elements of traditional lecture-based and technology. For instance, if the co-requisite lab was indicated in the college catalog, the co-requisite lab would provide justification to code those sections as hybrid rather than traditional. In order to be excluded from being coded as computer-based delivery, there must be an element of traditional delivery in addition to the computer lab element of the course listing. This might be shown through two different meeting places, one classroom and one computer lab.
Computer-based delivery	A computer-based section was listed in the schedule as one in which the students took the course in a computer lab for the entire class period. Sections that were coded as computer-based were those without any indication of lecture-based traditional classroom. These sections might be listed in the printed schedules as online or distance learning. Other sections were coded as computer-based if the printed schedule listing showed only a computer lab as the meeting place or if there was a printed comment that the course was based on a specific software package as the primary focus.

About the Author

Mary M. Bendickson received a Bachelor of Arts degree in Mathematics and Education in 1972 from Tift College, Forsyth, Georgia and a Master of Education degree in Counselor Education in 1975 from the University of Georgia, Athens, Georgia. More than thirty years of teaching and counseling experience in numerous educational settings involves 12 different locations including five states and two overseas locations. Her teaching assignments include Trident Technical College in Charleston, South Carolina; Virginia Beach City Public Schools in Virginia Beach, Virginia; Harrison Central High School in Gulfport, Mississippi; and a Department of Defense Dependent School (George Cannon School) on Midway Islands.

She served as guidance counselor and education specialist for military education programs at two different military bases, becoming uniquely conversant on the particulars of all branches of military service. She has served as an administrator at Hillsborough Community College in Tampa, Florida for five years