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# An evaluation of the emporium model as a tool for increasing student performance in developmental mathematics and college algebra

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*The University of Toledo*

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A Dissertation

entitled

An Evaluation of the Emporium Model as a Tool for Increasing Student Performance in

Developmental Mathematics and College Algebra

by

James K. Vallade

Submitted to the Graduate Faculty as partial fulfillment of the requirements for

The Doctor of Philosophy Degree in Higher Education

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December 2013

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## **An Abstract of**

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The purpose of this study was to examine the Emporium Model in an effort to determine the effectiveness of this strategy in increasing student performance in a developmental mathematics course as well as preparing students for a college-level mathematics course. The target population for this study was all community colleges that have redesigned their developmental mathematics courses based upon the Emporium Model. Each of the three community colleges included in this study provided data on student performance in both Intermediate Algebra and College Algebra. This study utilized a causal-comparative research design, and both a chi square analysis and independent samples t-test were employed to answer the research questions. The results show that students who took Intermediate Algebra in an Emporium format had passing rates that were higher than students who took the course in another format. Additionally, students who completed Intermediate Algebra in the Emporium format had higher passing rates and significantly higher mean grades in College Algebra than students who did not complete Intermediate Algebra in the Emporium format. Implications and recommendations for further research are included.

For Michael, Landon, Thomas, and Baby

## **Acknowledgments**

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## **Chapter One**

### **Introduction**

#### **Background of the Study**

Over the past few decades developmental education has become an important mission of the American community college as growing numbers of students enter college unprepared for college-level work. Sometimes referred to as “remedial education”, “college prep”, “compensatory education”, or “basic skills development”, the term developmental education is what is preferred and used by professionals and practitioners in the field (The Institute for Higher Education Policy, 1998; Kozeracki, 2002; Tomlinson, 1989). Developmental education, in its most general sense, refers to a wide range of courses and services that are designed and offered in hopes of increasing the retention rate of students and to help ensure the completion of their post-secondary educational goals by improving student skills, habits, and attitudes (Boylan, 2008; Boylan & Bonham, 2007).

The number of student enrollments in non-credit developmental courses has prompted Astin to describe the growing need for developmental education as “the most important educational problem in America today” (1998, p. 12). It is estimated that about 30% of all students entering a post-secondary institution require some form of developmental coursework (Bahr, 2007; Chung, 2005). In 2007, developmental courses were offered at 100% of community colleges, 80% of public four-year institutions, and 59% of private four-year institutions (Taylor, 2008). During this time, 63% of students who attended only a two-year institution and 64% of those who attended both two and four-year institutions enrolled in at least one developmental course (Tierney & Garcia, 2008). The

American Association of Community Colleges estimates that at the community college level approximately 60% of entering freshmen are not ready for college-level work (Stuart, 2009) and in a statewide study of Texas community college students, it was found that 88% took some developmental courses, typically developmental mathematics (Boyer, Butner, & Smith, 2007). The numbers in California are even worse where the Community College Chancellor's Office reports that up to 90% of first-time community college students test below college level in math and over 70% test below college level in reading and writing (Moore & Shulock, 2007).

Although developmental education usually encompasses the areas of math, reading, and writing, students are most likely to need assistance with math (Bahr, 2007; Le, Rogers, & Santos, 2011). For example, 22% of first-time college students enrolled in developmental math courses, compared with 14% who enrolled in developmental writing and 11% who enrolled in developmental reading (Parsad, Lewis, & Greene, 2003). Similarly, Adelman (2004) found that 34% of students earn credits in developmental math compared to 18% in developmental reading. Community colleges are of primary interest when it comes to developmental education due to the fact that they constitute the primary venue in which developmental education is delivered (Bahr, 2008b). For example, a recent study of institutions participating in *Achieving the Dream*, a national initiative to improve student success at community colleges, found that more than half of all the students attending the participating community colleges were referred to developmental math courses and that 19% of these students were directed to math courses that were three levels below college-level math (Le, Rogers, & Santos, 2011). In a study of California community college students, Bahr found that over 80% of first-time

freshmen who enrolled in non-vocational math enrolled specifically in developmental math.

In recent decades, educational professionals have increasingly turned to advances in technology and computer-assisted instruction in an attempt to improve the outcomes of developmental mathematics courses and programs. Computer-assisted instruction refers to the use of technology to supplement or replace various elements of a traditional course. Computer-assisted instruction can allow for the delivery of instruction that provides students the opportunity to work through the content at their own pace during some portion or all of classroom time, with the instructor providing various degrees of interaction through lecture and individualized attention (Hodora, 2011). Computer-assisted instruction also includes course redesign models, sometimes referred to as computer-mediated learning, which are a growing trend in the field of developmental mathematics (Epper & Baker, 2009; Twigg, 2005). These models replace some or all of the face-to-face interaction with self-paced content that is delivered through an online delivery system. These models have proven successful in reorganizing the curriculum to allow accelerated student learning and completion of educational requirements for the course (Speckler, 2012). It is hoped that the utilization of these models in the developmental mathematics classroom can increase student performance and retention by increasing the intensity of the course and allowing for accelerated student learning, variables that have shown some promise for improving overall academic accomplishment (Bailey, Jeong, & Cho, 2010; Epper & Baker, 2009; Rotman, 2012).

One specific type of computer-assisted instruction is known as the Emporium Model. The Emporium Model achieves reform by (1) eliminating all lectures and replacing them

with a learning resource center model featuring interactive software and on-demand personalized help, (2) relying on instructional software that includes homework, quizzes, and tests, and features immediate feedback to the student, (3) allowing students to work through the material at a pace that is appropriate for them, (4) using a staffing model that utilizes faculty and both professional and peer tutors, and (5) allowing the students to complete more than one course within a semester (The National Center for Academic Transformation, 2012a).

### **Statement of the Problem**

Due to the large numbers of students enrolled in developmental education and the costs associated with these programs, the need for sound and comprehensive research on the issue of developmental education is apparent. Surprisingly, few methodologically sound, multi-institutional, comprehensive evaluations of developmental education programs have been published (Bahr, 2008b) and little is known about whether developmental education programs are an effective tool in helping students stay in college and complete their academic goals (Moore, Jensen, & Hatch, 2002). Research regarding the effectiveness of developmental education programs is sporadic, underfunded, and the results are often inconclusive with an overwhelming majority of institutions not conducting any type of systematic evaluation of their developmental education programs (The Institute for Higher Education Policy, 1998).

Although developmental education usually encompasses the areas of math, reading, and writing, students are most likely to need assistance with math (Bahr, 2007; Le, Rogers, & Santos, 2011). Community colleges are of primary interest when it comes to developmental education due to the fact that they constitute the primary venue in which

developmental education is performed (Bahr, 2008b). Although developmental mathematics education is accessed by a large number of students, there is very little empirical research on this topic (Hodora, 2011). In one study, The Community College Research Center conducted an analysis of *Achieving the Dream* data and found that only 31% of students who were referred to developmental mathematics completed the course or courses within three years and only 20% eventually completed a college-level mathematics course (Bailey, Jeong, & Cho, 2010; Hodora, 2011; Speckler, 2012). In a study conducted by Bahr (2008b), only 75.4%, or more than three out of four of the students did not successfully complete their developmental mathematics courses and 81.5%, or more than four in five, did not complete a credential or did not transfer.

According to Bahr (2007), the most fundamental principle of remediation and developmental education is equality of opportunity. That is, students for whom developmental mathematics has been successful should exhibit educational outcomes that are comparable to those students who did not require developmental coursework. Ultimately, whether or not a developmental education program is effective is best decided by considering factors that include whether or not students are successfully completing the developmental education courses and whether or not students who completed developmental courses are eventually completing college-level courses (The Institute for Higher Education Policy, 1998; Weissman, Bulakowski, & Jumisko, 1997).

### **Purpose of the Study**

The need for finding new ways to deliver effective instruction to students is evident from the abysmal statistics on developmental mathematics education. Some institutions have responded to this need by experimenting with new ways of delivering mathematics

instruction to developmental students. One of these methods is the Emporium Model and is a relatively new approach to mathematics instruction. Some community colleges have experienced improvement in pass rates for developmental mathematics students after the introduction of a course redesign such as the Emporium Model (Speckler, 2012; Twigg 2005). However, Hodora (2011) has identified many questions that still remain regarding how the improved results are connected to the course redesign. Therefore, the purpose of this study was to examine the Emporium Model in an effort to determine the effectiveness of this strategy in increasing student performance in a developmental mathematics course as well as preparing students for a college-level mathematics course.

### **Significance of the Study**

Proponents of developmental education argue that it can “provide opportunities to rectify race, class, and gender disparities generated in primary and secondary schooling and to develop the minimum skills deemed necessary for functional participation in the economy” (Bahr, 2008b, p. 420). Basic levels of reading, writing, and mathematical ability are necessary in our increasingly complex society if individuals hope to be full participants in our free market system and enjoy all of the opportunities that it offers. For students lacking the minimum competencies in these basic subjects, developmental education is essential in order to achieve economic stability (Day & McCabe, 1997). Developmental education serves a unique role in education in that it is not designed to separate students into various levels of attainment but instead serves to equalize attainment by reducing disparities among advantaged and disadvantaged students (Mills, 1998). Therefore, developmental education can help to bring opportunity to those who

may otherwise be relegated to low wages, poor working conditions and other consequences of socioeconomic marginalization (Roueche and Roueche, 1999).

Failing to complete developmental mathematics and required college-level mathematics courses will not only prevent students from earning a college degree and entering a chosen professional field, but it also has an impact on an individual's likelihood of being unemployed since young adults with low levels of quantitative literacy skills, the types of skills that are typically taught in a developmental mathematics course, are more likely to be unemployed (Hodora, 2011). Considering the potential negative consequences of failing to complete developmental mathematics, it is critical to identify potential ways to improve these courses.

Using data to inform policy decisions regarding developmental programs in higher education is a top priority of college and university officials (Lesik, 2008). On the one hand, institutions are struggling with budget cuts and higher academic standards. On the other hand, there are a large and growing number of under-prepared students who depend upon developmental programs in order to be successful at the college level.

Developmental programs also help community colleges, who traditionally have an "open door" admissions policy, fulfill their mission by creating paths of access for the under-prepared student. Consequently, effectively assessing developmental programs is essential in order to balance the demands of economic and budgeting concerns while also giving under-prepared students an opportunity to improve their skills and the likelihood of college success.

Due to the large numbers of students enrolled in developmental education and the costs associated with these programs, the need for sound and comprehensive research on

the issue of developmental education is apparent. Surprisingly, few methodologically sound, multi-institutional, comprehensive evaluations of developmental education programs have been published (Bahr, 2008b) and little is known about whether developmental education programs are an effective tool in helping students stay in college and complete their academic goals (Moore, Jensen, & Hatch, 2002). Research regarding the effectiveness of developmental education in general, and developmental mathematics specifically, is sporadic, under-funded, and the results are often inconclusive with an overwhelming majority of institutions not conducting any type of systematic evaluation of their developmental education programs (The Institute for Higher Education Policy, 1998). Although developmental mathematics education is accessed by a large number of students, there is very little empirical research on this topic (Hodora, 2011) and according to Boylan, Bonham, and Bliss (1994), only 14% of the developmental programs at two-year colleges engage in evaluations that are ongoing or systematic.

### **Conceptual and Theoretical Framework**

Although the use of technology in the United States to facilitate learning goes back to at least the 19<sup>th</sup> century, the use of computers to assist in learning is a relatively recent development that has grown with the explosion in computer technology over the last few decades. In 1953, the psychologist B. F. Skinner, a behaviorist, visited his daughter's fourth-grade class and observed a lesson on arithmetic (Benjamin, 1988). During this visit, Skinner noted several criticisms of how the technology was being used. Consequently, he proposed a method known as programmed instruction that could be utilized to facilitate the use of technology in the learning process.

Behavioral psychology has provided instructional technology with several basic assumptions, concepts, and principles and, in fact, many computer-assisted instructional designs are based upon the theory of behaviorism (Burton, Moore, & Magliaro, 1996; Hung, 2001). More than five decades ago, Skinner utilized the basic tenets of behaviorism to design his programmed instruction that could be implemented with the assistance of a teaching machine. Skinner maintained that to be effective, the instruction should require the student to compose a response rather than select it from a list (no multiple choice questions) and require the student to pass through a carefully designed sequence of steps. Skinner felt that the instruction should duplicate the experience that a student would have with a private tutor.

During the 1960's, Fred Keller introduced a model of learning that can be regarded as an extension of the theories and concepts found in behaviorism and Skinner's programmed instruction (Kulik & Kulik, 1986; Lockee, Moore, & Burton, 2004; Price, 1999). This model is known as the Personalized System of Instruction (PSI) or the Keller Plan, and it employs a highly structured, student-centered approach to course design and instruction. There has been a substantial amount of research done that shows that the PSI model is an effective instructional strategy. Kulik, Kulik, and Carmichael (1974) and Kulik, Kulik, and Cohen (1979) found that students who completed a course using the PSI model learned at least as much or more than students taught in a traditional manner and students rate PSI classes as more enjoyable, more demanding, and higher in overall quality than traditionally taught classes.

Technology and how it is utilized in the developmental mathematics classroom is only part of the analysis necessary for a comprehensive framework for this study.

Additionally, an effective theory for developmental education is needed that will focus on the structure and function of the environment and accommodate individual student differences. Such a theory for developmental education has been proposed by Wambach, Brothen, and Dikel (2000) and is known as Self-Regulation Theory. The theory asserts that the goal of developmental educators should be to develop students who are capable of self-regulation. Self-regulation is defined as “self-generated thoughts, feelings, and actions that are directed toward attainment of one’s educational goals” (Zimmerman, Bonner, & Kovach, 1996, p. 141). Self-regulation is developed by creating an environment that is both demanding and responsive. Demanding environments are those that set standards for excellence and where expectations for appropriate behavior are clearly stated and enforced. Demanding courses require students to demonstrate competence in reading, writing, speaking, and computing. Responsive environments are created by providing timely and useful feedback that is given early and often.

The Personalized System of Instruction has been demonstrated to be successful with developmental students (Bonham, 1990), and it has been argued that PSI is consistent with Self-Regulation Theory (Wambach, Brothen, & Dikel, 2000). A key feature of PSI is the requirement for mastery, which developmental theory characterizes as highly demanding (Kinney, 2001b). The nature of PSI also provides a responsive environment through the frequent feedback that students receive through both the computer software and the proctor or instructor (Grant & Spencer 2003). The demanding and responsive environment that PSI provides helps to promote the development of self-regulation in students and has been shown to be well suited for developmental education (Kluger &

DeNisi, 1996; Kulik, Kulik, & Bangert-Downs, 1990; Wambach, Brothen, & Dikel, 2000).

### **Research Questions**

This study compared students who were enrolled in a developmental mathematics class that was redesigned utilizing the Emporium Model with students who were enrolled in the same course prior to the redesign. The study attempted to answer the following research questions:

1. Is there a significant difference in student performance in Intermediate Algebra between those students who completed the class in an Emporium format versus those students who completed the class in a pre-Emporium format?
2. Is there a significant difference in student performance in College Algebra between those students who completed Intermediate Algebra in an Emporium format versus those students who completed Intermediate Algebra in a pre-Emporium format?

### **Limitations**

This study examines the outcomes of students as it relates to mathematics curriculum re-design from an ex-post facto perspective and, consequently, presents limitations to both the internal validity of the research design as well as the external validity of the ability to generalize the findings from this research to other populations and settings.

The dependent variables for this study will be the grade earned in the developmental and college-level mathematics course. Different institutions, and even instructors, may have different criteria for a particular grade and so some loss of uniformity will be present.

Another limitation, which is a possible extraneous variable, is related to the teacher differences that are unaccounted for in the data. The focus of the research is the difference between student performance based upon enrollment in a developmental mathematics class that was redesigned to utilize a computer-assisted approach and students enrolled in the same course prior to the redesign. There are undoubtedly differences in both instructional strategies and styles, especially in the pre-redesigned course that might possibly explain some of the observed differences in the dependent variable.

Finally, the data came from three relatively small, rural institutions in the South. Therefore, it may prove difficult to generalize the results to an institution of a different size, or one located in a different geographic location, or one that contains a substantially different population in terms of student demographics.

### **Delimitations**

The majority of developmental education takes place at the community college level. Consequently, this study focuses on developmental mathematics programs at the community college level and only this type of institution was chosen as a possible participant in this study.

Although community colleges have experimented with a variety of strategies and methods for improving student performance in developmental mathematics, this study focuses on a form of computer-assisted instruction known as the Emporium Model. Therefore, only community colleges that are currently utilizing the Emporium Model in their developmental mathematics courses were considered.

Because the research utilized a causal-comparative design, the ability to infer causality is severely limited. The students were not randomly assigned and there was no intervention on the part of the researcher, therefore, causality cannot be claimed. Any relationship or association discovered by the research will only be suggestive of causality. Additionally, since the participants are not randomly assigned to the two groups (Emporium Model or pre-Emporium Model) as is done in a true experimental design, there might be other variables (extraneous variables) that explain the observed differences in the dependent variable.

Finally, in an effort to obtain enough data for a meaningful analysis, only community colleges that have been utilizing the Emporium Model for at least a year were considered for this study.

### **Organization of the Study**

This study is presented in five chapters. Chapter 1 includes the background of the study, the statement of the problem, the purpose of the study, the significance of the study, the conceptual and theoretical framework, the research questions, the limitations, and the delimitations of the study.

Chapter 2 presents a review of the literature which includes the history and mission of the community college, the “cooling out” process at the community college, a discussion of developmental education that emphasizes developmental mathematics education, computer-assisted instruction, and the conceptual and theoretical framework. Chapter 3 describes the methodology used for this study and includes the selection of participants as well as the data collection and data analysis procedures.

Chapter 4 presents the study's findings including the results of the data analyses for the two research questions. Chapter 5 provides a summary of the entire study, discussion of the findings, implications of the findings for both theory and practice, recommendations for future research, and conclusions.

## **Chapter Two**

### **Literature Review**

#### **Introduction**

Developmental education serves a crucial role for a vast number of college and university students across the country. In 2007, developmental classes were offered at 100% of community colleges, 80% of public four-year institutions, and 59% of private four-year institutions (Taylor, 2008). During this time, 63% of students who attended only a two-year institution and 64% of those who attended both two and four-year institutions enrolled in at least one developmental course (Tierney & Garcia, 2008).

Although developmental education usually encompasses the areas of math, reading, and writing, students are most likely to need assistance with math (Bahr, 2007; Le, Rogers, & Santos, 2011). Despite the fact that developmental mathematics education is accessed by large numbers of students, there is very little empirical research on this topic (Hodora, 2011). In one study, The Community College Research Center conducted an analysis of *Achieving the Dream* data and found that only 31% of students who were referred to developmental mathematics completed the course or courses within three years, and only 20% eventually completed a college-level mathematics course (Bailey, Jeong, & Cho, 2010; Hodora, 2011; Speckler, 2012). In a study conducted by Bahr (2008b) only 75.4%, or more than three out of four of the students did not successfully complete their developmental mathematics courses and 81.5%, or more than four in five, did not complete a credential or did not transfer.

At some institutions, educational professionals have responded to the dire state of student success in developmental mathematics by implementing course redesigns that

incorporate some method of computer-assisted instruction. One such method of course redesign is the Emporium Model. It is a relatively new method of instruction that is being utilized in developmental mathematics classrooms, especially at the community college level, where the majority of developmental education occurs (Bahr, 2008b). Some community colleges have experienced improvement in pass rates for developmental mathematics students after the introduction of a course redesign such as the Emporium Model (Speckler, 2012; Squires, Faulkner, & Hite, 2009; Twigg 2005). However, Hodora (2011) has identified many questions that still remain regarding how the improved results are connected to the course redesign.

This study investigated the effectiveness of the Emporium Model. To this end, it was necessary to perform a comprehensive literature review in several areas. Consequently, chapter 2 will be organized into the following sections: (a) history of the community college, (b) the community college mission, (c) the cooling out of the community college student, (d) the developmental education mission, (e) developmental mathematics education, (f) computer-assisted instruction, and (g) conceptual and theoretical framework.

### **History of the Community College**

The modern community college can trace its origins to the beginning of the twentieth century when Joliet Junior College was founded near Chicago in 1901. This institution offered a fifth and sixth year to the traditional high school curriculum of the time, and its primary function was to prepare students for transfer to a four-year institution. Since the focus of these early institutions was transfer, the name junior college was coined and used almost exclusively for the first few decades of the twentieth century. Throughout

the country, junior colleges were founded, usually as extensions of a local high school and oftentimes staffed by faculty from the local high school. These institutions offered access to higher education to communities without a four-year college or university, and they also helped to relieve senior institutions of higher education, especially those conducting research, from having to teach the first two years of the undergraduate degree (Bragg, 2001).

During the 1930's, as the nation was suffering under the Great Depression, some junior colleges began to offer vocational education and job training courses in an effort to help alleviate widespread unemployment. This expansion in the role of the junior college continued during the 1940's and 1950's, as millions of people who had served in the war returned home and looked for employment. In 1948, the Truman Commission Report supported the notion of offering vocational education in junior colleges as a means of improving and expanding access for students. The report concluded that "free and universal access to education, in terms of the interest, ability, and need of the student, must be a major goal of American education" (U.S. President's Commission on Higher Education, 1948, p. 36). As the focus of the junior colleges changed from primarily transfer to also include vocational and career training, the phrase community college became more common.

After the end of World War II, Bogue (1956) proposed three functions for the community college. In addition to arguing for an extension of education to address the need for vocational training and the preparation for additional college-level work through the transfer function, Bogue introduced the continuing education focus for the community college. This would not only offer students an opportunity to receive part-time

education, it would also help to satisfy community and business needs by providing job training and instruction in new technological developments to employees throughout the community (Bragg, 2001).

During the 1960's, the parents of the enormous baby boomer demographic were very much interested in obtaining postsecondary schooling for their children. As a result, the number of community colleges grew dramatically during the decade with student enrollment increasing from about 400,000 in 1960 to just over 2 million by 1970 (Thelin, 2004). It was estimated that during the decade, there was a new community college opening each week. It was also at this time that most community colleges adopted open access admission policies. This meant that schools were now accommodating all types of students without turning anyone away and, consequently, there was an influx of students who were under-prepared for college-level work. As a result, the need for developmental education grew. The goal of developmental education is to close the achievement gap between traditional college students and their nontraditional, under-prepared counterparts. According to McCabe (2001), poverty correlates highly with under-preparedness and minority students are overly represented in the highest poverty status. It was hoped that developmental education could serve to bridge the gap between high school and college for under-prepared college students, as well as “provide opportunities to rectify race, class, and gender disparities generated in primary and secondary schooling and to develop the minimum skills deemed necessary for functional participation in the economy” (Bahr, 2008b, p. 420).

The growth in community college enrollments nearly doubled again during the 1970's to almost four and a half million students by the end of the decade. This growth

can be explained primarily by three factors: the growing recognition that postsecondary education was becoming necessary to obtain meaningful employment, the growing population of the country, and students seeking draft deferment during the Vietnam War (Kasper, 2002).

Community college enrollments have continued to rise since the 1970's, but at a much slower rate. During the 1980's and 1990's, the number of students attending a community college increased from 4.5 million to about 5.5 million by 1999.

In the early twenty-first century, American community colleges continue to play a vital role in American higher education. As of January, 2011, there were 1,167 community colleges serving a total of 12.4 million students (American Association of Community Colleges, 2011).

### **The Community College Mission**

The mission of today's community colleges can trace their evolution to the report of the President's Commission on Higher Education in 1947. This report suggested that the purpose of the community college should be to provide educational service to the community and that as a consequence, a variety of functions and programs would be needed. According to the report, the primary effort of community colleges would be to provide all of the post-secondary needs of a community.

More than 60 years later, community colleges have increasingly played a larger and more diverse role in American higher education. Today, as opposed to when they first began, community colleges serve larger numbers of women and racial and ethnic minorities, first-generation college students, as well as older students who work full- or part-time and often times have families to support (Kasper, 2002; Bragg, 2001). Since

their inception over a century ago, the number of community colleges has grown, the number of students that they serve has increased dramatically, and the nature of the educational opportunities that they offer has expanded and continues to expand and evolve in response to societal changes.

The growth in the mission has also been fueled by a funding formula used in most states that provides a per capita subsidy for each student enrolled in a course. This has the effect of encouraging institutions to find ways to bring in new students in order to expand its enrollment and thereby increase its state funding. However, there has not been any guidance given by the legislative bodies on what is and is not appropriate for the community college to offer (Thelin, 2004).

Although academic preparation is still the primary function of most community colleges today, the mission of the community college is more comprehensive than it once was due to increasing emphasis placed upon vocational education, job training, and community education (Kasper, 2002). Despite the fact that community colleges have expanded their mission in an effort to meet growing and changing community needs, they are increasingly criticized by some who argue that they are still not meeting the needs of enough students (Bragg, 2001). Additionally, there are critics who contend that community colleges have sacrificed the quality of traditional academic outcomes in attempting to meet the needs of so many students. Eaton (1994), for example, argues that the quality of collegiate education is diminished when the focus on the liberal arts and the transfer mission is mixed with other missions.

Attempting to define the mission of the contemporary community college is not an easy task (Bogart, 1994). In fact, mission statements of community colleges will and

should differ in order to allow for the many different functions that a specific institution may need to play in response to the various needs of its community (Bogart, 1994).

Bogue (1956) was one of the first to argue for a more comprehensive mission for the community college. Bogue encouraged community colleges to expand their curriculum by offering vocational and occupational training in addition to the traditional liberal arts courses in order to serve the needs of all youths of the community (Bragg, 2001).

Although no two schools will offer the same courses, and consequently, have precisely the same mission, it is possible to generalize the notion of mission when speaking of contemporary American community colleges. For example, Cohen and Brawer (2003) have defined the community college mission to include college transfer, vocational education, continuing or lifelong education, and developmental education. A brief discussion of the first three missions will follow. Due to the fact that this study deals with issues directly related to the developmental education mission of the community college, a more comprehensive and detailed discussion of this aspect of the community college mission will be given.

**The transfer mission.** The role of the first junior colleges was to offer a fifth and sixth year to the high school curriculum in anticipation that the student would, upon completion, transfer to a four-year institution. Although it is no longer the only mission of the modern community college, the transfer function still plays an important role for students. In fact, 54% of the community college curriculum is made up of academic courses, also known as the liberal arts (Schuyler, 1999). However, the transfer patterns of today's community college students are much different than the upwardly vertical one envisioned by the early leaders of America's community colleges (Bragg, 2001).

Student transfer patterns at contemporary community colleges have been categorized into two groups by Townsend (2001): those students who begin at the community college, and those who begin at a four-year institution. Among students who begin at the community college, some (1) will transfer to a four-year school before completing an associate's degree, some (2) will transfer with a non-transfer degree such as an Associate of Applied Science degree, and some (3) will transfer back and forth between the community college and the four-year institution. Interestingly, studies have shown that students who finish an associate's degree at the community college and then transfer are more likely to complete their four-year degree than students who do not complete the associate's degree before transferring (Cohen & Brawer, 1996).

Among students who begin at a four-year school, some (4) transfer "dual enrollment" credits earned at a community college while still in high school, some (5) transfer community college credits earned over the summer semester, and some (6) transfer community college credits earned while concurrently enrolled and completing courses at a four-year school.

Although no longer the only role of the modern community college, the transfer function still plays an important, if not primary, role for millions of American post-secondary students.

**The vocational education mission.** Approximately 60% of community college students are pursuing a vocational course of study (Jacobs & Dougherty, 2006). Although vocational education courses and programs were present soon after the founding of the first community colleges, they did not become a major community college mission until the 1950's and 1960's. It was during this time that members of

state governments advocated the expansion of vocational training in order to stimulate the growth of state economies by offering public subsidies to the training and re-training of workers. Community college administrators also were strong advocates of vocational expansion in the belief that this would give their institutions an advantage in the training of workers and that this would attract much needed revenue (Jacobs & Dougherty, 2006). The expansion of vocational programs continued during the sluggish economies of the 1980's and the second half of the first decade of the new century. In both cases, millions of new or displaced workers have taken advantage of state subsidies in order to train or re-train for a new career.

As new technologies are developed and the needs and demands of the economy become more specialized, community colleges have responded by attempting to expand their vocational offerings. In general, non-liberal arts course offerings have grown in specificity as the demands of the job market have become more specific. Additionally, although there are certain areas in which almost all community colleges offer courses, there are also areas in which institutions offer specialized training in response to the unique needs of the local community and economy (Schuyler, 1999).

The expansion of the vocational education mission of the American community college has had enormous consequences, some of which are generally perceived to be positive and some negative. Positively, the expansion has led to larger and more diverse institutions and has allowed more students, including many from disadvantaged backgrounds, to find job training and, consequently, meaningful employment. It has also provided additional revenue for community colleges during a period when most sources of state funding for higher education have been decreasing. Negative consequences of

the expansion of vocational training include the perception that, as community colleges focus more on the training of workers, they will necessarily focus less on the more traditional development of the college student as a well-rounded and well-educated citizen. Consequently, conflict sometimes arises between the faculty who teach the liberal art subjects and the faculty who teach the vocational subjects (Jacobs & Dougherty, 2006).

Despite the resulting tensions, the expansion of the community college mission has generally been regarded as a success. In fact, the American Association of Community Colleges (2000) has given their blessing to the vocational mission and has indicated that the preparation of the nation's workforce should play a primary role of the community college mission. Some observers even go so far to suggest that, because the vocational mission has been so successful, community colleges should minimize the other missions and instead focus on the vocational mission in order to better prepare the citizens of the community for the workforce (Townsend, 2001).

**The continuing/lifelong education mission.** The decades of the 1970s and 1980s saw several changes that affected the mission of the community college. Among them was a decrease in the number of college-age students and new federal legislation that effectively shifted federal dollars away from institutions and towards individual students in the form of grants, work study programs, and loans (Bogart, 1994). These changes helped to foster the growth and expansion in the continuing and lifelong learning mission of the community college.

Today, millions of Americans turn to the local community college for noncredit continuing education opportunities. Some students are seeking courses and training that

will allow them to improve their job skills in order to advance in their current employment or to find other employment opportunities. In fact, several states have built their worker training programs around the local community college (Jacobs & Dougherty, 2006). The growth in certificate programs is a direct consequence of the increase in employers using the community college to train their employees (Kasper, 2002). These programs usually involve specific, work-related training and are utilized by those students who wish to upgrade their current skills or acquire new ones in order to increase their job opportunities.

Although the ability to attend the community college in order to increase one's job opportunities and earning potential is important, not all noncredit students have this goal in mind. Some simply wish to learn something new, to expand their current knowledge base and become a well-rounded citizen, while others have learned to appreciate art or music, use a computer more effectively, learned how to cook, or have learned a new language. Whatever the reason for attendance, there is little doubt that the continuing education and lifelong learning mission of the community college has helped students by offering local and affordable training and has helped community colleges by creating new sources of revenue in an era of declining governmental support.

**Conclusion.** The growth and expansion in the mission of the American community college has facilitated its evolution into an institution with a community orientation, an open-door admission policy, and a comprehensive program offering. Whether or not this will continue depends upon a variety of political, social, and economic realities. Some (Bogart, 1994; McPhail & McPhail, 2006) have argued that these political, social, and economic realities may force the community college to reexamine its mission within the

context of what can be done with the resources that are available in an attempt to decide which of their current and historic missions are viable.

Although the community college faces many challenges going forward, in the arena of higher education it possesses many advantages over other institutions. These include its low cost, its open-door admission policy, its geographic accessibility, its comprehensive curriculum, its focus on teaching and students, its community orientation, and its ability to be flexible and innovative. All of these serve to shape the mission of the community college in a synergistic way and help to transform the community college into a total learning environment that possesses a value added dimension when it comes to economic development (Bogart, 1994).

As we progress through the 21st century, the mission of the community college will certainly continue to evolve. Regardless of the new challenges that these institutions face, Vaughn (1988) believes that there will forever remain certain constants in the mission of the community college. Namely, the community college (1) is an institution of higher education, (2) is a mirror of society, (3) is a teaching institution, (4) offers a comprehensive program, and (5) is committed to open access. Of all of these, perhaps the open access dimension is what makes the community college so unique in American higher education. Access implies opportunity and diversity, two ideas that require the availability of comprehensive curricular and program options to meet the needs of students (Bogart, 1994).

Access alone, however, will not ensure success. There are, unfortunately, far too many students who are under-prepared for college-level work. It has been estimated that only about one-third of students who graduate from high school are prepared for college

(Calcagno & Long, 2009). Consequently, in order for these students to be successful, they will require remediation and possibly other forms of assistance. This is the goal of developmental education, the fourth and final mission of the community college to be discussed.

### **The Cooling Out of the Community College Student**

The open-door admission policy of the American community college serves to encourage the aspirations of individuals who seek access to higher education for a variety of reasons. For some students these reasons may include completion of the general education courses and transfer to a four-year institution in hopes of earning a bachelor's degree or higher in order to increase their own socio-economic status. The overwhelming majority of these students attended high schools that had no screening mechanism in place to help students determine whether a professional or vocational route would be more appropriate given their own attitudes, aptitudes, and abilities. Consequently, many of these students will find, as a result of their experience in the community college, that what they had planned for their future might not be achievable.

Over fifty years ago, Burton Clark (1960) proposed that, in fact, one of the functions of the community college is to urge students to recognize their academic deficiencies and lower their aspirations. Clark used the term "cooling out" to describe this process. Derived from Goffman's (1952) description of the way an individual who has been the victim of a con game is eased by a confidence man from the status of sure winner to some identity other than victim, cooling out is used to describe the ways community colleges get their students to lower unrealistic expectations for bachelor's degrees and to instead aim for a vocational degree. This is accomplished by a combination of pre-entrance

testing, counseling, orientation classes, enrollment in developmental courses, notices of unsatisfactory work, and probation. This process is driven primarily by the adviser or counselor in a soft, consoling manner with alternatives always being offered to the student. According to Clark (1980), the cooling out process is necessary due to (1) the open-door admission policy of most community colleges, (2) the maintenance of transfer standards, and (3) the need to deny some aspirants the transfer possibility.

Since Clark's initial proposition over half a century ago, other researchers have examined the cooling out function and have attempted to extend or revise the idea. Baird (1971) for example, examined the aspirations of community college students using questionnaire data from twenty seven community colleges and found not only coolers (students who lowered their aspirations), but also warmers (students who increased their aspirations). Emphasizing the large proportion of lower-income and minority students in community colleges, Karabel (1972) concluded that the primary function of the community college is to maintain the social class system and that college standards serve, not necessarily in an intentional way, as a covert mechanism for excluding the poor and minorities from gaining access to the upper reaches of society.

Dell-Amen and Rosenbaum (2002) found that community college personnel have found ingenious ways to preserve students' aspirations and avoid damaging their self-confidence by encouraging the students to improve their skills, qualify for college-level work, and transfer to a four-year institution. However, this stigma-free approach has some unintended consequences such as leading to confusion among students as to whether or not they are making sufficient progress to attain their goal and, in fact, sometimes the delaying of the inevitable: realization that a bachelor's degree is not

obtainable. Finally, Bahr (2008a) has asserted that there is no evidence that cooling out is occurring at all due to the lack of a large-scale, quantitative study that utilizes advising as a predictor variable. To remedy this deficiency, Bahr designed a quantitative study that utilized data from over one hundred community colleges in the state of California in an effort to determine whether or not cooling out is in fact occurring. Bahr concluded that there is “no evidence to support direct, active, counselor-driven cooling out as a general phenomenon of transfer-seeking community college students” (p. 724). In fact, Bahr found that under-prepared students appear to benefit from advising more than their college-ready counterparts.

### **The Developmental Education Mission**

Astin has described the need for post-secondary remediation as “the most important educational problem in America today” (1998, p. 12). Sometimes referred to as “remedial education,” “college prep,” “compensatory education,” or “basic skills development,” the term developmental education is what is preferred and used by professionals and practitioners in the field (The Institute for Higher Education Policy, 1998; Kozeracki, 2002). Developmental education, in its most general sense, refers to a wide range of courses and services that are designed and offered in hopes of increasing the retention rate of students and to help ensure the completion of their post-secondary educational goals by improving student skills, habits, and attitudes (Boylan, 2008; Boylan & Bonham, 2007). The basic philosophy of developmental education is learner-centered and consists of (1) assessment and placement, (2) curriculum design and delivery, (3) support services, and (4) evaluation.

The traditional core of developmental education has been remediation. Remediation usually consists of noncredit courses that are designed to compensate for students under-preparedness and inability to complete college-level coursework. Although remedial courses can be found at practically all community colleges, there is disagreement among researchers regarding the effectiveness of these courses (McCabe, 2000). In fact, some researchers purposely resist the term “remedial” with its implication that these courses will cure or fix some weakness exhibited by the student. Casazza (1999) has defined four assumptions about developmental education in an attempt to distinguish it from remedial education: (1) it is a comprehensive process that deals with the learner in a holistic manner; (2) it focuses on not only the intellectual development of the student, but also the social and emotional aspects of student growth; (3) it assumes that all students can learn; and (4) it is not limited to learners at any one level.

In addition to remediation, developmental education also includes courses that are not usually taught in high school but contain elements that are viewed as necessary for success in college. These courses usually carry college credit, are designed to address both the cognitive and affective needs of the student, and teach study skills, time management and learning strategies, as well as critical thinking skills (Higbee, Arendale, & Lundell, 2005). Additionally, developmental education encompasses a wide variety of support services for the student. These services include assessment, advising, and various tutoring services.

**The history of developmental education.** Developmental education has a long history in the United States. Although some may argue that the quality of the American high school has diminished over the last few generations, the fact is that developmental

education has been present in American higher education since at least the early colonial days when Harvard College provided tutors in Latin and Greek for those students who did not want to study for the ministry. In the mid 18<sup>th</sup> century, land-grant colleges established programs and courses for those students that were weak in reading, writing, and arithmetic. By 1894, more than 40 percent of college freshmen were enrolled in developmental programs and at the beginning of the 20<sup>th</sup> century, more than half of all students who attended Ivy League schools were considered under-prepared and were required to take remedial courses. The need for remediation grew after World War II and the establishment of the GI Bill when thousands of under-prepared students enrolled in college. Finally, with the explosion in the number of community colleges during the 1960's and the establishment of open-admission policies, the need for developmental education grew still more (The Institute for Higher Education Policy, 1998). These facts help to illustrate that there has never been a time in the history of American higher education when the need for developmental education did not exist. It has been estimated that about 30% of all students entering a post-secondary institution require some form of developmental coursework (Bahr, 2007; Chung, 2005). The American Association of Community Colleges estimates that at the community college level approximately 60% of entering freshmen are not ready for college-level work (Stuart, 2009) and in a statewide study of Texas community college students, it was found that 88% took some developmental courses, typically developmental mathematics (Boyer, Butner, & Smith, 2007). The numbers in California are even worse where the Community College Chancellor's Office reports that up to 90% of first-time community

college students test below college level in math and over 70% test below college level in reading and writing (Moore & Shulock, 2007).

Community colleges around the country have responded to students' need for developmental education services by offering these programs and courses to their students. In fact, according to the National Center for Educational Statistics (NCES), developmental courses are offered at 100% of community colleges (Brothen & Wambach, 2004). For first-time freshmen at the community college level, between 36% and 41% are enrolled in at least one developmental course (Quirk, 2005). These developmental courses are comprised of students of all ages. According to NCES, over 30% of the students in developmental courses were 19 years old or younger, almost half were over 22 years of age and over one-quarter of the students were 30 years of age or older. It is not surprising that such a large percentage of students enrolled in developmental courses are non-traditional age students since the population of students age 40 or older has grown faster than any other age cohort (The Institute for Higher Education Policy, 1998). Policy makers need to recognize that demand for these courses is being driven in part by older students who need a refresher in mathematics or writing.

**Controversy surrounding developmental education.** The recent economic downturn and the resulting tightening of state budgets has prompted many politicians and some researchers to question the appropriateness of offering developmental education services, especially remedial coursework, at the college level. Some of these critics argue that taxpayers should not be required to pay for the same education twice (Bahr, 2008b). In other words, if the student did not learn the information the first time in high school at the taxpayer's expense, then it is the student's responsibility to get the appropriate

remediation and pay for it once the student has left high school. Or, some assert, it is the high schools that should pay for the remediation since the institution was not successful in imparting the knowledge to the student. Also, some argue that developmental education, especially remedial coursework, diminishes academic standards and devalues postsecondary credentials and that the large number of students enrolling in remedial classes in colleges and universities only serves to demoralize the faculty (Bahr, 2008b).

Proponents argue that developmental education is essential since some students require remediation to compensate for an inadequate secondary schooling experience. They also contend that for those students who may be returning to college after a long absence, remediation can serve as a necessary and indispensable “refresher”.

Additionally, proponents argue that developmental education can “provide opportunities to rectify race, class, and gender disparities generated in primary and secondary schooling and to develop the minimum skills deemed necessary for functional participation in the economy” (Bahr, 2008, p. 420). Basic levels of reading, writing, and mathematical ability are necessary in our increasingly complex society if individuals hope to be full participants in our free market system and enjoy all of the opportunities that it offers. For students lacking the minimum competencies in these basic subjects, developmental education is essential in order to achieve economic stability (Day & McCabe, 1997). College graduates are more likely to vote and participate in community activities, and they are less likely to be involved in criminal activity (Pascarella & Terenzini, 2005). Developmental education serves a unique role in education in that it is not designed to separate students into various levels of attainment but instead serves to equalize attainment by reducing disparities among advantaged and disadvantaged students (Mills,

1998). Therefore, developmental education can help to bring opportunity to those who may otherwise be relegated to low wages, poor working conditions and other consequences of socioeconomic marginalization (Roueche & Roueche, 1999).

**The cost of developmental education.** In a time of tightening state budgets and rising college costs, some policy makers and politicians argue that institutions can no longer afford to offer developmental education services. Several states have already taken legislative action in an attempt to address this concern. Ohio, for example, has passed legislation that will phase out all remedial education at state universities by the year 2014 (Rau, 2007). At that time, students will be required to take any remedial courses at the community college level. However, there is no evidence that suggests that community colleges are more effective than four-year institutions at delivering developmental education services (Boylan & Bonham, 1992) and Roueche and Roueche (1999) argue that moving all developmental education to the community college will further strengthen the notion that community colleges are for less-able students and will significantly decrease the diversity of the four-year institutions. Other states have considered additional action concerning developmental education. Proposals have included requiring specific scores on placement exams, charging high schools for the full cost of remediation, charging students enrolled in developmental courses the full cost of remediation, and eliminating public funding for remedial coursework altogether (Education Commission of the States, 2002; Parker, 2007).

The true cost of developmental education programs is difficult to measure due to several factors. These include (1) the definition of what constitutes a developmental education student or service is not universally agreed upon, (2) how costs are distributed

among the many activities with a college vary significantly, (3) it is not always clear whether reported costs include expenditures or appropriations, and (4) the extent and cost of developmental services are often understated, especially at private or exclusive public four-year institutions or at schools attempting to avoid public scrutiny (The Institute for Higher Education Policy, 1998). The best estimate puts the cost of developmental education at about \$1 billion annually out of a total budget (state support, federal support, and student tuition) of \$115 billion annually (Bahr, 2007; Saxon & Boylan, 2001). This means that developmental education accounts for less than 1% of the total costs of higher education. Since a higher proportion of community college students are enrolled in developmental education courses and programs, it would be expected that costs for these programs at these institutions are higher than at the four-year schools. In fact, 9% of total expenditures at Arkansas community colleges were for developmental education (The Institute for Higher Education Policy, 1998).

Although costs for developmental education make up a small portion of the total budget, critics contend that the fact remains that the majority of this money consists of state and federal dollars. However, proponents counter by asking what would be the consequences of not offering these programs. They contend that helping to ensure that students succeed in college will decrease the likelihood of their future dependency on various social programs that are funded by state and federal dollars. Abraham used Census Bureau data to estimate that if 30% of students enrolled in developmental courses earned their bachelor's degree, they would contribute as much as \$87 billion in federal and state taxes over their lifetime of work (Saxon & Boylan, 2001). This would more than pay for the estimated \$1 billion dollar annual cost of delivering developmental

education to students over this same period. Additionally, students who complete their developmental coursework and continue working towards a degree continue to pay tuition, participate in the collegiate experience, and contribute to the culture of the campus. Therefore, successful developmental education programs can help to offset the cost of developmental education.

**Effectiveness of developmental education.** Due to the large numbers of students enrolled in developmental education and the costs associated with these programs, the need for sound and comprehensive research on the issue of developmental education is apparent. Surprisingly, few methodologically sound, multi-institutional, comprehensive evaluations of developmental education programs have been published (Bahr, 2008b) and little is known about whether developmental education programs are an effective tool in helping students stay in college and complete their academic goals (Moore, Jensen, & Hatch, 2002). Research regarding the effectiveness of developmental education programs is sporadic, under-funded, and the results are often inconclusive with an overwhelming majority of institutions not conducting any type of systematic evaluation of their developmental education programs (The Institute for Higher Education Policy, 1998). McCabe (2000) notes that most studies of developmental education look at the number of degrees earned over a relatively short period of time, such as three or four years for an associate's degree. Consequently, these studies do not account for the many students at a community college who attend only part-time and do not complete their degree within three or four years. Additionally, McCabe notes that these studies do not typically take into consideration a certificate completion or a career success.

Although most of the research done in the area of developmental education is limited in one way or another, there are some recent large-scale and comprehensive studies that provide some insight into the efficacy of developmental education programs. One study done by Bettinger and Long (2004) found that students in public four-year colleges in Ohio, who are in need of remediation and remediate successfully, are only slightly less likely to complete a four-year degree than college ready students. Bettinger and Long (2009) also found that developmental students were more likely to persist in college and to complete a bachelor's degree than students with similar backgrounds and test scores who did not require developmental courses. In another study, Attewell, et al. (2006), found that students at community colleges who require English remediation and remediate successfully have an increased likelihood of graduation compared to students who do not require English remediation. There were no other differences found between college ready students and those who require remediation and remediate successfully in terms of college success and completion.

Bahr (2008b) has conducted what is arguably the most comprehensive study of developmental education to date. In the study, Bahr used multi-nominal logistic regression to analyze data collected from 107 community colleges in California. The population included 85,894 freshman college students and over a dozen variables were considered in the analysis. These variables included age, race, gender, English competency, persistence, and enrollment inconsistency. The students were followed for a period of six years to determine if developmental education was successful for them. Success was defined as earning a passing grade in a college level mathematics course within the six year period of observation. Bahr found that students who remediate

successfully in mathematics exhibit long-term academic attainment that is comparable to that of students who had no need for mathematics remediation. So it would seem that developmental mathematics education is effective for those students who successfully complete the developmental program. However, 75.4%, or more than three out of four of the students did not remediate successfully. Bahr concludes that “when remediation works, it works extremely well” (p. 444).

The extent of a student’s need for developmental education is inversely related to the likelihood of the student completing a degree (Brothen & Wambach, 2004; Kozeracki, 2002). According to Adelman (2006), about half of students taking remedial courses completed a bachelor’s degree compared to 70% of those who did not require remediation. In another study, the graduation rate was 60% for those students who took no developmental courses and only 35% for those who required five or more developmental courses (Education Commission of the States, 2002; The Institute for Higher Education Policy, 1998). Additionally, only about 25% of students enrolling in a developmental reading course ever enroll in a college-level course and only 10% of students enrolling in a basic math course ever enroll in a college-level math course (The Carnegie Foundation for the Advancement of Teaching, 2008).

Researchers often take opposite sides in the debate over whether developmental education is effective. Critics point to the dismal number of degree completers and argue that students who are required to take many developmental education courses get discouraged and drop out, and that those students who complete the developmental courses do so because of their motivation or abilities (Brothen & Wambach, 2004; Hodora, 2011). On the other hand, proponents of the effectiveness of developmental

education point to studies that show that community college students who were recommended for developmental courses and completed them had higher GPA's and persistence levels than did those students who did not complete the developmental courses (Brothen & Wambach, 2004) and that students who complete developmental programs are as successful in college-level work as those students who place directly into college-level courses (Waycaster, 2011).

**Improving developmental education.** It has been estimated that more than two million students each year would drop out of post-secondary education if developmental education resources were not available to them (McCabe & Day, 1998). In order to help maximize the number of their graduates each year, higher education professionals need to provide effective developmental education services. This is best accomplished by implementing best practices that have been shown effective through rigorous research and evaluation using strong theoretical foundations and decisions about the developmental program should be grounded in research (Boylan, 2008; Chung, 2005; Higbee, Arendale, & Lundell, 2005; Weissman, Bulakowski, & Jumisko, 1997). Well-designed developmental education programs must employ a strong evaluation component, and this process of evaluation should be a routine activity of any institution offering developmental education. Unfortunately, only a small percentage of two- and four-year institutions conduct rigorous and routine evaluations of their developmental education programs (Weissman, Bulakowski, & Jumisko, 1997).

Research on developmental education has provided some specific suggestions for maximizing the effectiveness of these programs. Orientation, assessment and mandatory placement of all students who are identified as being under-prepared for college-level

courses is cited as the most important and effective element in helping these students succeed in college (Boylan, 2008; Kozeracki, 2002; Weissman, Bulakowski, & Jurnisko, 1997). A study conducted by the California State University system found that 70% of students not completing their developmental work during their first year of college failed to graduate. Conversely, 69 % of students who did complete their developmental work during the first year did graduate (Stuart, 2009). Similarly, Boylan, Bliss, and Bonham (1997) found that students attending two-year colleges where placement in developmental education courses was mandatory were more likely to pass those courses than students enrolled in similar courses where placement was not mandatory. Finally, Castator and Tollefson (1996) found that students who completed their developmental coursework either prior to or concurrently with their college-level courses earned grades that were comparable to those students who were identified as college-ready. As can be seen, the research indicates that mandatory placement into developmental courses and completion of those courses early in the college career can be effective in helping students complete their college goals.

Other suggestions to improve the effectiveness of developmental education programs include (1) taking advantage of advances in technology (2) providing a high degree of structure within the course, (3) regular program evaluations, (4) providing professional development opportunities for faculty, (5) finding ways to accelerate students through developmental courses by reorganizing instruction and curricula in a way that expedites the completion of coursework, and (6) collaboration with high schools in an effort to reduce the need for developmental programs at the college level (The Carnegie

Foundation for the Advancement of Teaching, 2008; Edgecombe, 2011; The Institute for Higher Education Policy, 1998; Kozeracki, 2002; Parker, 2007).

Ultimately, whether or not a developmental education program is effective is best decided by considering four factors: (1) whether or not students are successfully completing the developmental education courses, (2) whether or not students are moving from developmental to college courses, (3) whether or not students who completed developmental courses are eventually completing college-level courses, and (4) whether or not developmental education students are persisting and completing their college goals (The Institute for Higher Education Policy, 1998; Weissman, Bulakowski, & Jumisko, 1997).

### **Developmental Mathematics Education**

Developmental mathematics most commonly refers to any non-vocational math course that presents material below the level of college algebra (Adelman, 2004; Bahr, 2007). Although developmental education usually encompasses the areas of math, reading, and writing, students are most likely to need assistance with math (Bahr, 2007; Le, Rogers, & Santos, 2011). For example, 22% of first-time college students enrolled in developmental math courses, compared with 14% who enrolled in developmental writing and 11% who enrolled in developmental reading (Parsad, Lewis, & Greene, 2003). Similarly, Adelman (2004) found that 34% of students earn credits in developmental math compared to 18% in developmental reading. Community colleges are of primary interest when it comes to developmental education due to the fact that they constitute the primary venue in which developmental education is delivered (Bahr, 2008b). For example, a recent study of institutions participating in *Achieving the Dream*, a national

initiative to improve student success at community colleges, found that more than half of all the students attending the participating community colleges were referred to developmental math courses and that 19% of these students were directed to math courses that were three levels below college-level math (Le, Rogers, & Santos, 2011). In a study of California community college students, Bahr found that over 80% of first-time freshmen who enrolled in non-vocational math enrolled specifically in developmental math. It can be seen from these statistics that developmental mathematics education serves the greatest number of students that require developmental education. Although developmental mathematics education is accessed by a large number of students, there is very little empirical research on this topic (Hodora, 2011). According to Boylan, Bonham, and Bliss (1994), only 14% of the developmental programs at two-year colleges engage in evaluations that are ongoing or systematic. However, several researchers have found a positive correlation between program evaluation and success in developmental mathematics programs (Waycaster, 2011).

**Effectiveness of developmental mathematics education.** Several small scale studies of the effectiveness of developmental mathematics have been conducted in the last decade. Although most of them are limited in one way or another, they can help to shed some light on the effectiveness of developmental mathematics at the community college level.

The Community College Research Center conducted an analysis of *Achieving the Dream* data and found that only 31% of students who were referred to developmental mathematics completed the course or courses within three years and only 20% eventually completed a college-level mathematics course (Bailey, Jeong, & Cho, 2010; Hodora,

2011; Speckler, 2012). Bettinger and Long (2005) found that community college students who took developmental mathematics were 15% more likely to transfer to a four-year institution and complete more credit hours than students with similar backgrounds and test scores who did not take developmental mathematics.

A recent examination of the effectiveness of the developmental mathematics program at Virginia Highlands Community College compared students who placed directly into a college-level mathematics course (Business Math, Introduction to Elementary Statistics, Mathematics for Allied Health, or College Algebra) to those who were required to enroll in at least one developmental mathematics course before completing a college-level course (Waycaster, 2011). The study found that the success rates (earning a C or better) of the two groups were almost identical, with 77% of the developmental group succeeding in a college-level mathematics course compared to 75% of the non-developmental group. A similar finding was reported in a study conducted at the University of Minnesota (Kinney, 2001b) where the passing rates of developmental mathematics students who completed college algebra or pre-calculus were examined. The study found no significant difference in the passing rates of students who took one or more developmental courses and those who placed directly into college algebra or pre-calculus. Also, in research conducted for completion of a dissertation, Hutson (1999) examined the effectiveness of developmental mathematics courses in preparing students for the next mathematics course. No difference was found between students who first completed Intermediate Algebra before taking College Algebra and those students who placed directly into College Algebra.

Another study was conducted by Bahr (2008b), and it is the most comprehensive study of developmental mathematics education to date. In the study, Bahr used multinomial logistic regression to analyze data collected from 107 community colleges in California. The population included 85,894 freshman college students and over a dozen variables were considered in the analysis. These variables included age, race, gender, English competency, persistence, and enrollment inconsistency. The students were followed for a period of six years to determine if students in need of developmental mathematics were more or less successful than students who required no developmental mathematics. Bahr summed up the findings as follows:

Within the context of the community college, students who remediate successfully in math exhibit attainment that is comparable to that of students who achieve college math skill without the need for remediation, and this finding generally holds true even across the various levels of initial math skill deficiency. In fact, the two groups effectively are indistinguishable from one another in terms of credential attainment and transfer (p. 442). So it would seem that developmental mathematics is effective for those students who successfully complete their developmental mathematics courses. However, 75.4%, or more than three out of four of the students did not successfully complete their developmental mathematics courses and 81.5%, or more than four in five, did not complete a credential or did not transfer. So it would seem that developmental mathematics is working for some students and, in fact, it is working quite well for these students. However, the problem is that it only works for a minority of students. Bahr (2008b) concludes that “when remediation works, it works extremely well” (p. 444).

Bahr's findings agree with earlier findings of Boylan and Bonham (1992) who found that developmental programs have a positive impact on retention and success in later courses, noting that of those students who completed their developmental mathematics courses with a C or better, about 77% also passed a college-level math course with a grade of C or better. Finally, Short (1996) also found that students who completed their developmental mathematics courses were as successful as those students who did not require developmental mathematics.

When determining the effectiveness of developmental mathematics education, it is necessary to consider both the breadth and depth of need. Breadth refers to the number of basic skill areas in which the student is in need of assistance. These areas can include mathematics, as well as reading and writing. Weissman, Silk, and Bulakowski (1997) found that almost 70% of students who are placed into developmental writing or mathematics successfully complete these courses within two years. However, the success rate drops to 53% if the student is placed into both developmental mathematics and writing, and the success rate drops to only 33% for those students placed into all three: developmental mathematics, writing, and reading. Similarly, for community college students who place into all three developmental areas, McCabe (2000) found that only 20% of them successfully complete their developmental courses compared to an overall success rate of 43% for developmental students.

Bahr (2007) found that developmental mathematics students who place into college-level English are 25% more likely to complete their developmental mathematics courses than those students who place into developmental writing and about 33% greater for those students who place into developmental reading. Bahr additionally noted that it is

the degree of mathematics deficiency that is the most important. He concluded that “a ‘typical’ student who has very poor math skills is exceedingly unlikely to acquire college-level math skills regardless of the student’s English competency” (p. 719).

Depth of developmental need refers to the degree of deficiency within a given subject area. Developmental mathematics courses can be classified into four levels:

Intermediate Algebra or Geometry is usually considered the highest level, followed by Beginning Algebra, then Pre-Algebra, and finally Basic Arithmetic. Bahr (2007) found that about 40% of developmental mathematics students initially place into the two lowest levels: Pre-Algebra or Basic Arithmetic. In a study conducted by the Community College Research Center and reported by Jenkins, Jaggars, and Roksa (2009) of the students enrolled in Virginia community colleges in the summer or fall of 2004, it was found that students who started at the lower levels of developmental mathematics coursework were much less likely to take college-level mathematics courses than those students who started at the highest level of developmental mathematics. The study found that for students who placed into pre-algebra for their first developmental mathematics course, only 19% of them eventually enrolled in a college-level mathematics course.

Similarly, in an analysis of developmental mathematics students who attended one of the 57 community colleges participating in *Achieving the Dream*, only 16% of students referred to the lowest levels of developmental mathematics (pre-algebra or basic arithmetic) eventually completed their developmental mathematics coursework (Le, Rogers, & Santos, 2011). Additionally, only 10% of this group ever completed a college-level mathematics course. Finally, Bahr (2007) found that students who placed into the highest level of developmental mathematics were more than twice as likely to complete

their developmental coursework as students who placed into Beginning Algebra and more than three times as likely as students who placed into either Pre-Algebra or Basic Arithmetic. According to Bahr, only about 11% of the students who placed into the two lowest levels of developmental mathematics successfully completed a college-level mathematics course within six years, compared with about 54% of students who placed into the highest level of developmental mathematics.

**Improving developmental mathematics education.** Developmental mathematics courses are working for those students who successfully complete them. The issue is, what is the reason so many students fail to complete their developmental mathematics courses and what steps, if any, can be taken to increase the number of students who do successfully complete them? Researchers have proposed several reasons why students fail to complete their developmental mathematics courses. Some have suggested that placement in a low ability group negatively impacts a student's self-perception and thereby affects the academic performance of the student (Hadden, 2000). Additionally, the depth of a student's need may also be a factor. If a student places into the lowest levels of developmental mathematics, not only might the student's self-perception become even more negatively impacted, but the student may become discouraged at the prospect of taking so many courses for which no credit will be earned (McCusker, 1999). Finally, the breadth of developmental need may also be a factor as these multiple skill deficiencies may affect a student's performance in developmental mathematics (Bahr, 2007). For example, if a student is unable to read effectively, then it will be difficult to interpret the material and perform well academically. Approximately 40% of students who place into developmental mathematics place into the two lowest levels (Bahr, 2007).

These students face the “perfect storm” of placement into a low ability group, as well as almost certain multiple skill deficiencies. No wonder so many of these students fail to complete their developmental mathematics courses. Although these explanations may appear plausible in explaining why so many students fail to complete developmental mathematics, Bahr (2007) indicates that more research in this area is needed.

An examination of the literature has identified several recommendations for increasing student performance in developmental mathematics. One recommendation relates to the intensity of the course. Intensity models have the major component of increasing the time on task and can be accomplished through additional class hours, supplemental instruction, or tutoring (Epper & Baker, 2009). These models can incorporate mastery learning, self-paced instruction, and technology in an attempt to increase the intensity level of the course. Strategies to accelerate a student through the sequence of developmental courses are also gaining attention as research indicates that there is a negative correlation between time spent on developmental courses and degree and certificate completion (Bailey, Jeong, & Cho, 2010). Acceleration is accomplished by reducing the amount of material covered and/or combining courses in an effort to minimize the number of developmental courses a student needs to complete, thereby getting the student through the sequence of courses faster (Epper & Baker, 2009; Rotman, 2012). Another recommendation is the formation of learning communities. Learning communities are emerging as an effective method for improving the retention and performance of developmental mathematics students (Epper & Baker, 2009). In a learning community, a group or cohort of students is enrolled in a cluster of classes. These cohorts provide stability and support for the students as they proceed toward their

academic goals. Finally, in 1995 the American Mathematical Association of Two-Year Colleges articulated their standards for what mathematics instruction should look like at the community college level. These standards provide some guidance for developmental mathematics programs. The standards recommend the use of instructional strategies that require student activity and interaction as well as for student constructed knowledge (American Mathematical Association of Two-Year Colleges, 1995).

All of these recommendations provide some hope that the woeful statistics on student retention and performance in developmental mathematics can be improved. This may be most crucial for the first developmental mathematics course in which a student enrolls since the grade earned in the first math class attempted has been shown to have a strong positive correlation with completion of developmental mathematics (Bahr, 2008b).

### **Computer-Assisted Instruction**

As technology continues to advance, evolve, and become more pervasive, computer-assisted or computer-based instruction is becoming an integral part of higher education. Among its advantages, computer-assisted instruction provides the opportunity to reach a broader student audience, address student learning needs, and to save money (Hagerty & Smith, 2005; Zavarella & Ignash, 2009). Concerns have been raised, however, about the effectiveness of computer-assisted instruction with certain types of student learners, especially those enrolled in developmental education courses (Zavarella & Ignash). The use of technology in developmental mathematics began decades ago with the introduction of calculators into the classroom. Almost immediately, debates began over the wisdom of using technology that is capable of performing the very skill that is being assessed (Epper & Baker, 2009). However, most educators saw the potential that new

technological developments possessed for improving learning and student performance and in 1995, the American Mathematical Association of Two-Year Colleges published its standards for developmental mathematics which established the “use of technology as an essential part of an up-to-date curriculum” (American Mathematical Association of Two-Year Colleges, 1995).

Computer-assisted instruction refers to the use of technology to supplement or replace various elements of a traditional course. Computer-assisted instruction can allow for the delivery of instruction that provides students the opportunity to work through the content at their own pace during some portion or all of classroom time, with the instructor providing various degrees of interaction through lecture and individualized attention (Hodora, 2011). Computer-assisted instruction also includes course redesign models, sometimes referred to as computer-mediated learning, which are a growing trend in the field of developmental mathematics (Epper & Baker, 2009; Twigg, 2005). These models replace some or all of the face-to-face interaction with self-paced content that is delivered through an online delivery system. These models have proven successful in reorganizing the curriculum to allow accelerated student learning and completion of educational requirements for the course (Speckler, 2012). It is hoped that the utilization of these models in the developmental mathematics classroom can increase student performance and retention by increasing the intensity of the course and allowing for accelerated student learning, variables that have shown some promise for improving overall academic accomplishment (Bailey, Jeong, & Cho, 2010; Epper & Baker, 2009; Rotman, 2012).

**Two types of computer-assisted instruction.** Most of the software that is used in the developmental mathematics classroom has been developed by textbook publishers and has generally been developed to support one of two types of computer-assisted instruction described by Gifford (1996). These two models are (1) the bolt-on model and (2) the mediated learning model.

The bolt-on model consists of resources that were designed to support the traditional lecture course where the instructor is the primary source of information. This model usually consists of (1) software for generating homework problems using an algorithm so that multiple versions of the same problem can be presented, (2) videos that present instruction, and (3) the textbook. The bolt-on model provides software that is designed to enhance, not replace the traditional lecture, and simply combining the two does not necessarily lead to an environment that provides a well-organized, coherent, and effective presentation of the material (Kinney & Robertson, 2003).

The second type of software that has been developed supports the mediated-learning model. Mediated learning is defined as a learner-centered model of technology-mediated instruction (Gifford, 1996). In this model, the learner is at the center of the teaching and learning environment. The mediated learning model comprises the integration of (1) technologically sophisticated and comprehensive interactive multimedia software, (2) a competency based assessment system designed to support learner-centered instruction and immediate feedback, and (3) an instructional management system that provides analysis of the learning activities to both students and instructors (The Institute for Higher Education Policy, 1998).

The mediated learning model requires students and teachers to assume different roles than those found in a traditional lecture course. The interactive multimedia software is the primary means by which the student receives instruction and feedback. Instead of attending a traditional lecture, students navigate through lessons that are delivered through videos and the student utilizes the software to complete homework assignments, quizzes and tests. Students are able to proceed through the material at a pace that is appropriate for them. The software tracks student performance on each task, as well as the time spent by the student completing the task, and provides the student with immediate feedback. The instructor, although no longer the center of learning, retains an important role in the classroom by providing individual or group assistance and feedback on overall student performance and progress.

According to Gifford (1996), mediated learning has several advantages over a traditional lecture course. First, students can exercise more effective and efficient control over their own learning. This is accomplished by enabling students to navigate through the material at their own pace, spending as much time as is necessary on any particular topic or exercise until the appropriate level of mastery has been achieved. Second, the students receive immediate feedback and assessment. This is the result of utilizing the multimedia software to complete all homework and assessment activities. Third, students obtain learning assistance that is appropriate to the situation. This is accomplished by allowing the students to receive assistance that is informed by detailed assessments of individual student learning. Fourth, students are given learning assistance that is individualized due to the fact that the instructor is freed from delivering a lecture and can instead help students on a more personalized basis.

Mediated learning environments can be an effective means of achieving the goals of developmental education (Kinney, 2001a). Instructors are afforded great flexibility in how their courses will be structured in order to accommodate individual student learning needs and the students are afforded the advantage of receiving immediate feedback as they navigate through the course. The multimedia software also allows the instructor to monitor individual student progress and provides detailed information on performance and time on task for each lesson. This can allow the instructor to monitor student progress and performance and determine if and when intervention is necessary in order to facilitate retention and successful course completion.

Until recently the technology available to instructors usually consisted of the bolt-on type of computer assisted instruction. This technology was primarily used for drill and practice, did not allow for rich, interactive multimedia presentations, and provided only limited feedback. The ongoing evolution in technology has provided educators more choices when designing developmental mathematics courses. Contrasting the bolt-on model to the mediated leaning model yields one fundamental difference in these two types of computer-assisted instruction. In the bolt-on model, the technology is “bolted-on” to the existing components of a traditional lecture course and is incapable of being the primary vehicle to deliver instruction and feedback. Consequently, the teacher remains the center of learning. However, in the mediated leaning model, the student becomes the center of learning (Kinney, 2001a).

**Effectiveness of computer-assisted instruction.** Most of the research on the effectiveness of computer-assisted instruction has found that it is at least as effective as lecture based instruction (Kinney, 2001a; Perez & Foshay, 2002; Zavarella & Ignash,

2009). Evidence of the impact of computer-assisted instruction upon retention is mixed, with some studies showing that utilizing computer-assisted instruction helps to increase student retention while others have found the opposite to be true (Cartnal, 1999; McClendon and McArdle, 2002; Zavarella & Ignash, 2009).

In a study of success and retention by Cartnal (1999), students who took computer-assisted courses in either Beginning Algebra or Intermediate Algebra had higher retention rates, but students in the corresponding lecture-based courses had higher success rates, defined as earning a grade of C or higher. However, a greater percentage of the students in the computer-assisted courses went on to take higher-level mathematics courses. Similarly, Kinney (2001b) conducted a study of students enrolled in a developmental mathematics course that utilized either a traditional lecture-based format or a computer-assisted format. The study found no significant difference in student final exam scores between the two methods of instruction. Also, Hagerty & Smith (2005) conducted a study of eight sections of College Algebra courses, four taught in a traditional lecture format and four taught using computer-assisted instruction. Students did not know what type of instruction would be utilized when they enrolled in the course. The researchers concluded that students enrolled in the computer-assisted format performed significantly better than the students enrolled in the traditional lecture format. Additional analysis showed that the type of instruction was the only factor that statistically influenced the outcome. Finally, Zavarella and Ignash (2009) examined the likelihood of students withdrawing from either a computer-assisted developmental mathematics course or a traditional lecture course. The results showed that students enrolled in the computer-

assisted course were twice as likely to withdraw as those enrolled in the traditional lecture course.

In a more comprehensive study, McClendon and McArdle (2002) compared three different modes of instruction: traditional lecture, the bolt-on model, and the mediated-learning model. The study examined students enrolled in Beginning Algebra and the students were able to self-select into the type of learning format. No significant difference in success rates was found, however, there were differences in retention rates. The study found that the traditional lecture course had a retention rate of 60%, followed by the mediated-learning format at 48%, and the bolt-on format at 39%. Students were then followed for an additional year to see if there was any difference in performance in subsequent mathematics courses. The next course in the sequence, Intermediate Algebra, was only offered in the traditional lecture-based format and there was concern that students who completed Beginning Algebra using either the bolt-on or mediated learning model would have difficulty transitioning to a traditional lecture format. However, the results showed no significant difference in the success rate for Intermediate Algebra. Following the remaining students into College Algebra again showed no significant difference in performance.

The research on the effectiveness of computer-assisted instruction suffers from a variety of limitations. Studies are often limited to a single institution; statistical techniques employed are either not identified or are unsophisticated; students are allowed to self-select into the type of instruction; type of computer-assisted instruction (bolt-on or mediated learning) is often not identified; and important terms such as success or retention are not always defined for the purposes of the study. Additionally, since the

technology continues to evolve and its capability is always increasing, results of studies become outdated quickly since analysis is conducted upon previous generation technology and software.

**The Emporium Model.** The Program in Course Redesign was created in 1999 by the National Center for Academic Transformation. Supported by a grant from the Pew Charitable Trusts, the Program in Course Redesign has the goal of demonstrating how colleges and universities could redesign curriculum using technology to achieve both the enhancement of quality and cost savings. Key elements of the Program in Course Redesign include whole course redesign (as opposed to individual sections), active learning, computer-assisted learning resources, mastery learning, on-demand help, and alternative staffing (replacing more expensive faculty with less expensive tutors or computer technology). Among the 30 institutions that have participated in the Program in Course Redesign, 25 have demonstrated significant increases in the level of student learning and, of the 24 institutions that measured retention, 18 have shown significant increases (Epper & Baker, 2009). All of this was accomplished with a reduction in costs of 37% on average, ranging from a low of 15% to a high of 77% (Epper & Baker, 2009). The unique element of the Program in Course Redesign is its demand that effective reform cannot include the redesign of individual sections of courses and that technology cannot simply be bolted on to the existing course structure. Rather, reform must occur throughout all sections of the course and the utilization of technology must permeate the entire course.

One of the specific strategies for implementing the type of reform advocated by the Program in Course Redesign is known as the Emporium Model. The Emporium Model

achieves reform by (1) eliminating all lectures and replacing them with a learning resource center model featuring interactive software and on-demand personalized help, (2) relying on instructional software that includes homework, quizzes, and tests, and features immediate feedback to the student, (3) allowing students to work through the material at a pace that is appropriate for them, (4) using a staffing model that utilizes faculty and both professional and peer tutors, and (5) allowing the students to complete more than one course within a semester (The National Center for Academic Transformation, 2012a). As part of a three-year project, the Tennessee Board of Regents undertook an effort to reform the developmental mathematics program at several colleges in the state. The goal of the effort was to increase the completion rate in developmental mathematics courses while reducing both the time and money that students spent in these courses (Epper & Baker, 2009). Two of the colleges that participated in this reform effort were Jackson State Community College and Cleveland State Community College.

In 2008, Jackson State conducted a redesign of its developmental mathematics program utilizing the Emporium Model of instruction. The school combined three developmental mathematics courses into one new course that was modularized into twelve modules. Students were given a pre-test to identify deficiencies and determine what concepts they would be required to master for their majors. Following this assessment, students were given an individualized learning contract that provided a path to achieving the desired learning outcomes. Students were then required to attend a computer learning center that utilized mediated learning technology. This software contained the course content modules, video lectures, homework, and tests. At the

learning center, students were able to receive on-demand help from both faculty and tutors.

During the spring semester of 2008, Jackson State piloted the redesign and offered sections of both traditional sections and redesigned sections. In the traditional sections, the average post-test score for all 12 modules was 73% and in the redesigned sections it was 82%. In the traditional sections, 41% of the students earned a grade of C or better compared to 54% in the redesigned sections (The National Center for Academic Transformation, 2012b). Students were able to accelerate through the developmental mathematics with 25 students completing one complete course and part of a second and 10 students completing the equivalent of two full courses in one term (Epper & Baker, 2009).

In 2008, Cleveland State piloted a similar redesign of its developmental mathematics program that, like Jackson State, also utilized the Emporium Model of instruction. Three courses were redesigned with each course containing 10-12 modules and students were expected to complete at least one module per week. Students met in class one hour each week and were required to attend a computer lab two hours each week. Mediated learning technology was utilized with students viewing video lectures, and completing all homework assignments, quizzes, and test using the software. Results of the redesign have been impressive. Course completion rates have increased from 54% before the redesign to 72% afterwards and the rate of students exiting developmental mathematics increased by 47% compared to previous semesters (The National Center for Academic Transformation, 2012c). At the same time, costs have been reduced by over 10% in the mathematics department (Squires, Faulkner, & Hite, 2009).

In May of 2010, the Tennessee Board of Regents released a study of the Cleveland State developmental mathematics redesign (Tennessee Board of Regents, 2010). The study examined the population of recent high school graduates (defined as age of 17, 18, or 19) who enrolled in either Beginning Algebra or Intermediate Algebra. The research questions were

1. After controlling for race, gender, ACT math score, and the pre-college course, what is the impact of Cleveland State's redesign of Beginning and Intermediate Algebra on recent high school graduates?
2. Within the model, what are the effects of the controlling variables of race, gender, and ACT math score, and pre-college course?

The study follows students who enrolled in the two years prior to the redesign and it also follows students who enrolled in the redesign courses in either the fall of 2008 or the spring of 2009. The study utilized logistical regression to measure the effects of five predictor variables on three dichotomous outcome variables. The five predictor variables are redesign course indicator, developmental course type, gender, underrepresented minority indicator, and ACT math score. The outcome variables were (1) successfully completed the course which was defined as earning a grade of A, B, C, P, or S, (2) entered the next math class by the fall of the next year, and (3) was successful in the next math class. The study found that the redesign had a positive and strong impact on the ability of students to complete developmental mathematics courses. A student who enrolled in the redesign course was twice as likely to complete the initial developmental mathematics course with a satisfactory grade as a student who enrolled before the redesign. Similarly, a positive and strong impact was observed for students who enrolled

in another mathematics course. Furthermore, the study showed that when controlling for the student characteristics of race and gender, the significance of the redesign is unchanged. However, the study found that the redesign did not have any significant impact on the likelihood that a successful student will sign up for another mathematics course.

**Conclusion.** The need for finding new ways to deliver effective instruction to students is evident from the abysmal statistics on developmental mathematics education. Utilizing both their experience and thoughtfulness, and reflecting upon the standards of developmental mathematics as articulated by the American Mathematical Association of Two-Year Colleges, perhaps educators and administrators involved in developmental mathematics may find a useful tool in the form of computer-assisted instruction. The standards indicate that students need to read, write, listen to, and speak mathematics, engage in problem solving, expand their mathematical reasoning skills, and use technology to enhance their mathematical thinking. Students utilizing mediated learning environments are actively engaged in reading, listening to, and working with mathematical ideas and concepts. The standards also encourage students to utilize multiple representations for mathematics: numerical, graphical, tabular, and verbal. Interactive mediated learning environments incorporate use of multiple representations of the mathematical concepts being studied. Finally, mediated learning environments offer the opportunity to model real-world situations and make connections to other disciplines in ways that aren't possible in either a traditional lecture format or a bolt-on environment. Mediated learning embeds the use of technology directly into the learning environment,

allowing the student to actively learn, explore, and develop their mathematical abilities (Kinney, 2001a).

### **Conceptual and Theoretical Framework**

The use of computers to assist in learning is a relatively recent development that has grown with the explosion in computer technology over the last few decades. However, the use of technology in the United States to facilitate learning goes back to at least the 19<sup>th</sup> century when the U.S. Patent Office issued a patent to Halcyon Skinner in 1866 for a device used for teaching spelling (Benjamin, 1988). In 1928, Sidney Pressey obtained a patent for a machine that could be used for teaching and testing “drill” type material (Benjamin, 1988). The machine was designed so that students could not proceed to the next question until they had correctly answered the current question.

In 1953, the psychologist B. F. Skinner visited his daughter’s fourth-grade class and observed a lesson on arithmetic (Benjamin, 1988). During the visit, Skinner made several observations about the lesson: (1) all students had to proceed at the same pace, (2) the material was not broken down into smaller steps that grew in complexity as the student learned, (3) there was no frequent reinforcement, and (4) the students had to wait at least 24 hours for feedback on their work. Skinner was critical of these components of the lesson and felt that if they could be corrected, more learning would occur. Skinner was aware of the machine that Pressey had developed, but he felt that the machine was principally a testing device and not a true teaching machine since students had to study some material prior to using the machine. Skinner set out to develop a device that would be a true teaching machine. One of the characteristics of Skinner’s machine was that the material was organized in a logical, coherent fashion and students were taught the new

material in small increments. The term “programmed instruction” was coined to describe this process.

As the popularity of the teaching machine grew throughout the 1960’s, so did the criticisms of this new technology, with the major complaint being that the machines dehumanized students and the learning process. Critics also contended that students were receiving less personal attention from the teacher and that use of the teaching machine had the potential for putting thousands of teachers out of a job. Most of these criticisms and concerns appeared in the popular press, where public opinion seemed overwhelmingly opposed to the new technology. However, psychologists of the time were divided on the efficacy of the new technology (Benjamin, 1988).

As the years passed, more and more teaching machines were used in schools for the purposes of learning and acceptance of them grew. This acceptance was helped by the explosion in computer technology and the development of the personal computer. Throughout the 1970’s and early 1980’s, computers had been expensive and not user-friendly. However, improvements in both hardware and software, combined with a reduction in the cost of the machines, made computers commonplace in the classroom beginning in the late 1980’s. Today, the internet, along with modern computing and communications capabilities makes computer-assisted instruction a viable option at all levels of instruction.

**Behaviorism and programmed instruction.** Behavioral psychology has provided instructional technology with several basic assumptions, concepts, and principles and, in fact, many computer-assisted instructional designs are based upon the theory of behaviorism (Burton, Moore, & Magliaro, 1996; Hung, 2001). The primary tenet of

behaviorism is that responses to stimuli that are followed by either positive or negative reinforcement will lead to the conditioning of consistent and correct responses (Hodora, 2011). Essential to strengthening the responses to the stimuli is the repeated pairing of the stimulus and the response (Skinner, 1968). According to Skinner, knowledge is action. That is, the learner does not passively absorb information but rather plays an active role in the acquisition of knowledge. Skinner asserted that students learn by doing, experiencing, and engaging in trial and error (Burton, Moore, & Magliaro, 1996).

Behaviorism postulates that learning complex ideas and concepts, such as mathematics, involves learning incremental behaviors that are ordered in sequences, usually with small steps, arranged in order from the simple to the more complex, and presented in a logical and coherent manner. The desired behavior is maintained through the use of reinforcement that is contingent upon successful achievement at each step. To be most effective, the reinforcement should occur immediately after each response. In order to change behavior in an educational setting, the students must be assessed for their needs and abilities so that instruction is appropriate for each student (Deubel, 2003).

More than five decades ago, Skinner utilized the basic tenets of behaviorism to design a method of instruction that could be implemented with the assistance of a teaching machine. Skinner maintained that to be effective, the instruction should require the student to compose a response rather than select it from a list (no multiple choice questions) and require the student to pass through a carefully designed sequence of steps. Skinner felt that the instruction should replicate the experience that a student would have with a private tutor. Skinner believed these characteristics to be (1) there is a constant interchange between the student and the instructor, (2) the student completely

understands a concept before proceeding to the next concept, (3) material is presented in a logical and coherent fashion as the student is ready, (4) assistance is provided to the student in order to help the student arrive at the correct answer, and (5) the desired behavior is reinforced immediately (Skinner, 1958). Students would be given the freedom to proceed through the material at their own pace as they mastered each concept. This method of instruction became known as “programmed instruction”.

**Self-Regulation Theory.** Most theories of developmental education involve the application of already existing theories such as behaviorism, constructivism, and mastery learning to the field of developmental education. In the search for a unique theory of developmental education, it may be useful to consider what a true theory should do. Denzin (1970) has described the three functions that a theory should perform. As applied to developmental education, Denzin asserts that a true theory should (1) discuss and unite what happens in diverse developmental courses such as math, reading, and writing, (2) explain what aspects of a course make it effective or ineffective, and (3) allow educators to make predictions about the efficacy of a particular approach to teaching a course. Additionally, an effective theory for developmental education needs to focus on the structure and function of the environment and accommodate individual student differences (Wambach, Brothen, and Dikel, 2000).

Such a comprehensive theory for developmental education has been proposed by Wambach, Brothen, and Dikel (2000) and is known as Self-Regulation Theory. The theory asserts that the goal of developmental educators should be to develop students who are capable of self-regulation. Self-regulation is defined as “self-generated thoughts, feelings, and actions that are directed toward attainment of one’s educational goals”

(Zimmerman, Bonner, & Kovach, 1996, p. 141). Self-regulation is developed by creating an environment that is both demanding and responsive (Wambach, Brothen, & Dikel, 2000). Demanding environments are those that set standards for excellence and where expectations for appropriate behavior are clearly stated and enforced. Demanding courses require students to demonstrate competence in reading, writing, speaking, and computing. Responsive environments are created by providing timely and useful feedback that is given early and often.

The effectiveness of Self-Regulation Theory has been investigated by looking at how demanding and responsive different parenting styles are and how they affect the development of children. Four parenting styles have been identified (Baumrind, 1971):

1. authoritative (highly demanding and highly responsive)
2. authoritarian (highly demanding but not responsive)
3. permissive/indulgent (highly responsive but not demanding)
4. neglectful (neither demanding nor responsive)

A review of studies provided a consistent conclusion for the four parenting styles and the development of children (Wambach, Brothen, & Dikel, 2000). The children of authoritative parents achieved more positive outcomes in areas of psychosocial competence, academic achievement, and problem behaviors. The children demonstrated high levels of self-regulation and high self-esteem. Children of the other three parenting styles exhibited fewer positive outcomes. The authors of Self-Regulation Theory believe that the implication for developmental educators is clear: authoritative teaching that is competent, demanding and responsive will serve to create students that are self-regulated

and have a powerful and positive impact on students' academic accomplishments (Wambach, Brothen, & Dikel, 2000).

**Personalized System of Instruction.** During the 1960's, Fred Keller introduced a model of learning that can be regarded as an extension of the theories and concepts found in behaviorism and Skinner's programmed instruction (Lockee, Moore, & Burton, 2004; Price, 1999; Kulik & Kulik, 1986). This model is known as the Personalized System of Instruction (PSI) or the Keller Plan, and it employs a highly structured, student-centered approach to course design and instruction. A course designed upon the PSI model will contain the following characteristics (Burton, Moore, & Magliaro, 1996; Grant & Spencer, 2003; Price, 1999):

1. Students proceed through the course at their own pace.
2. Content is broken down into smaller units (modularizing) and students are required to demonstrate mastery of a unit before being allowed to proceed to the next unit.
3. The instructional content is presented in written form rather than in lectures. Instead, lectures and demonstrations are utilized primarily to motivate students.
4. Proctors provide tutorial support for the students.

There has been a substantial amount of research done that shows that the PSI model is an effective instructional strategy. Kulik, Kulik, and Carmichael (1974) and Kulik, Kulik, and Cohen (1979) found that students who completed a course using the PSI model learned at least as much or more than students taught in a traditional manner and students rate PSI classes as more enjoyable, more demanding, and higher in overall

quality than traditionally taught classes. When taught using a PSI model student examination scores were, on average, 0.48 standard deviations higher and 0.49 standard deviations higher on final examinations (Kulik, Kulik, & Bangert-Drowns, 1990).

**Putting it all together.** Developmental education can be viewed as a process for creating self-regulated learners (Wambach, Brothen, & Dikel, 2000). Developing self-regulated learners requires a demanding and responsive environment. In the context of a developmental mathematics class, a demanding environment is created by requiring students to attend each class, follow instructions as stated in the syllabus, complete assignments on time, make sufficient progress through the course, and take advantage of additional resources such as tutoring when necessary. A responsive environment is created by providing feedback that is timely, personal and explicit (Kinney, 2001b).

The PSI model for learning has been demonstrated to be successful with developmental students (Bonham, 1990), and it has been argued that PSI is consistent with Self-Regulation Theory (Wambach, Brothen, & Dikel, 2000). A key feature of the PSI model is the requirement for mastery, which developmental theory characterizes as highly demanding (Kinney, 2001a). The nature of the PSI model also provides a responsive environment through the frequent feedback that students receive through both the computer software and the proctor or instructor (Grant & Spencer 2003; Kinney, 2001b). The demanding and responsive environment that the PSI model provides helps to promote the development of self-regulation in students and has been shown to be well suited for developmental education (Kluger & DeNisi, 1996; Kulik, Kulik, & Bangert-Drowns, 1990; Wambach, Brothen, & Dikel, 2000).

The Emporium Model is essentially a Personalized System of Instruction that utilizes advances in modern computer technology to replace the written element of the PSI model with interactive multimedia software. The Emporium Model maintains all of the other elements of the PSI model: breaking the information to be presented into smaller modules of instruction, allowing for self-pacing, requiring learners to be active participants in the learning process, insisting that students demonstrate mastery of concepts before moving on to the next concept, and providing immediate feedback to the student. Consequently, it might be argued that the goal of teaching developmental mathematics using the Emporium Model is to create self-regulated learners by providing a demanding and responsive environment through the use of a computer mediated learning environment.

### **Summary**

Due to the large numbers of students enrolled in developmental education and the costs associated with these programs, the need for sound and comprehensive research on the issue of developmental education is apparent. Surprisingly, few methodologically sound, multi-institutional, comprehensive evaluations of developmental education programs have been published (Bahr, 2008b) and little is known about whether developmental education programs are an effective tool in helping students stay in college and complete their academic goals (Moore, Jensen, & Hatch, 2002). Research regarding the effectiveness of developmental education programs is sporadic, underfunded, and the results are often inconclusive with an overwhelming majority of institutions not conducting any type of systematic evaluation of their developmental education programs (The Institute for Higher Education Policy, 1998).

Although developmental education usually encompasses the areas of math, reading, and writing, students are most likely to need assistance with math (Le, Rogers, & Santos, 2011; Bahr, 2007). Community colleges are of primary interest when it comes to developmental education due to the fact that they constitute the primary venue in which developmental education is performed (Bahr, 2008b). Although developmental mathematics education is accessed by a large number of students, there is very little empirical research on this topic (Hodora, 2011). In one study, The Community College Research Center conducted an analysis of *Achieving the Dream* data and found that only 31% of students who were referred to developmental mathematics completed the course or courses within three years and only 20% eventually completed a college-level mathematics course (Bailey, Jeong, & Cho, 2010; Hodora, 2011; Speckler, 2012). In a study conducted by Bahr (2008b) only 75.4%, or more than three out of four of the students did not successfully complete their developmental mathematics courses and 81.5%, or more than four in five, did not complete a credential or did not transfer.

Some community colleges have experienced improvement in pass rates for developmental mathematics students after the introduction of a course redesign such as the Emporium Model (Speckler, 2012; Squires, Faulkner, & Hite, 2009; Twigg 2005). However, Hodora (2011) has identified many questions that still remain regarding how the improved results are connected to the course redesign.

According to Bahr (2007), the most fundamental principle of remediation and developmental education is equality of opportunity. That is, students for whom developmental mathematics has been successful should exhibit educational outcomes that are comparable to those students who did not require developmental coursework.

Ultimately, whether or not a developmental education program is effective is best decided by considering factors that include whether or not students are successfully completing the developmental education courses and whether or not students who completed developmental courses are eventually completing college-level courses (The Institute for Higher Education Policy, 1998; Weissman, Bulakowski, & Jumisko, 1997).

## **Chapter Three**

### **Methodology**

#### **Introduction**

The purpose of this study was to test the two research questions that relate to whether or not the Emporium Model affects student performance in both developmental and college-level mathematics. The study compared students who were enrolled in a developmental mathematics class that was redesigned utilizing the Emporium Model, with students who were enrolled in the same course prior to the redesign. The methodology employed to test the research questions is presented in this chapter. The chapter is organized into four sections: (a) design of the study, (b) selection of participants, (c) data collection, and (d) data analysis.

#### **Design of the Study**

Because of the nature of the phenomena being investigated, it was not possible to conduct an experimental study, since there was no intervention on the part of the investigator and no random assignment of the students. However, the absence of a true experimental study does not diminish the integrity or importance of the results of the study and other well-designed research approaches can be sufficient (Slavin, 2001).

For the purposes of this research, a quantitative study utilizing inferential statistics and comprising a causal-comparative research design was used to answer both research questions. Causal-comparative research involves exploring possible cause and effect, though true cause and effect cannot be determined for certain without an experimental design where the independent variable is manipulated by the researcher. In causal-comparative research, the independent variable is (1) naturally occurring, (2) does not

involve intervention by the researcher, and (3) is made up of comparison groups. For the two research questions included in this study, the independent variable is the type of developmental mathematics course taken. This variable is naturally occurring, since the course in which the student was enrolled was chosen by the student, in conjunction with the institution of attendance, and not determined by the researcher. Also, this variable does not involve intervention by the researcher, since the analysis relates to an instructional strategy chosen and implemented by the institution. Finally, the independent variable is made up of comparison groups, since it has two possible values, Emporium Model or pre-Emporium Model.

Each research question attempts to determine if there is a difference between two conditions as they already exist. Consequently, the analysis was done *ex post facto*, or after the fact, and is an indication that a causal-comparative research design is an appropriate method of analysis (Mertler & Charles, 2008). This study examined the causative relationship between the independent variable and the two dependent variables, although any relationship that was discovered is only suggestive.

Before the effectiveness of a developmental mathematics course or program can be evaluated, it is necessary to determine what particular aspect is indicative of success. However, according to a review of the literature performed by the U. S. Department of Education (2005), there is no clear consensus on what academic outcomes are the most appropriate to analyze. The report notes that “numerous metrics are used in evaluating the effectiveness of college developmental mathematics courses or programs” (p. 43). According to the report, the metrics used by researchers include examining the passing rate or final class GPA, examining the completion rate of the course, and determining the

level of anxiety or satisfaction with the course. Each of these metrics, especially when considered in isolation, is inadequate in determining if a developmental mathematics program has been successful in preparing students for college-level math. For example, examining the passing rate for a developmental course does not necessarily indicate that the student is ready for college-level coursework. Similarly, examining the completion rate of the course only serves to indicate if a student is “hanging around”, but this in and of itself is not a goal of remediation. Therefore, this study would be incomplete if it only addressed the first research question. The second research question attempts to address this issue by examining student success in what is typically the first college-level mathematics course: College Algebra.

### **Selection of Participants**

The target population for this study was all community colleges that have redesigned their developmental mathematics courses based upon the Emporium Model. To answer the two research questions in this study, the institutions chosen for the sample had to meet certain criteria. First, the institution must have redesigned its developmental mathematics course, Intermediate Algebra, in a manner consistent with the Emporium Model. Second, the institution must have data on student performance in Intermediate Algebra, both before the implementation of the Emporium Model, as well as after the implementation. Third, the institution must have data on student performance in College Algebra. This set of data must include those students who first took Intermediate Algebra before taking College Algebra, and include both students who took Intermediate Algebra prior to and after the implementation of the Emporium Model. Finally, in an

effort to acquire a satisfactory-sized data set, the institution must have been utilizing the Emporium Model for at least one year.

With the assistance of a representative from a large publishing firm, it was possible to locate a sample of three community colleges that met the desired criteria. The three institutions will be referred to as Community College A, Community College B, and Community College C. All three institutions agreed to provide data for the study. They are located in rural areas of their respective states, and each have an approximate student population that ranges from 3,500 to 6,000 students. All of the community colleges selected for the sample in this study have redesigned their developmental mathematics programs in recent years in a manner consistent with the Emporium Model. Both Community Colleges A and B implemented the Emporium Model in 2008, and Community C implemented the redesign in 2011.

### **Data Collection**

The first step in the data collection process was determining what kind of data each of the three community colleges possessed in relation to the Emporium Model and developmental mathematics. An inquiry was made with the institutional review board official at each institution, and it was confirmed that all three schools had data that would make it possible to address the two research questions addressed in this study. In order to obtain the data, it was necessary to obtain permission from each of the institution's office of institutional research, as well as from the University of Toledo Institutional Review Board. During the summer of 2012, the appropriate applications were filed with the community colleges, and all three institutions granted permission to access the data. Additionally, it was determined that the study proposed in this dissertation qualified as

exempted research, as determined by the University of Toledo Institutional Review Board. This is due to the fact that (a) the research will be conducted in an established and commonly accepted educational setting, (b) will involve normal educational practices, (c) will consist of research on the effectiveness of an instructional technique and (d) this research will involve the collection and study of existing data that contains no student names. Letters of permission to collect the data were received from each community college.

Each of the three community colleges provided data on student performance in the developmental mathematics course Intermediate Algebra as well as data on student performance in College Algebra. The data includes student grades in these courses at least one year prior to the implementation of the Emporium Model, and at least one year subsequent to implementation. Table 3.1 presents the number of student data files by institution.

Community College A provided student-level data from the spring semester of 2006 through the fall semester of 2011. The institution provided 4,447 Intermediate Algebra grades which were used to answer the first research question and 1,021 College Algebra grades which were used to answer the second research question. This data was at the student level and contained a unique identifier so that it was possible to follow individual students throughout the years investigated. The data contained the student outcome in the course. This included a letter grade (A, B, C, or F) or withdrawal.

Community College B provided course-level data from the fall semester of 2006 through the spring semester of 2010. The institution provided 327 College Algebra grades which were used to answer the second research question. The data contained the

student outcome in course. This included a letter grade (A, B, C, D, or F) or withdrawal. Community College B was not able to provide any data on student performance in Intermediate Algebra prior to the implementation of the Emporium redesign. Consequently, the analysis conducted to answer the first research question did not include Community College B.

Community College C provided student-level data from the fall semester of 2005 through the summer semester of 2012. The institution provided 7,498 Intermediate Algebra grades which were used to answer the first research question and 3,114 College Algebra grades which were used to answer the second research question. This data was at the student level and contained a unique identifier so that it was possible to follow individual students throughout the years investigated. The data contained the student outcome in the course. This included a letter grade (A, B, C, D or F) or withdrawal.

Table 1 Number of Student Data Files

	Intermediate Algebra		College Algebra	
	Pre-Emporium	Emporium	Pre-Emporium	Emporium
Community College A	1,291	3,156	253	768
Community College B	None	None	230	97
Community College C	5,616	1,882	2,575	539

## Data Analysis

The quantitative analysis used in this study sought to determine if there was a statistically significant difference between the comparison groups of the independent variable on the dependent variables. The independent variable for this study is as follows:

*Type of Developmental Mathematics Course:* This is the independent variable for both research questions. This is a dichotomous variable and its two possible values are Emporium Model or pre-Emporium Model.

There are two forms of the dependent variable for each research question. One form of the dependent variable is categorical in nature and has three possible values. The other form of the dependent variable is continuous. In order to accomplish this analysis it was necessary to utilize both a chi square analysis and an independent samples t-test.

**Chi square analysis.** The dependent variables deal with student performance as measured by the grade earned in the course. One form of the dependent variable has three possible values: pass, fail, and withdraw. Because this variable is not continuous, it was not possible to use a parametric test. Consequently, a chi square analysis was used. A chi square analysis is a non-parametric analysis that is used to determine if there are differences in frequency counts of two or more dependent categorical variables. The dependent variables for this part of the analysis are as follows:

*Grade Earned in the Developmental Mathematics Course:* This is the dependent variable for the first research question. This is a categorical variable consisting of the student's grade earned in the developmental mathematics course Intermediate

Algebra. The possible values are pass (A-C), fail, and withdraw. Given that some students repeat courses, the last grade they earned in the course was utilized.

*Grade Earned in College-Level Mathematics Course:* This is the dependent variable for the second research question. This is a categorical variable consisting of the student's grade earned in the college-level mathematics course College Algebra. The possible values are pass (A-D), fail, and withdraw. A student's first outcome from the course was the one utilized.

The dependent variable for the first research question defines passing as earning a grade of A, B, or C. This was done for several reasons. First, it is consistent with the concept of mastery learning, which is one of the key elements of the Emporium Model (The National Center for Academic Transformation, 2012a). Second, it is consistent with other studies that have investigated the Emporium Model (Tennessee Board of Regents, 2010, The National Center for Academic Transformation, 2012b). Finally, it was necessary since one of the participating institutions for this study defined passing in this manner and the data provided reflected this definition.

**Independent samples t-test.** The other form of the dependent variable is continuous in nature, with values assigned that were congruent with a 4.0 scale (A=4, B=3, C=2, D=1, and E=0). Consequently, an independent samples t-test was used. An independent samples t-test is used to test for group mean differences between two groups on one dependent continuous variable. The dependent variables for this part of the analysis are as follows:

*Grade Earned in the Developmental Mathematics Course:* This is the dependent variable for the first research question. This is a continuous variable consisting

of the student's grade earned in the developmental mathematics course Intermediate Algebra.

*Grade Earned in College-Level Mathematics Course:* This is the dependent variable for the second research question. This is a continuous variable consisting of the student's grade earned in the college-level mathematics course College Algebra.

It should be noted that when the mean grade is reported for the first research question, the mean cannot be interpreted as a traditional GPA, since D's were grouped with the failing category. However, the mean grade for the second research question can be interpreted as a traditional GPA since all five letter grades (A, B, C, D, and E) were included in the independent samples t-test analysis.

### **Summary**

This chapter restated the purpose of this study and presented the research questions. For the purposes of this research, a quantitative study utilizing a causal-comparative research design was used to answer both of the research questions and the analysis was conducted ex post facto. The three community colleges chosen to be included in the sample for this study were the only institutions found to meet the criteria necessary to answer the two research questions. Each of the community colleges provided either student-level or course-level data on student performance in both Intermediate Algebra and College Algebra. These data include student performance in these classes both before and after the implementation of the Emporium Model. Finally, the analysis of data for this study was conducted using a chi square analysis and independent samples t-test. Results of the data analysis are presented in the following chapter.

## **Chapter Four**

### **Presentation and Analyses of Data**

#### **Introduction**

This study intended to investigate the effectiveness of a relatively recent development in the teaching of developmental mathematics known as the Emporium Model. The analysis includes an investigation of student performance in a developmental mathematics course (Intermediate Algebra), as well as student performance in a college-level mathematics course (College Algebra), in an attempt to discover if the type of instruction received in the developmental course (Emporium or Pre-Emporium) makes a significant difference in student performance in either the developmental course or the college-level course.

The presentation of the findings is arranged in order of the two research questions. Both a chi square analysis and an independent samples t-test were utilized to answer the first research question: Is there a significant difference in student performance in Intermediate Algebra between those students who completed the class in an Emporium format versus those students who completed the class in a pre-Emporium format? Similarly, both a chi square analysis and an independent samples t-test were utilized to answer the second research question: Is there a significant difference in student performance in College Algebra between those students who completed Intermediate Algebra in an Emporium format versus those students who completed Intermediate Algebra in a pre-Emporium format? The first research question investigates student performance in Intermediate Algebra only and attempts to determine if the type of instruction received, either pre-Emporium or Emporium, had any significant effect on

student performance in the course. The second research question investigates student performance in College Algebra for those students who first took Intermediate Algebra. Some of the students will have taken Intermediate Algebra in a pre-Emporium format and some in an Emporium format. The goal of the second research question is to determine if the type of instruction received in Intermediate Algebra had any significant effect upon student performance in College Algebra.

The findings indicate that the Emporium Model is an effective means of improving student performance in Intermediate Algebra and preparing developmental mathematics students for College Algebra. Students enrolled in Intermediate Algebra in an Emporium format at Community College A performed significantly better than Intermediate Algebra students in a Pre-Emporium format, while students at Community College C performed about the same in both formats. Similarly, College Algebra students at all three Community Colleges who first took Intermediate Algebra in an Emporium format performed better in College Algebra than students who had taken Intermediate Algebra in a pre-Emporium format. This chapter presents the complete results of the data analysis for the two research questions.

### **Testing the Research Questions**

**Research question one.** Question 1: Is there a significant difference in student performance in Intermediate Algebra between those students who completed the class in an Emporium format versus those students who completed the class in a pre-Emporium format?

**Community College A.** A significant relationship  $\chi^2(2, N = 4447) = 70.54, p < .001$ , was found to exist between the type of developmental mathematics course completed and student performance in the class. However, it is not possible to say without additional testing what components of student performance were significant. Follow-up pair-wise comparisons could determine where statistically significant effect(s) occurred amongst the passing, failing, and withdrawal rates. Table 4.1 illustrates the cross-tabulation results of student performance in Intermediate Algebra according to whether the student took the course in a pre-Emporium or Emporium format. Of the 1,291 students who took the course in a pre-Emporium format, slightly more than half (56.0%) of them passed (earned a grade of A, B, or C). Of the 3,156 students who took the course in an Emporium format, more than two-thirds (69.2%) of the students passed the course (earned a grade of A, B, or C). Both groups had failure rates that exceeded withdrawal rates, with both of these rates being higher for the pre-Emporium format.

Table 2 Grade Frequencies for Intermediate Algebra (Community College A)

	Intermediate Algebra Grades			
	Passed	Failed	Withdrew	Total
Pre-Emporium	56.0%	27.2%	16.8%	100.0%
Emporium	69.2%	19.5%	11.3%	100.0%
Pre-Emporium (Count)	723	351	217	1,291
Emporium (Count)	2,183	616	357	3,156

The magnitude of the effect size as measured by the contingency coefficient was 0.125. This indicates that 12.5% of the variance in the performance of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

An independent samples t-test was conducted to evaluate the hypothesis that there is a difference in mean scores for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in Intermediate Algebra) revealed a significant difference in the means of the two groups,  $t(1935.4) = -14.70, p < .001$ . As evidenced in Table 4.2, students who took Intermediate Algebra in the Emporium format had mean scores that were greater than those who took Intermediate Algebra in the pre-Emporium format. The eta squared was 0.053 indicating that 5.3% of the variance in the means of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

Table 3 Mean Grade for Intermediate Algebra (Community College A)

Instruction Type	N	Mean	SD
Pre-Emporium	1,074	2.38	1.18
Emporium	2,799	2.99	1.17

**Community College C.** A significant relationship,  $\chi^2(2, N = 7498) = 35.60, p < .001$ , was found to exist between the type of developmental mathematics course completed and student performance in the class. However, it is not possible to say without additional

testing what components of student performance were significant. Follow-up pair-wise comparisons could determine where statistically significant effect(s) occurred amongst the passing, failing, and withdrawal rates. Table 4.3 illustrates the cross-tabulation results of student performance in Intermediate Algebra according to whether the student took the course in a pre- Emporium or Emporium format. Of the 5,616 students who took the course in a pre-Emporium format, slightly more than half (51.6%) of them passed (earned a grade of A, B, or C). Of the 1,882 students who took the course in an Emporium format, slightly less than half (49.4%) passed (earned a grade of A, B, or C). A higher percentage of students in the Emporium format failed the course, but a lower percentage in the Emporium format withdrew from the course.

Table 4 Grade Frequencies for Intermediate Algebra (Community College C)

	Intermediate Algebra Grades			Total
	Passed	Failed	Withdrew	
Pre-Emporium	51.6%	27.6%	20.8%	100.0%
Emporium	49.4%	34.1%	16.5%	100.0%
Pre-Emporium (Count)	2,898	1,548	1,170	5,616
Emporium (Count)	930	642	310	1,882

The magnitude of the effect size as measured by the contingency coefficient was 0.069. This indicates that 6.9% of the variance in the performance of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

An independent samples t-test was conducted to evaluate the hypothesis that there is a difference in mean scores for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in Intermediate Algebra) revealed a statistically significant difference in the means of the two groups,  $t(2906.78) = 4.99, p < .001$ . As evidenced in Table 4.4, students who took Intermediate Algebra in the Emporium format had mean scores that were less than those who took Intermediate Algebra in the pre-Emporium format. The eta squared was 0.004 indicating that approximately 0.4% of the variance in the means of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

Table 5 Mean Grade for Intermediate Algebra (Community College C)

Instruction Type	N	Mean	SD
Pre-Emporium	4,446	2.14	1.04
Emporium	1,572	2.00	0.98

**Combined analysis.** The data for Community Colleges A and B were combined and analyzed using both a chi-square and independent samples t-test. A significant relationship,  $\chi^2(2, N = 11,945) = 131.64, p < .001$ , was found to exist between the type of developmental mathematics course completed and student performance in the class.

However, it is not possible to say without additional testing what components of student performance were significant. Follow-up pair-wise comparisons could determine where statistically significant effect(s) occurred amongst the passing, failing, and withdrawal rates. Table 4.5 illustrates the cross-tabulation results of student performance in Intermediate Algebra according to whether the student took the course in a pre-Emporium or Emporium format. Of the 6,907 students who took the course in a pre-Emporium format, slightly more than half (52.4%) passed the course (earned a grade of A, B, or C). Of the 5,038 students who took the course in an Emporium format, more than 6 in ten (61.8%) passed (earned a grade of A, B, or C). The failure rates for the two groups were similar, but fewer students withdrew from the Emporium format.

Table 6 Grade Frequencies for Intermediate Algebra (Combined Analysis)

	Intermediate Algebra Grades			Total
	Passed	Failed	Withdrew	
Pre-Emporium	52.4%	27.5%	20.1%	100.0%
Emporium	61.8%	25.0%	13.2%	100.0%
Pre-Emporium (Count)	3,621	1,899	1,387	6,907
Emporium (Count)	3,113	1,258	667	5,038

The magnitude of the effect size as measured by the contingency coefficient was 0.104. This indicates that 10.4% of the variance in the performance of the two groups

can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

An independent samples t-test was conducted to evaluate the hypothesis that there is a difference in mean scores for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in Intermediate Algebra) revealed a significant difference in the means of the two groups,

$t(8835.55) = -19.13, p < .001$ . As evidenced in Table 4.6, students who took

Intermediate Algebra in the Emporium format had mean scores that were greater than

those who took Intermediate Algebra in the pre-Emporium format. The eta squared was

0.037 indicating that approximately 3.7% of the variance in the means of the two groups

can be accounted for by the different instructional strategies (pre-Emporium or

Emporium).

Table 7 Mean Grade for Intermediate Algebra (Combined Analysis)

Instruction Type	N	Mean	SD
Pre-Emporium	5,520	2.19	1.07
Emporium	4,371	2.64	1.20

**Research question two.** Question 2: Is there a significant difference in student performance in College Algebra between those students who completed Intermediate Algebra in an Emporium format versus those students who completed Intermediate Algebra in a pre-Emporium format?

**Community College A.** Although slightly more of the Emporium group passed the course than the pre-Emporium group, no statistically significant relationship,  $\chi^2(2, N = 1021) = 3.24, p = .20$ , was found to exist between the type of instruction received in Intermediate Algebra (pre-Emporium or Emporium) and student performance in College Algebra. Table 4.7 illustrates the cross-tabulation results of student performance in College Algebra according to whether the student took Intermediate Algebra (the prerequisite course) in either an Emporium or pre-Emporium format. Of the 253 students who took Intermediate Algebra in a pre-Emporium environment, about two-thirds (68.0%) passed College Algebra (earned a grade of A, B, C, or D). Of the 768 students who took Intermediate Algebra in an Emporium environment, almost three-fourths (73.7%) passed College Algebra (earned a grade of A, B, C, or D). The failure rate and the withdrawal rates were lower for those College Algebra students who had Intermediate Algebra in an Emporium format.

Table 8 Grade Frequencies for College Algebra (Community College A)

	College Algebra Grades			Total
	Passed	Failed	Withdrew	
Pre-Emporium	68.0%	13.0%	19.0%	100%
Emporium	73.7%	11.3%	15.0%	100%
Pre-Emporium(Count)	172	33	48	253
Emporium (Count)	566	87	115	768

An independent samples t-test was conducted to evaluate the hypothesis that there is a difference in mean scores for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in College Algebra) revealed a significant difference in the means of the two groups,  $t(333.48) = -5.69, p < .001$ . As evidenced in Table 4.8, students who took Intermediate Algebra in the Emporium format performed better than those who first took Intermediate Algebra in the pre-Emporium format. The eta squared was 0.037 indicating that approximately 3.7% of the variance in the means of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

Table 9 Mean Grade for College Algebra (Community College A)

Instruction Type	N	Mean	SD
Pre-Emporium	205	2.36	1.34
Emporium	653	2.97	1.30

**Community College B.** No significant relationship,  $\chi^2(2, N = 327) = 0.51, p = .77$ , was found to exist between the type of instruction received in Intermediate Algebra (pre-Emporium or Emporium) and student performance in College Algebra. Table 4.9 illustrates the cross-tabulation results of student performance in College Algebra according to whether the student took Intermediate Algebra (the prerequisite course) in either an Emporium or pre-Emporium format. Of the 230 students who took Intermediate Algebra in a pre-Emporium environment, almost three-fourths (73.0%) passed College

Algebra (earned a grade of A, B, C, or D). Of the 97 students who took Intermediate in an Emporium environment, slightly fewer (70.1%) passed College Algebra (earned a grade of A, B, C, or D). The failure rate was almost identical for the two formats and a higher percentage of College Algebra students who had Intermediate Algebra in an Emporium format withdrew from the course.

Table 10 Grade Frequencies for College Algebra (Community College B)

	College Algebra Grades			Total
	Passed	Failed	Withdrew	
Pre-Emporium	73.0%	13.5%	13.5%	100%
Emporium	70.1%	13.4%	16.5%	100%
Pre-Emporium(Count)	168	31	31	230
Emporium (Count)	68	13	16	97

An independent samples t-test was conducted to evaluate the hypothesis that there is a difference in mean grade in College Algebra for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in College Algebra) revealed no statistically significant difference in the means of the two groups,  $t(278) = -0.16, p = .87$ . As evidenced in Table 4.10, students who first took Intermediate Algebra in the Emporium format performed almost identically to those who first took Intermediate Algebra in the pre-Emporium format.

Table 11 Mean Grade for College Algebra (Community College B)

Instruction Type	N	Mean	SD
Pre-Emporium	199	2.12	1.27
Emporium	81	2.15	1.33

**Community College C.** A significant relationship,  $\chi^2(2, N = 3114) = 19.97, p < .001$ , was found to exist between the type of instruction received in Intermediate Algebra (pre-Emporium or Emporium) and student performance in College Algebra. However, it is not possible to say without additional testing what components of student performance were significant. Follow-up pair-wise comparisons could determine where statistically significant effect(s) occurred amongst the passing, failing, and withdrawal rates. Table 4.11 illustrates the cross-tabulation results of student performance in College Algebra according to whether the student took Intermediate Algebra (the prerequisite course) in either an Emporium or pre-Emporium format. Of the 2,575 students who took Intermediate Algebra in a pre-Emporium environment, about two-thirds (66.4%) passed College Algebra (earned a grade of A, B, C, or D). Of the 539 students who took Intermediate in an Emporium environment, more than three-fourths (75.9%) passed College Algebra (earned a grade of A, B, C, or D). Failure and withdrawal rates were also lower for those College Algebra students who had Intermediate Algebra in an Emporium format.

Table 12 Grade Frequencies for College Algebra (Community College C)

	College Algebra Grades			Total
	Passed	Failed	Withdrew	
Pre-Emporium	66.4%	13.3%	20.3%	100%
Emporium	75.9%	11.1%	13.0%	100%
Pre-Emporium(Count)	1,710	343	522	2,575
Emporium (Count)	409	60	70	539

The magnitude of the effect size as measured by the contingency coefficient was 0.080. This indicates that 8.0% of the variance in the performance of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

An independent samples t-test was conducted to evaluate the hypothesis that there is a difference in mean scores for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in College Algebra) revealed a significant difference in the means of the two groups,

$t(2520) = -4.82, p < .001$ . As evidenced in Table 4.12, students who first took

Intermediate Algebra in the Emporium format performed better than those who first took Intermediate Algebra in the pre-Emporium format. The eta squared was 0.009 indicating that approximately 0.9% of the variance in the means of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

Table 13 Mean Grade for College Algebra (Community College C)

Instruction Type	N	Mean	SD
Pre-Emporium	2,053	2.07	1.27
Emporium	469	2.38	1.23

**Combined analysis.** The data for Community Colleges A, B, and C were combined and analyzed using both a chi-square and independent samples t-test. A significant relationship,  $\chi^2(2, N = 4462) = 25.32, p < .001$ , was found to exist between the type of instruction received in Intermediate Algebra (pre-Emporium or Emporium) and student performance in College Algebra. However, it is not possible to say without additional testing what components of student performance were significant. Follow-up pair-wise comparisons could determine where statistically significant effect(s) occurred amongst the passing, failing, and withdrawal rates. Table 4.13 illustrates the cross-tabulation results of student performance in College Algebra according to whether the student took Intermediate Algebra (the prerequisite course) in either an Emporium or pre-Emporium format. Of the 3,058 students who took Intermediate Algebra in a pre-Emporium environment, about two-thirds (67.0%) passed College Algebra (earned a grade of A, B, C, or D). Of the 1,404 students who took Intermediate in an Emporium environment, almost three-fourths (74.3%) passed College Algebra (earned a grade of A, B, C, or D). Failure and withdrawal rates were also lower for those College Algebra students who had Intermediate Algebra in an Emporium format.

Table 14 Grade Frequencies for College Algebra (Combined Results)

	College Algebra Grades			
	Passed	Failed	Withdrew	Total
Pre-Emporium	67.0%	13.3%	19.7%	100%
Emporium	74.3%	11.4%	14.3%	100%
Pre-Emporium(Count)	2,050	407	601	3,058
Emporium (Count)	1,043	160	201	1,404

The magnitude of the effect size as measured by the contingency coefficient was 0.075. This indicates that 7.5% of the variance in the performance of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

An independent samples t-test was conducted to evaluate the hypothesis that there is no difference in mean scores for the pre-Emporium and Emporium groups. Examining the difference of the means of the dependent variable (grade earned in College Algebra) revealed a significant difference in the means of the two groups,

$t(3658) = -12.91, p < .001$ . As evidenced in Table 4.14, students who first took

Intermediate Algebra in the Emporium format performed better than those who first took Intermediate Algebra in the pre-Emporium format. The eta squared was 0.044 indicating that approximately 4.4% of the variance in the means of the two groups can be accounted for by the different instructional strategies (pre-Emporium or Emporium).

Table 15 Mean Grade for College Algebra (Combined Results)

Instruction Type	N	Mean	SD
Pre-Emporium	2,457	2.10	1.27
Emporium	1,203	2.69	1.31

### Summary

This chapter began with an introduction regarding the analysis and statistical tests that would be used to answer the two research questions for this study. This was followed by the analysis of the two research questions that was accomplished using both a chi square analysis and independent samples t-test.

Results from the first research question were mixed. Individual institution analysis revealed that students enrolled in an Emporium format had higher passing rates and mean grades at Community College A, while students at Community College C had higher passing rates and mean grades in a pre-Emporium format. However, withdrawal rates for both institutions were lower for students in the Emporium format. When the data were combined, students in an Emporium format had higher passing rates and mean grades, and had lower failure and withdrawal rates. There was a statistically significant difference in the mean grades, with students in the Emporium format having higher mean grades than those students in a pre-Emporium format.

Results for the second research question were also somewhat mixed, but less so than the first research question. Individual institution analysis revealed that students who had taken Intermediate Algebra in an Emporium format had higher mean grades in College

Algebra at all three institutions; however, the results at Community College B were not statistically significant. At Community College A, passing rates were higher, and failure and withdrawal rates were lower, for those students in College Algebra who had first taken Intermediate Algebra in an Emporium format. However, the results were not statistically significant. At Community College C, there was a statistically significant difference in student performance, with higher passing rates and lower failure and withdrawal rates. However, it is not possible to say whether the difference is in the passing, failing, or withdrawal rates without additional analysis. At Community College B, although no statistically significant difference in student performance was found, passing rates were higher and withdrawal rates were lower under pre-Emporium instruction. When the data were combined, students in College Algebra who had first taken Intermediate Algebra in an Emporium format had higher passing rates and mean grades, and had lower failure and withdrawal rates. There was a statistically significant difference, with students in the Emporium format having higher mean grades than students in the pre-Emporium format.

The next chapter will summarize the study by providing an in-depth analysis and discussion of the findings and presenting implications for practice as well as some recommendations for further research.

## **Chapter Five**

### **Summary, Discussion, and Conclusions**

#### **Introduction**

This chapter begins with a summary of the study that includes a brief review of the purpose of the study, the theoretical framework, the research questions, and the methodology. This will be followed by a discussion of the major findings of the study as well as conclusions from these findings and how they relate to the research questions. Finally, implications for practice and recommendations for further research will be discussed. The purpose of the latter sections is to expand upon what is known and understood about the Emporium Model and to provide some guidance on how this new information might be used to improve instruction in developmental mathematics and to highlight some areas in which further investigation might be warranted.

#### **Summary of the Study**

The need for finding new ways to deliver effective instruction to students is evident from the abysmal statistics on developmental mathematics education. Therefore, the purpose of this study was to examine the Emporium Model in an effort to determine the effectiveness of this strategy in increasing student performance in a developmental mathematics course, as well as preparing students for a college-level mathematics course.

The target population for this study was all community colleges that have redesigned their developmental mathematics courses based upon the Emporium Model. Each of the three community colleges included in this study provided data on student performance in the developmental mathematics course Intermediate Algebra as well as student performance in College Algebra. The data included student grades in these courses at

least one year prior to the implementation of the Emporium Model, and at least one year subsequent to implementation.

Grade information on over 16,000 students was received from the participating institutions and the data were analyzed in an effort to answer the two research questions for this study.

1. Is there a significant difference in student performance in Intermediate Algebra between those students who completed the class in an Emporium format versus those students who completed the class in a pre-Emporium format?
2. Is there a significant difference in student performance in College Algebra between those students who completed Intermediate Algebra in an Emporium format versus those students who completed Intermediate Algebra in a pre-Emporium format?

There were two forms of the dependent variable for each research question. One form of the dependent variable was categorical in nature and had three possible values. The other form of the dependent variable was continuous. Consequently, in order to accomplish the analysis for this study, it was necessary to conduct both a chi square analysis and an independent samples t-test.

### **Discussion of the Findings**

The Emporium Model is a relatively new method of instruction that is being utilized in developmental mathematics classrooms, especially at the community college level, where the majority of developmental education occurs (Bahr, 2008b). Some community colleges have experienced improvement in student performance for developmental mathematics students after the introduction of a course redesign such as the Emporium

Model (Twigg 2005; Speckler, 2012; Squires, Faulkner, & Hite, 2009). However, Hodora (2011) has identified many questions that still remain regarding how the improved results are connected to the course redesign. The goal of this study was to examine the Emporium Model in an effort to determine the effectiveness of this strategy in increasing student performance in a developmental mathematics course, as well as preparing students for a college-level mathematics course. This section discusses the findings for each of the research questions.

**Research question one.** *Is there a significant difference in student performance in Intermediate Algebra between those students who completed the class in an Emporium format versus those students who completed the class in a pre-Emporium format?*

**Combined analysis.** The findings were mixed for research question one. When the data for both of the institutions were combined and analyzed, the independent samples t-test revealed a statistically significant difference in the mean grade earned in Intermediate Algebra. Additionally, there was almost a ten-percentage point difference in the passing rates in favor of the Emporium group. Although the percentage of students failing the course were similar for the two groups, the number of students withdrawing from the Emporium format was seven percentage points lower than the pre-Emporium group. Although the chi square analysis showed a significant relationship between the instructional strategy and student performance, additional analysis is necessary to determine if the difference is in the passing, failing, or withdrawal rate(s).

The findings from the combined analysis are generally consistent with the limited research that has been done in the area of computer-assisted instruction generally, and the Emporium Model specifically. The results of the combined analysis show a clear

advantage to the Emporium format for both the grade earned in the course and the percentage of students passing the course. This is consistent with most of the research on the effectiveness of computer-assisted instruction, which has found that it is at least as effective as lecture-based instruction in the area of student success rates (Kinney, 2001a; McClendon and McArdle, 2002). It is also consistent with studies of the Emporium Model performed by Jackson State Community College (The National Center for Academic Transformation, 2012b) and Cleveland State Community College (The National Center for Academic Transformation, 2012c). Both of these studies compared developmental mathematics students enrolled in an Emporium format with students enrolled in a pre-Emporium format. The results showed increased student success, as measured by passing rates, for the students in the Emporium format.

The research on student retention is more mixed, with some studies showing that utilizing computer-assisted instruction helps to increase student retention, while others finding the opposite to be true (Cartnal, 1999; McClendon and McArdle, 2002; Zavarella & Ignash, 2009). The results of the combined analysis in this study indicate an advantage to the Emporium format, with those students having a lower withdrawal rate versus the students in the pre-Emporium format. Additional analysis would be necessary to determine if the difference in withdrawal rates is significant.

***Individual analysis.*** The results for Community College A were similar to those found for the combined analysis. The independent samples t-test revealed a statistically significant difference in the mean grade earned in Intermediate Algebra. Additionally, there was almost a ten-percentage point difference in the passing rates in favor of the Emporium group.

However, the analysis for Community College C showed a statistically significant lower mean grade earned for the students in an Emporium format. The analysis also revealed lower passing rates and higher failing rates for the students in an Emporium format. Interestingly, the students in the Emporium format had lower withdrawal rates, a finding consistent with both Community College A and the combined analysis. Although the literature is mixed regarding the impact of computer-assisted instruction upon retention (Cartnal, 1999; McClendon and McArdle, 2002; Zavarella & Ignash, 2009), the results of this study consistently show lower withdrawal rates in developmental mathematics courses taught in the Emporium format.

One possible explanation for the mixed results is the length of time that the Emporium Model had been implemented at each of the institutions. Community College A implemented the Emporium Model during the spring semester of 2008 and the data used in the analysis of this institution was collected through the fall semester of 2011. Community College C implemented the Emporium Model in the spring semester of 2011 and the data used in the analysis of this institution were collected through the summer semester of 2012. So while Community College A had been utilizing the Emporium Model in its developmental mathematics courses for over three years, Community College C had only been utilizing the Emporium Model for just over a year. This difference in duration of implementation may mean better familiarity with the new method of instruction for both students and faculty, possibly resulting in more effective use of the Emporium Model.

**Research question two.** *Is there a significant difference in student performance in College Algebra between those students who completed Intermediate Algebra in an*

*Emporium format versus those students who completed Intermediate Algebra in a pre-Emporium format?*

**Combined analysis.** The results of the analysis for research question two were mixed. When the data for all three of the institutions were combined and analyzed, the independent samples t-test revealed a statistically significant difference in the mean grade earned in College Algebra for those students who first took Intermediate Algebra in an Emporium format. Additionally, there was more than a seven-percentage point difference in the passing rates in favor of the Emporium group. The percentage of students failing and withdrawing from the course was also lower for those students who took College Algebra after first taking Intermediate Algebra in an Emporium format. Although the chi square analysis showed a significant relationship between the instructional strategy and student performance, additional analysis is necessary to determine if the difference is in the passing, failing, or withdrawal rate(s).

Like the results for research question one, the findings from the combined analysis for research question two are generally consistent with the limited research that has been done in the area of computer-assisted instruction generally and the Emporium Model specifically. The literature is especially limited in terms of evaluating instructional strategies in developmental mathematics courses and student success in the following college-level course. The limited research has generally shown no difference in success rates between students who placed directly into a college-level mathematics course, and those who were required to complete at least one developmental course first (Bahr, 2008b; Hutson, 1999; Kinney, 2001b; Waycaster, 2011). The results from this study clearly indicate an additional advantage for those students who took the developmental

course in an Emporium format. These results are also consistent with research conducted by the Tennessee Board of Regents (2010) at Cleveland State Community College, which showed that first taking Intermediate Algebra in an Emporium format had a positive and strong impact on student success in College Algebra, versus those students who took Intermediate Algebra in a pre-Emporium format prior to taking College Algebra.

***Individual analysis.*** When the results were analyzed individually by institution, an advantage to the Emporium format also emerged, although the advantage was not as great as was seen in the combined analysis. At all three institutions, students earned a higher mean grade in College Algebra if Intermediate Algebra was first taken in the Emporium format; however, the difference was not significant at Community College B.

The chi square analysis showed a significant relationship in instructional format and student performance only at Community College C, with a clear advantage to those students completing Intermediate Algebra in the Emporium format. Although the relationship between instructional format and student performance was not found to be statistically significant, students at Community College A who first took Intermediate Algebra in the Emporium format exhibited higher passing rates, and lower failing and withdrawal rates. Students at Community College B exhibited higher passing and withdrawing rates for those who first took Intermediate Algebra in the pre-Emporium format, although the failing rates for the two groups were about the same. Although the results found at Community College B conflict with those found at the other two institutions as well as the combined analysis, the chi square analysis found the difference in instructional format and student performance to be not significant. Also, the sample

size of student grades provided by Community College B was smaller than those provided by the other institutions.

Research has generally shown no significant difference in success rates between students who placed directly into a college-level mathematics course and those who were required to complete at least one developmental course first (Bahr, 2008b; Hutson, 1999; Kinney, 2001b; Waycaster, 2011). Similar to the combined analysis, the results of the individual analysis for research question two generally show an increased advantage to students who first take Intermediate Algebra in the Emporium format and are consistent with the findings of the Tennessee Board of Regents (2010).

### **Implications for Practice**

Over the past few decades developmental education has become an important mission of the American community college, as growing numbers of students enter college unprepared for college-level work. Researchers have found that a majority of students attending a community college require at least one developmental course (Boyer, Butner, & Smith, 2007; Stuart, 2009; Tierney & Garcia, 2008), and that overwhelmingly mathematics is the area in which students enroll (Bahr, 2007; Parsad, Lewis, & Greene, 2003; Le, Rogers, & Santos, 2011). Surprisingly, few methodologically sound, multi-institutional, comprehensive evaluations of developmental education programs have been published (Bahr, 2008b). Research regarding the effectiveness of developmental education programs is sporadic, under-funded, and the results are often inconclusive, with an overwhelming majority of institutions not conducting any type of systematic evaluation of their developmental education programs (The Institute for Higher Education Policy, 1998).

The need for finding new ways to deliver effective instruction to developmental mathematics students is evident from the abysmal statistics on developmental mathematics education. Some institutions have responded to this need by experimenting with new ways of delivering mathematics instruction to developmental students. One of these methods is the Emporium Model and it is a relatively new approach to mathematics instruction. Some community colleges have experienced improvement in success rates for developmental mathematics students after the introduction of a course redesign such as the Emporium Model (Speckler, 2012; Twigg 2005). However, because these redesign models are relatively new, there is little known about their effectiveness, and Hodora (2011) has identified many questions that still remain regarding how the improved results are connected to the course redesign.

This study has identified a relationship between the use of the Emporium Model in a developmental mathematics course and student success in both the developmental course and the following college-level mathematics course. These findings are consistent with the limited research that is available regarding the Emporium Model. In a study conducted at Jackson State Community College, students who took a developmental mathematics course that had been redesigned utilizing the Emporium Model exhibited higher passing rates and higher final grades than students who took the same class in a lecture format (The National Center for Academic Transformation, 2012b). A similar study of the Emporium Model was conducted by the Tennessee Board of Regents (2010) at Cleveland State Community College. The study found that the redesign had a positive and strong impact on the ability of students to complete developmental mathematics courses. A student who enrolled in the redesign course was twice as likely to complete

the initial developmental mathematics course with a satisfactory grade as a student who enrolled before the redesign. Similarly, a positive and strong impact was observed for students who enrolled in another mathematics course.

This study has added to the limited body of research regarding the Emporium Model and community colleges in several ways. First, this study was a multi-institutional analysis that utilized data from three community colleges. No other study could be found in the literature that had investigated the effects of the Emporium Model on student performance in developmental mathematics at more than one institution. Second, the fact that the analysis conducted for this study is more recent than other similar studies gives it an advantage by allowing for longer implementation times and more technological advances. More familiarity with the Emporium Model as a result of a longer implementation time and advances in educational technology may affect the efficacy of the redesigned format. Finally, this study followed students as they progressed from the developmental course to a college-level course. The ultimate goal of developmental education is to prepare students for college-level courses, and this study is more complete by including an investigation into student performance in College Algebra.

This study has identified a significant relationship between the use of the Emporium Model in a developmental mathematics course and student success in both the course and the following college-level mathematics course. Consequently, the findings of this study have implications for stakeholders in the area of improved student performance in developmental mathematics, as well as the costs associated with delivering this instruction.

For students, the results of this study offer several implications. Increased student performance in developmental mathematics means that students are more likely to pass the course and less likely to fail, withdraw or repeat the course. Not only does this lead to increased student satisfaction and confidence in mathematics, but not having to repeat the course means that students save money by not having to enroll in, and pay for, the same course more than once. Bahr (2008b) found that although students who successfully complete developmental mathematics exhibit attainment that is comparable to those students with no need of developmental mathematics, only about 25% of students successfully complete developmental mathematics. The findings of this study suggest it may be possible to increase the percentage of students successfully completing the course. Also, increased performance and success in a college-level course might allow students to pursue a degree or program that had once been considered out of reach for some developmental students, and it may serve to increase the chances of degree or program completion.

The findings provide at least one important implication for faculty. Critics of developmental education, especially remediation, have argued that these courses diminish academic standards and devalue postsecondary credentials, and that the large number of students enrolling in remedial classes in colleges and universities only serves to demoralize the faculty (Bahr, 2008b). Increased student performance in both Intermediate Algebra, as well as College Algebra, may lead to happier and more confident students, which might translate into more satisfied faculty. Additionally, fewer student withdrawals might mean that there are fewer developmental courses, and

increased student success in College Algebra might provide a need for more college-level courses.

Administrators can find at least one important implication from the results of the study. One of the elements of the Emporium Model is its ability to utilize a staffing model that incorporates faculty as well as professional and peer tutors (The National Center for Academic Transformation, 2012a). This can translate into cost savings for the institution by increasing the student-teacher ratio and offsetting the increase by using lower-paid tutors. Since the Emporium Model has been shown to be an effective means of improving student performance in developmental mathematics courses, administrators may want to consider incorporating the model for these courses.

Policy makers will find implications in the results of this study. Many states have taken legislative action in an attempt to address the concerns, including the cost of and student performance in, raised by developmental education. These actions include moving all developmental education to the community college level, requiring specific scores on placement exams, charging high schools for the full cost of remediation, charging students enrolled in developmental courses the full cost of remediation, and eliminating public funding for remedial coursework altogether (Education Commission of the States, 2002; Parker, 2007). The findings of this study offer some hope that increased student performance in developmental mathematics and the associated lower costs of the programs will allow more rational and deliberate legislation in the area of developmental education.

This study also provides implications for both taxpayers and society. Fewer withdrawals and increased student performance and success in developmental

mathematics offers hope that the associated costs of the programs can be lowered. This would be a direct benefit to taxpayers since, depending upon the state and institution, a significant share of the costs is borne by the taxpayer. Finally, increased student performance and success in both developmental and college-level mathematics might lead to more college graduates and a more educated workforce, both of which would be a benefit to society. Proponents of developmental education have argued that it can “provide opportunities to rectify race, class, and gender disparities generated in primary and secondary schooling and to develop the minimum skills deemed necessary for functional participation in the economy” (Bahr, 2008b, p. 420). Basic levels of reading, writing, and mathematical ability are necessary in our increasingly complex society if individuals hope to be full participants in our free market system and enjoy all of the opportunities that it offers. For students lacking the minimum competencies in these basic subjects, developmental education is essential in order to achieve economic stability (Day & McCabe, 1997). College graduates are more likely to vote and participate in community activities, and they are less likely to be involved in criminal activity (Pascarella & Terenzini, 2005). Therefore, developmental education can help to bring opportunity to those who may otherwise be relegated to low wages, poor working conditions and other consequences of socioeconomic marginalization (Roueche & Roueche, 1999).

### **Implications for Theory**

The primary tenet of behaviorism is that responses to stimuli that are followed by either positive or negative reinforcement will lead to the conditioning of consistent and correct responses (Hodora, 2011). Essential to strengthening the responses to the stimuli

is the repeated pairing of the stimulus and the response (Skinner, 1968). According to Skinner, knowledge is action. That is, the learner does not passively absorb information, but rather plays an active role in the acquisition of knowledge. Skinner asserted that students learn by doing, experiencing, and engaging in trial and error. Behavioral psychology has provided instructional technology with several basic assumptions, concepts, and principles and, in fact, many computer-assisted instructional designs are based upon the theory of behaviorism (Burton, Moore, & Magliaro, 1996; Hung, 2001).

More than five decades ago, Skinner utilized the basic tenets of behaviorism to design a method of instruction, known as programmed instruction, which could be implemented with the assistance of a teaching machine. During the 1960's, Fred Keller introduced a model of learning that can be regarded as an extension of the theories and concepts found in behaviorism and Skinner's programmed instruction (Kulik & Kulik, 1986; Lockee, Moore, & Burton, 2004; Price, 1999). This model is known as the Personalized System of Instruction (PSI) or the Keller Plan.

Just as the Personalized System of Instruction is an extension of the tenets of behaviorism and Skinner's programmed instruction, The Emporium Model is simply an extension of the PSI. Through its use of self-pacing, modularizing of material, elimination of lectures, and on-demand support for students, the Emporium Model is a modern-day PSI that utilizes advances in technology to provide students with an effective format for learning. Both the PSI and the Emporium Model employ a highly structured, student-centered approach to course design and instruction. The substantial body of research that has shown the PSI model to be an effective instructional strategy (Kulik, Kulik, & Carmichael (1974); Kulik, Kulik, & Cohen, 1979) is consistent with the results

of this study, which show the Emporium Model to be an effective means for improving student performance in both Intermediate Algebra and College Algebra.

Wambach, Brothen, and Dikel (2000) have argued that the goal of developmental education should be to develop students who are capable of self-regulation. Their theory, known as Self-Regulation Theory, asserts that a self-regulated student is developed by creating a learning environment that is both demanding and responsive. The Personalized System of Instruction has been demonstrated to be successful with developmental students (Bonham, 1990), and it has been argued that PSI is consistent with Self-Regulation Theory (Wambach, Brothen, & Dikel, 2000). The Emporium Model, as an extension of the Personalized System of Instruction, and with its emphasis on mastery learning and its on-demand assistance to students, certainly qualifies as an environment conducive to the creation of self-regulated learners.

### **Recommendations for Further Research**

The goal of this study was to examine the Emporium Model in an effort to determine the effectiveness of this strategy in increasing student performance in a developmental mathematics course as well as preparing students for a college-level mathematics course. Data was collected and analyzed to test two research questions related to this goal and some significant relationships were discovered. Although the findings were significant, there were some limitations. One limitation is that the study only looked at performance in Intermediate Algebra, and not at any lower levels of developmental mathematics such as Beginning Algebra or Pre-Algebra. Similarly, no effort was made to determine if the developmental mathematics student had other areas of deficiency, such as reading or writing. Another limitation is that the sample for this study included only three

institutions, and one of the institutions in this study had only been utilizing the Emporium Model for about one year when the data were collected. Based upon these limitations, some suggestions are made for further research.

Further research could include an investigation of whether or not the Emporium Model increases student performance for those students who have a greater depth of developmental need than just Intermediate Algebra. Depth of developmental need refers to the degree of deficiency within a given subject area. Developmental mathematics courses can be classified into four levels: Intermediate Algebra or Geometry is usually considered the highest level, followed by Beginning Algebra, then Pre-Algebra, and finally Basic Arithmetic. Research has shown that students who start in the lowest levels of developmental mathematics are less likely to enroll in a college-level mathematics course (Bahr 2007; Jenkins, Jaggars, & Roksa, 2009; Le, Rogers, & Santos, 2011). Since this study only investigated how the Emporium Model impacted student performance in Intermediate Algebra, the highest level of developmental mathematics, additional research into the Emporium Model and how it might impact student success in lower levels of developmental mathematics may yield some useful results.

Similarly, further research might include an analysis of whether or not the Emporium Model is effective at increasing student performance in developmental mathematics for those students who have a greater breadth of need. Breadth refers to the number of basic skill areas in which the student is in need of assistance. These areas can include mathematics, as well as reading and writing. Research has shown that students with multiple areas of deficiency are less likely to ever complete a college-level mathematics course (Bahr, 2007; McCabe, 2000; Weissman, Silk, and Bulakowski, 1997).

Consequently, an investigation of whether or not the Emporium Model significantly improves student performance for students with multiple areas of deficiency might prove useful.

The Emporium Model is a relatively new method of instruction in the area of developmental mathematics. As a result, it was only possible to obtain a sample of three community colleges that have been using the Emporium Model exclusively and for at least one year in their developmental mathematics courses. If the Emporium Model continues to show promise in improving student success in these courses, the number of institutions utilizing it may increase, and it might then be possible to obtain a larger sample for analysis. Additionally, it may be possible to include those institutions that have been using the Emporium Model for more than just a single year. Consequently, further research might include more institutions that have been utilizing the Emporium Model in their developmental mathematics courses for a longer period of time.

This study utilized a quantitative research design in order to answer the two research questions. Additional research into the question of the effectiveness of the Emporium Model may want to include a qualitative research design. This might provide a more holistic view of the Emporium Model by examining the thoughts, feelings, and attitudes that students and faculty have regarding this method of instruction.

Finally, the examination of the data included a chi square analysis to determine if there was a significant difference between the instructional method and student performance. However, student performance consisted of three different cells in the contingency table. Consequently, when a significant difference was discovered, it was not possible to determine which component of student performance exhibited the

significant difference. Therefore, additional research might include a more detailed analysis with follow-up pair-wise comparisons between passing, failing and withdrawal rates in an attempt to determine which of these components of student performance was demonstrating the significant difference.

## **Conclusions**

Research has shown that mediated learning environments can be an effective means of achieving the goals of developmental education (Kinney, 2001a). The findings of this study have expanded the work of previous researchers in the area of the utilization of mediated learning in developmental mathematics. This investigation has shown that some students who took Intermediate Algebra in an Emporium format were more likely to pass, less likely to withdraw, and more likely to earn a higher grade than students who took the course in another format. Also, this study has shown that some students who completed Intermediate Algebra in the Emporium format, were more likely to pass, less likely to withdraw, and more likely to earn a higher grade in College Algebra.

Ultimately, whether or not a developmental education program is effective is best decided by considering four factors: (1) whether or not students are successfully completing the developmental education courses, (2) whether or not students are moving from developmental to college courses, (3) whether or not students who completed developmental courses are eventually completing college-level courses, and (4) whether or not developmental education students are persisting and completing their college goals (The Institute for Higher Education Policy, 1998; Weissman, Bulakowski, & Jumisko, 1997). This study has shown that the Emporium Model can be effective at addressing

some of these factors and, hopefully, increasing the chances of students succeeding in college.

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