

EXAMINING METHODS OF TEACHING DEVELOPMENTAL MATH COURSES
TO MEET THE INDIVIDUAL NEEDS OF ADULT LEARNERS
AT COMMUNITY AND TECHNICAL COLLEGES

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Abstract

EXAMINING METHODS OF TEACHING DEVELOPMENTAL MATH COURSES TO MEET THE INDIVIDUAL NEEDS OF ADULT LEARNERS AT COMMUNITY AND TECHNICAL COLLEGES

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Under the Supervision of Dr. Richard A. Rogers

This paper examined alternative approaches to teaching developmental mathematics at community and technical colleges. At the time of this research, a class schedule at Madison College offered one option when a student was placed in developmental math courses: the traditional 16-week course in a lecture-based setting. Adult learners came to campus with a variety of learning styles and unique needs and were searching for options in course deliveries and learning methods. The literature contained numerous instructional models to meet the needs of non-traditional students by providing options, both in traditional classroom settings and in a variety of online formats.

Using the review of literature as a guide, recommendations were developed to assist the developmental math faculty at Madison College in a redesign of the math course sequence. The team began to develop a redesign in Fall 2012 with a pilot course to be offered in Spring 2013. Full implementation was planned for Fall 2013.

TABLE OF CONTENTS

	PAGE
APPROVAL PAGE	i
TITLE PAGE	ii
ABSTRACT	iii
TABLE OF CONTENTS.....	iv
CHAPTER I. INTRODUCTION.....	1
Introduction	
Statement of the Problem	
Definitions of Terms	
Delimitations	
Method of Approach	
CHAPTER II. REVIEW OF LITERATURE	4
Characteristics of the Adult Learner	
Developmental Math Courses Currently Being Offered	
Delivery Methods of Developmental Math Courses	
Instructional Models for Developmental Math Courses	
CHAPTER III. CONCLUSIONS AND RECOMMENDATIONS.....	14
REFERENCES	16

Chapter One: Introduction

Over 2 million students enroll in developmental education in U.S. colleges every year (Bonham & Boylan, 2011). Poor academic preparation limits access to and achievement in higher education opportunities for many of these students. Those who do enroll often struggle academically, dropping out before completing a course or earning a degree. Community colleges offer developmental courses to help these students prepare for college level courses. As open access institutions, these colleges tend to enroll students facing many academic challenges, especially in the area of mathematics. Several factors often in combination contributed to remedial placement in mathematics. The student might be returning to school after a long absence. For many students a negative experience in middle school or in high school caused math anxiety. Others only needed certain skills to meet their vocational needs, but were forced to take the entire course to satisfy a prerequisite or improve their placement scores. For some students one semester of developmental math might be enough, while other students might find themselves in developmental courses for two, three, or even four semesters before their skills were at the college level. It seemed unusual to this researcher that that many colleges offered just one solution, a traditional 16- week course delivered in face-to-face classrooms. At the time of this study, students had more access to technology than ever before, and many were looking to move through math content at a pace that fit their learning styles and readiness while utilizing their technology skills.

The purpose of this research was to identify alternative approaches to teaching developmental mathematics at the technical and community college level. These alternatives were expected to give students options when choosing course sections beyond the traditional face-to-face course offerings.

Statement of the Problem

Did the teaching method that was applied to developmental math courses relate to course success and completion rates? Was a 16-week developmental math course, taught face to face, the best type of delivery for all students? Could traditional developmental math courses be restructured to meet the individual needs of students and improve retention and program completion rates?

Definition of Terms

Computer-based instruction - This delivery format requires a computer and a packaged software product to deliver the content of the course (Zavarella & Ignash, 2009).

Open access institutions - Learning institutions that attract “nontraditional students, including nonworking mothers, working adults, or people in the military. Today, many online schools do not require SATs or other entrance exams. Students need only a high school diploma or GED to be admitted” (Sturgis, 2012).

Remedial education - “Courses in reading, writing, or mathematics for college-level students lacking those skills necessary to perform college-level work at the level required by the institution” (Tierney & Garcia, 2008).

Delimitations of Research

The references used for the review of literature were collected over a period of 45 days using the resources of the Karmann Library at the University of Wisconsin-Platteville. Several search engines provided by EBSCOHOST were used, primarily ERIC, Education Research Complete, and Education Full Text (H.W. Wilson). The key search terms used were “Developmental Education,” “Mathematics,” and “Teaching Methods.”

Method of Approach

A review of literature relating to research, studies, and delivery options in mathematics was conducted. Another review of literature on related research was conducted on best practices in teaching and learning mathematics. Attendance at The National Center for Postsecondary Research at Columbia University was made. The findings were summarized and recommendations made.

Chapter Two: Review of Related Literature

Characteristics of the Adult Learner

At the time of this study, community colleges served students with little or no experience in higher education, coming from a variety of backgrounds. A growing number of students were from three distinct groups: workers displaced as a result of the current economic situation, veterans returning from Iraq and Afghanistan, and adults seeking higher education after completing the GED (Kenner & Weinerman, 2011). Additionally, these non-traditional students often had at least one of the following characteristics: delayed enrollment into college, full time work, care for independents, single parenting, or non-completion of traditional high school (Spellman, 2007). According to Spellman, 33% of community college students were married, 25% were single parents, 57% worked at least half time, and 21% commuted a minimum of six hours per week to and from classes. These students faced many challenges in their educational journeys. Adapting to the role of being a learner and recognizing that learning as an adult was a different experience from that of a traditional college student could be challenging and overwhelming.

The pedagogical theory of adult learning, referred to as andragogy, recognized that adults sought to develop independence in their method of learning (McGlone, 2011). According to McGlone, adults approached learning from a perspective of life experience, seeking knowledge that helped them through life's goals and challenges. These students were voluntary learners, who came to class with an intention to learn (Harker, 2009). They were self-directed, had a depth of experience, and were ready and motivated to learn (Kenner & Weinerman, 2011).

Several common characteristics of adult learners contributed to how they learned. For educators, it was imperative that these characteristics were recognized and honored. First, adult

students had many roles, and may not have been fully focused on their education, as would a traditional student (Polson, 1993). Their experience of returning to school would have to have been successfully integrated into a non-traditional learner's already complex life. Polson stated that this meant making exceptions for the adult learner regarding family and career obligations. Secondly, adults had a wealth of life experiences, which could provide positive reinforcement, as well as detract from new learning. The experiences provided valuable resources applicable to the content of the course, or it could have created barriers to learning (Polson, 1993). Finally, adult learners usually had clear educational goals and were more likely to be paying for their education (Polson, 1993). This financial commitment led to a more focused learner, who had less time and patience for deviation from the course content.

Understanding characteristics of the adult learner helped educators develop strategies to improve learning and increase chances for student success. One strategic method included framing the learning strategies so that learners could see relevance to their academic careers (Kenner & Weinerman, 2011). These learners wanted to know how the course would meet their individual needs. As a second strategy, Kenner and Weinerman also recommended repetition, which allowed learners to test the usefulness of the objectives to their personal needs. The third strategy recommended by Kenner and Weinerman suggested offering learners new strategies that competed with ineffective existing strategies. By understanding their learning preferences, adults could compare new strategies with previous instructional models (Kenner & Weinerman, 2011). Implementing these strategies into developmental math courses would help instructors guide adult learners transitioning into college level math courses (Kenner & Weinerman, 2011).

Developmental Courses Currently Being Offered

At the time of this study, Madison College offered several options to students who sought to attain math skills at a college level. Options included a booster workshop and two courses designed to bring the math competency up to a college entry level. These options offered students an opportunity to review or learn math in preparation for a more rigorous college math course. All were offered in a traditional lecture-based format.

Math Concepts and Basic Algebra were structured courses designed to review and enhance speed and competency in basic math skills through pre-algebra skills. According to the Madison College Web site, emphasis was placed on assisting students to improve organizational skills, study skills, and mental math skills in order to enhance the student's ability to proceed further in mathematics and science classes or successfully complete occupational program courses that relied on these skills. As of Fall 2012, all Math Concepts and Basic Algebra courses at Madison College were offered in traditional, face-to-face settings and ran a full 16-week semester (<http://programs.matcmadison.edu/programs/basic-skills-education/math-concepts/>).

Booster workshops were designed for students who aimed to place into Elementary Algebra, but had not met the requirements. They were a fast-paced, intense review of basic algebra principles. These workshops were offered in the summer, met ten days for two hours per day, and were taught in traditional, face-to-face settings (<http://programs.matcmadison.edu/programs/basic-skills-education/math-concepts/>).

Delivery Methods of Developmental Math Courses

Fortunately, all of the attention focused on developmental math programs forced community colleges and policy makers to make major changes in the content, organization, and delivery of these programs (Bonham & Boylan, 2011). In an effort to meet the diverse needs of the non-traditional learners, a shift occurred from simply providing access for underprepared students to a more rigorous involvement in the developmental sequence. Community colleges served a population with diverse needs and a wide range of skills, and non-credit courses were offered to prepare students for college level courses. Community colleges adapted to the changing needs of non-traditional students and delivered courses in a way that improved students' opportunity for success. Adults needed flexibility in the time, location, and delivery method of their classes (Bonham & Boylan, 2011).

According to the research in 2012, the most common delivery method used at community colleges in the early 2000s was lecture-based instruction in a traditional classroom. This was the primary teaching method used at Madison College and was successfully integrated with other aspects of college student support systems such as enrollment, financial aid, and scheduling. In lecture-based instruction, teachers gained a better understanding of student needs, and could adjust their instruction accordingly (Hodara, 2011, *Reforming*). Frequent testing, classroom assessment techniques, formative assessments, and student input contributed to student success. Developmental math students performed well with regular instructional contact and support. However, with a lecture-based model, students were required to take an entire semester-long course, even if they only showed deficiencies in certain areas. This was often frustrating and costly for students, both in terms of time and money. In a research study conducted by Bailey, Jeiog, and Cho (2010), as cited by Hodara (2011, *Reforming*), only one third of students who were placed in developmental math courses at 57 community colleges completed the

recommended courses. Only 20% of students enrolled in a developmental math course went on to complete a college level math course. Although many students were successful in lecture-based classes with daily instruction, practice, and support, other students looked for alternative options to complete the requirements more efficiently.

Another delivery option was computer-based instruction (CBI), which included online and hybrid delivery, both requiring a computer and software. It quickly became a popular choice in adult education. Advantages of computer-based instruction included cost savings, flexibility in scheduling needs, and use of modern technology (Zavarella & Ignash, 2009). With computer-based instruction, students worked through content at their own pace, often from a remote location, with instructors providing support as needed. Computer-based learning might have been delivered exclusively online or in a combination of lecture and supported computer work. Instructional models were continuously evolving including models where some or all face-to-face instruction was being replaced with self-paced online curriculum models.

At Cleveland State Community College, for example, developmental math courses were redesigned by replacing three hours per week of lecture time with one hour per week in a computer lab with an instructor and two hours per week in a large computer lab (Squires, Faulkner, & Hite, 2009). This hybrid model combined the support many students needed through instructor presence with technology-based instruction that some non-traditional students sought for their personal scheduling needs. Pellissippi State Technical Community College in Tennessee developed a math redesign that integrated individual computer-assisted instruction with classroom instruction, in hopes of providing a more customized education for students (Squires, et al, 2009). Distance learning allowed adult students who had families, jobs, and other

responsibilities to improve their skills and knowledge on a more flexible schedule, saving time and money (Park & Choi, 2009).

Questions still remained, however, about the effectiveness of computer-based instruction for learners in developmental courses. A research study by Lesh and Ramp (2000), Perez and Foshay (2002), and Tucker (2001), as cited by Zavarella and Ignash (2009), examined student outcomes, attitudes, and overall satisfaction of their computer based courses (CBC). These researchers concluded that computer-based instruction was as effective as lecture-based instruction. However, studies by Carr (2000), Diaz (2002), and Parker (2003), as cited by Zavarella and Ignash (2009), showed the dropout rate in these courses was higher than lecture-based developmental courses. These conflicting results led to questions as to whether computer-based instruction was appropriate for all students in developmental mathematics. Zavarella and Ignash (2009) conducted further research on this issue in an effort to find a relationship between a student's learning style and completion of developmental math courses. Results of the study showed that students enrolled in computer-based instruction had a higher withdrawal rate (39% for distance learning and 42% for hybrid) than those enrolled in lecture-based format (20%) (Zavarella & Ignash, 2009). Park and Choi's quasi-experimental research sought to identify factors affecting learners' decisions to drop out of online courses. They concluded that most adult learners dropped out based on family and job responsibilities. This study also showed that adult learners in CBC experienced only small gains in math learning compared to students in traditional math courses (Park & Choi, 2009).

Instructional Models for Developmental Math Courses

This research study identified several models that were designed to teach math at the remedial level. One instructional model in the literature was the acceleration model. This model was defined as a reorganization of curriculum and instruction in an effort to reduce the time necessary to complete developmental education requirements (Edgecombe, 2011). This could be accomplished through a course restructure reducing the number of courses a student had to take or by compressing existing course curricula into a tighter timeframe. Acceleration could be taught in a traditional lecture-based classroom or as an online course. An important component of accelerated courses was instructor availability. Advocates of acceleration believed that the quicker students moved through a developmental sequence of courses, the more likely they were to enroll in higher level courses (Edgecombe, 2011).

Epper and Baker recognized two approaches to acceleration. The first was reducing time spent in developmental math courses by offering traditional content in a shorter timeframe. An example of this approach was recognized as successful at The Community College of Denver, where students were allowed to complete two levels of remedial math in one semester (Epper & Baker, 2009). Using a mastery approach, and Pearson's My Math Lab software, this model incorporated "accelerated instruction, student support, a learning community format, interactive teaching, and career exploration" into its format (Epper and Baker, 2009).

The second approach demonstrated acceleration by reducing time spent in remediation by targeting specific skills gaps. This approach had been effectively used at Indiana's Ivy Tech Community College. Its Online Accelerated Remediation (OAR) program was also designed using Pearson's My Math Lab software (Epper & Baker, 2009). Students worked through tutorials, practice, and assessments, successfully testing out of developmental coursework at their

own pace (Epper & Baker, 2009). The acceleration models were gaining attention as strategies to accelerate students through the developmental math sequence reduced time spent in remediation, allowing students to complete certificates and degrees in a more efficient and cost effective manner (Epper & Baker, 2009).

Another instructional model, referred to as contextual learning, focused on blending academic and vocational competencies (Epper & Baker, 2009). This model was based on the idea that students learned more effectively when they were learning about topics that were applicable to them. The emphasis was on understanding the math in context, rather than the ability to memorize facts and solve algorithms. Authentic learning activities valued the adult learners' prior knowledge and experience, and allowed them to transfer their learning in a context that was more meaningful and applicable to them (Hodara, 2011, *Reforming*). In the contextualized learning model, occupational program instructors introduced a new concept by modeling how to solve a problem familiar to the students. As students became more comfortable with the concept, they worked collaboratively in groups on additional application problems. Finally, students used the math concepts learned to apply to a variety of situations, helping them contextualize the concepts in real-world problems (Hodara, 2011, *Reforming*).

Community colleges had practiced the idea of contextual learning in math for years. One example was “shop math,” which was a standard part of many apprenticeship programs (Epper & Baker, 2009). In this example the math was integrated into the program introductory material, taught by program faculty, and often consumed a good portion of the curriculum (Epper & Baker, 2009). In Indiana, Ivy Tech Community College piloted a contextualized learning project as part of a six-state effort to move low-skilled workers in career pathways (Epper &

Baker, 2009). This project attempted to integrate developmental math skills into the introductory coursework in the college's industrial technology and automotive certificate programs (Epper & Baker, 2009). Epper and Baker's study was to determine if students improved their math skills within the framework of the program curriculum and achieved math readiness at the college level.

The final instructional model identified in the research was the modularization of a developmental math curriculum. The underlying principle of this approach was that math concepts were offered in shorter segments (modules), and students needed only to enroll in the modules that addressed their individual deficiencies. Furthermore, students worked at their own pace, while adhering to deadlines to stay on track. This allowed students the flexibility of completing math assignments and assessments at a pace compatible to their learning style and personal needs. Key elements to success were interactive software, personalized instructional support, and documented student participation (Twigg, 2011). Online modular math students found their experience to be similar to distance learning, with the added benefit of having an instructor on site for personalized instruction when needed (Flowers & McCray, 2012).

Jackson State Community College in Tennessee combined three developmental math courses into one course containing 12 modules (Epper & Baker, 2009). According to Epper and Baker, students were allowed to enter the sequence based on their individual needs, and studied only the concepts they needed to master, with significant gains made. In a 2008 pilot course, the number of students earning a C or better increased from 41% in the traditional course to 54% in the redesigned modular course (Epper & Baker, 2009).

Virginia Tech redesigned its developmental math courses, naming the new design, “The Emporium Model” (Twigg, 2011). Many restructured math programs were then referred to as Emporium models despite being implemented in various ways. Some learning institutions had large computer labs, others small. Some required attendance in lectures and lab, others offered lectures online, and varied the homework and attendance requirements. The important variable was the pedagogy, reducing or eliminating face-to-face lectures and using interactive software combined with personalized instructional support (Twigg, 2011). According to Twigg (2011), four reasons contributed to the success of the Emporium Model:

1. Students spent the bulk of their time doing math problems rather than listening to lectures.
2. Students spent more time on concepts they did not understand and less time on those they had already mastered.
3. Students got assistance when they encountered problems.
4. Students were required to participate and do math.

Personalized assistance was the key to a successful modularized math program. The redesigns were not simply about putting courses online, but rather changed the instructional method. The structure and well-articulated expectations of student engagement led to improved outcomes (Twigg, 2011). According to Twigg (2011), The National Center for Academic Transformations (NCAT) enlisted 37 institutions in developmental math redesigns, resulting in an increase in the percentage of students successfully completing a developmental math course by an average of 51%, while reducing the cost of instruction by an average of 31%.

This review of literature provided a clear picture of various alternative approaches to teaching developmental math. The literature on effective practice in developmental math programs as well as implementation of innovative instructional models demonstrated that all approaches could be utilized to move students through the developmental sequence.

Chapter Three: Conclusions and Recommendations

The review of the literature and the data collected for this report were the key precipitators for restructuring the developmental math courses currently being offered at Madison College. The focus was primarily to address changes that could be made to improve completion of and retention in courses by non-traditional students.

A number of studies have been done on different delivery methods and instructional models and their effects on student success and retention in developmental mathematics. Although traditional face-to-face instruction has historically been beneficial for many students who need instructional support, this method can be a barrier for the non-traditional adult learner who has work, family, and other responsibilities to manage. In their study of the traditional lecture-based delivery, online delivery, and hybrid delivery, Epper and Baker concluded that, in most cases, no significant difference in learning outcomes was found based on the delivery method. Consequently, before institutions spend time and money on a redesign involving computer labs and software, they should seek input from students to gain a better understanding of their needs, issues, and concerns. Also, a further recommendation is to use a placement tool that determines if students in online and hybrid courses have the learning characteristics necessary for successful completion in this type of course delivery.

A closer look at the three instructional models reveals common characteristics that directly support the needs of the adult learner. Acceleration promotes the opportunity to move through content more efficiently, reducing the amount of time a student spends in the developmental sequence. Contextualization provides the learners with real world application, increasing the opportunity for success in their programs. Finally, the modularized approach gives students the opportunity to move at their own pace and concentrate only on the math

content in which they are deficient, saving them both time and money. All three methods are innovative, combining several instructional, programmatic, and student support strategies.

New pedagogical initiatives or curriculum redesigns that work well at individual colleges or for some faculty are often difficult to replicate at other colleges or with a different staff. At Madison College, the purpose of restructuring the developmental math sequence was to reduce the amount of time students spend in the remedial sequence, decrease the cost of higher education, and improve completion rates. By offering options, the college can meet the needs of students who are ready to learn. Identifying students who test close to cut-off scores and advising them to appropriate placement is key to their success. All of the pedagogical practices reviewed in the literature may have the potential to improve the outcomes of adult learners at Madison College. The initial recommendation is to redesign the current developmental math delivery. At the time of this research, students who placed in developmental math courses had just one option, a 16-week face-to-face course. The literature showed that modularization and computer-based instruction were evolving and success rates were rising. By offering online and hybrid courses as recommended by this research, the college would be able to give students additional options when registering for courses.

The next recommendation is to begin to create modules with the current course objectives. The courses being taught at Madison College could be restructured into modules, whereby students need only complete modules identified through a placement tool. Once established, these modules could be linked to programs and contextualized to fit individual program requirements. Whether students find success through a modularized program, contextualized courses, or accelerated courses, the objective is to provide an educational

experience that is conducive to students' learning styles, meeting the individual needs of the non-traditional student.

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