A Dissertation

titled

The Influence of the College Environment on Community College Remedial Mathematics Instructors’ Use of Best Practices in Remedial Mathematics

by

Kathleen K. Shepherd

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Ronald D. Opp Ph.D., Committee Chair

Debra S. Harmening Ph.D., Committee Member

William B. Weber Ed. D., Committee Member

Grace B. Yackee Ph.D., Committee Member

Patricia R. Komuniecki, Ph.D., Dean
College of Graduate Studies

The University of Toledo
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An estimated 41% of the more than 11 million students who attend a community college need remediation, with remedial mathematics the most common course students need. The literature pertaining to best practices for student success in remedial mathematics abounds, yet, there is little evidence of the factors that influence instructor use of these best practices in the classroom. This study evaluated results of a 29-item survey of American Mathematical Association of Two Year Colleges’ members on the influence of instructor demographics, faculty development, institutional policies and procedures, and student support services on instructor use of best practices in teaching remedial mathematics. Developmental Theory served as the study’s theoretical framework, while the Seven Principles for Good Practice in Undergraduate Education and the Input-Environment-Output Model served as conceptual frameworks. Analysis revealed nine significant predictors of overall use of best practices, four of which were influenced by instructor demographics, three by institutional policies and procedures, and two by professional development. This study may inform policymakers and administrators alike as they scrutinize the delivery of remedial mathematics courses.
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Chapter 1

Introduction

As enrollment in post-secondary institutions has increased, so has the demand for remedial courses. Research shows enrollment in community college remedial classes increased 45% from 2000 to 2003 for first-year students, with mathematics being the most common subject in which students need remediation (Attewell, Lavin, Domina, & Levey, 2006; Parsad & Lewis, 2003; Provasnik & Planty, 2008). This increase is of great importance, as researchers have found that the first year of college is the most critical for student success and degree attainment (Center for Community College Student Engagement [CCCSE], 2004; Kuh, 2009; Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008). Typical failure rates in entry-level community college classes are 50-60% (Twigg, 2009).

Effective academic support services, course delivery formats, and classroom techniques for students enrolled in remedial coursework at the post-secondary level are essential, especially with respect to remedial mathematics. Bahr (2007) reported only 25% of community college students who enroll in remedial mathematics eventually succeed in college-level mathematics, while other studies have found students who successfully remediate in mathematics are as likely to earn a degree or credential as students who did not need mathematics remediation (Attewell et al., 2006; Bahr, 2008b; Bettinger & Long, 2005). Astin (1998) believes “providing effective ‘remedial’ education would do more to alleviate our most serious social and economic problems than almost any other action we could take” (p. 12). The Tennessee Board of Regents (http://www.tbr.edu/schools/default.aspx?id=2650) and the University System of Maryland (2011) have implemented policies that require remedial courses, including
remedial mathematics, to be taught using a National Center for Academic Transformation (NCAT) computer-assisted instruction (CAI) format. NCAT’s CAI format is a structured, self-paced, active learning environment that uses computer software or internet-based learning resources (Twigg, 2005, 2009). These policies significantly impact institutions in these states by shifting the method by which remedial mathematics has been taught in the past.

**Theoretical Framework**

The theoretical framework used for the study is Developmental Theory. Developmental Theory is a comprehensive theory that “accommodates individual differences and provides a structure for addressing them” (Wambach, Brothen, & Dikel, 2000, p. 2). The goal of the theory is to serve different types of developmental students through an effective educational environment. The theory has three concepts, self-regulation, demandingness, and responsiveness.

Self-regulation as defined by Zimmerman, Bonner, and Kovach, ‘self-generated thoughts, feelings, and actions that are directed toward attainment of one’s educational goals’ (Wambach et al., 2000, p. 3). Developmental instructors want developmental students to become independent learners who are motivated and self-directed.

Demandingness requires the instructor to be demanding of the developmental student. The instructor communicates high expectations that require the student to think critically and complete numerous assignments, in which the student is expected to read, write, speak, and compute to demonstrate competency of the subject (Wambach et al., 2000).
Responsiveness means the educational environment must be responsive. The instructor must be responsive in giving timely useful feedback to the student. The instructor must also be able to respond to the needs of the individual students (Wambach et al., 2000).

Developmental Theory is appropriate to use in this study, which focuses on the methods the developmental mathematics instructor employs to develop an underprepared student into a student who is self-directed and prepared for college-level work. The theory unites the structure of the educational environment with the social and emotional growth of students. The utility of development theory for this study was tested through structured response survey questions.

Problem Statement

The literature pertaining to best practices for remedial mathematics student success abounds, yet, there is little evidence about the factors that influence instructor use of these best practices in the classroom. This study examines the influence, if any, of the types of faculty development, including faculty mentoring and institutional policies and procedures pertaining to academic support services and student services, on instructor use of best practices in teaching remedial mathematics. Boylan (2002) points out that there are more than 25 years of research to reinforce what works in remedial education, so “why are you doing something else?” (p. 6).

Purpose of the Study

The purpose of this study was to examine the instructor use of best practices in developmental mathematics. Developmental mathematics was chosen because, as stated earlier, it is the most common subject in which students need remediation. In addition,
studies have shown students who successfully remediate in mathematics earn a degree or
credential at a similar rate to students who do not need remediation (Atwell et al., 2006;
Bahr, 2008b; Bettinger & Long, 2005). Yet, other researchers have shown non-
traditional students who needed mathematics remediation persisted and earned a degree
at three-quarters the rate as non-traditional students who did not need mathematics
remediation (Calcagno, Crosta, Bailey, & Jenkins, 2007).

Researchers have not empirically conducted research with community college
remedial mathematics faculty on how they determine which practices to utilize in
teaching remedial mathematics. Numerous studies have attempted to determine what
institution-wide practices and classroom practices lead to positive student outcomes, but
community college remedial mathematics faculty have not been the focus of these
studies.

Jenkins & Kerrigan (2009) surveyed community college faculty and
administrators to determine what type of data they used in their jobs and how the data
was used to improve student outcomes. Other scholars have conducted studies with
faculty related to mentoring and faculty development. Studying the effects of mentoring
and types of faculty development processes faculty feel are most useful for their careers
(Hopkins, 2005; Kozeracki, 2005; Lawler, 2003; Rouseff-Baker, 2002), but these studies
did not focused on community college remedial mathematics faculty and the influence
mentoring had on these faculty employing best practices in teaching mathematics.

For the purpose of this nationwide study, instructor use of best practices in
remedial mathematics classes is the criterion variable. Remedial mathematics was
chosen because, as stated, it is the most common subject in which students need
remediation. This study adds to the literature by investigating the influence, if any, faculty development practices, academic support services, instructor demographics, institutional characteristics, and institutional policies and procedures have on instructor use of best practices in remedial mathematics.

**Research Questions**

1. What instructor demographics, if any, influence instructor use of best practices in remedial mathematics?
2. What institutional characteristics, if any, influence instructor use of best practices in remedial mathematics?
3. What institutional policies and procedures, if any, influence instructor use of best practices in remedial mathematics?
4. Which methods of faculty development, if any, influence instructor use of best practices in remedial mathematics?

**Research Design**

The study was conducted by an email survey to members of the American Mathematical Association of Two-Year Colleges (AMATYC) from an AMATYC-generated email list. The organization has 2,500 individual members from the United States and Canada. AMATYC members are individuals who are dedicated to improving mathematics instruction in the first two years of college (http://www.amatyc.org). In addition, the survey was sent to the members of the Michigan Mathematical Association of Two Year Colleges (MichMATYC). AMATYC and MichMATYC members represent a sample of convenience from the population of all individuals involved in
teaching mathematics in two-year colleges. The researcher obtained permission from the AMATYC president and the MichMATYC president to survey the members.

**Significance of the Study**

This study adds to the literature by demonstrating the faculty development activities, support services, institutional characteristics, and institutional policies and procedures that influence remedial instructor use of best practices nationally. State policymakers are beginning to implement policies that dictate the method in which remedial mathematics is to be taught at the community college. These policies have a significant impact on the institutions by completely shifting the ways in which remedial mathematics has been taught in the past. Before policymakers create policies requiring the method remedial mathematics is to be taught in all community colleges, the policymakers need to be informed by research to assist them in determining best practices in teaching remedial mathematics, and the factors that influence an instructor’s use of best practices. The policymakers must make informed decisions before they dictate the method by which all remedial mathematics classes are taught within their purview.

The study provides information to administrators and faculty about the academic support services and institutional policies or procedures that influence instructor use of best practices. Administrators ultimately decide how resources are allocated between student services, academic services, and faculty development (CCSE, 2010; Jenkins & Kerrigan, 2009). Administrators need to be up-to-date on which academic services, student services, and faculty development activities have the most influence on faculty use of best practices, so that funds may be distributed accordingly.
In addition, the study provides information to faculty on the pedagogical techniques that are considered best practices, so that they may seek training in best practices through professional development activities or from colleagues. Researchers have commented they do not know what causes effective teaching, but faculty can learn behaviors that are associated with enhancing student learning (Pascarella & Terenzini, 2005).

Moreover, this study helps to inform those philanthropic organizations that fund initiatives to improve remedial education and student access to higher education. These philanthropic organizations could invest their resources in improving and implementing processes that are already known as best practices (Saxon & Boylan, 2010).

The significance of this study extends also to the current political climate, whereupon state legislatures are mandating the means, methods, and access to higher education remedial instruction. In the past decade, the number of states that have enacted policies pertaining to remedial education has doubled. Some states limit funds for remedial education to four-year institutions, others require community colleges to provide all remedial instruction, eliminating remedial instruction completely from four-year institutions, and still other states require students to earn a certain placement test score before they can enroll in a four-year institution (Jenkins & Boswell, 2002; Parker, 2007; S.B. 311, 2005-2006). In other developments, a few states now dictate how remedial courses are taught (http://www.tbr.edu/schools/default.aspx?id=2650, 2013; University system of Maryland expands course redesign across the state, 2011), and Connecticut has banned remedial education completely from all of post-secondary institutions (Conn. Acts 12-40, 2012). From these developments, it is imperative that all
aspects of best practices in remedial education be explored, particularly remedial mathematics. This study does not focus on learners and their outcomes, but on their instructors and how community colleges influence instructor use of best practices, both in the classroom and in preparing remedial education instructors for their role. By extension, this study could inform policymakers, such that their decisions on the efficient use of remedial education funds could target community college programs that influence instructor use of best practices. When instructors use best practices, it is reasonable to believe, remedial students have a greater chance for success.

Furthermore, the study adds to the developmental theory literature as it applies to the developmental mathematics educational environment based on self-regulation, demandingness, and responsiveness. Because best practices in teaching remedial mathematics are elements of *Seven Principles for Good Practice in Undergraduate Education* (Chickering & Gamson, 1987), the study also adds to the *Seven Principles’* literature.

**Conceptual Frameworks**

One of the conceptual frameworks for the study is Chickering and Gamson’s (1987) *Seven Principles for Good Practice in Undergraduate Education*. These Seven Principles were identified so as to improve teaching and learning in colleges and universities. These Seven Principles are: 1) encourages contact between students and faculty; 2) develops cooperation among students; 3) uses active learning techniques; 4) gives prompt feedback; 5) emphasizes time on task; 6) communicates high expectations; and, 7) respects diverse talents and ways of learning.
These principles are appropriate to use in this study because when an instructor structures the classroom in a way that requires the student to actively do mathematics through in-class group work, outside-of-class group projects, a self-paced e-learning environment, or a distance-learning environment, the student is involved in the learning process with peers and faculty, while at the same time actively gaining mathematics skills. Ultimately, a combination of instructor methods and institutional policies and procedures dictate the manner in which remedial instruction is delivered.

The instructor may not have much control over the policies and procedures of the institution that are considered best practices, but the instructor has control of the classroom, and may be able to implement best practices inside and outside of the classroom. The instructor should have the ability to implement all seven principles in the classroom. Researchers have found student-faculty interaction, and student-to-student collaboration significantly influences student success (Astin, 1993, 1996, 1999; Community College Survey, 2012; Kuh & Vesper, 1997).

The data analysis is based on the conceptual framework Astin’s I-E-O model, Input, Environment, Output. The data are analyzed using a blocked form of stepwise regression. Astin notes the model was developed to be used with “natural experiments” (Astin, 2002, p. 28). A natural experiment studies phenomena that are naturally occurring, in contrast to a true experiment that has a control group and a treatment group. The model explores the influence, if any, the input and environmental variables have on the outcome variable.
Assumptions

The results of this study add to the literature by substantiating developmental theory and the use of the Seven Principles. As expected, the study reveals institutional characteristics and institutional policies or procedures influence instructor use of best practices in remedial mathematics. The instructor plays a key role in the use of classroom best practices, and the findings of previous studies indicate instructor demographics, such as instructor familiarity with multiple teaching methods and coursework in teaching mathematics, influence instructor use of best practices. In addition, if the instructor is involved in his/her own faculty development, it influences the instructor to utilize best practices. The study also investigates the availability of supplemental instruction, peer tutoring, and college skills courses on instructor use of best practices.

Limitations

Ideally, the population of the survey should be all individuals who teach remedial mathematics in a community college in the United States. Therefore, a survey sent out to a sample of individuals has its limitations. The members of AMATYC and MichMATYC do not represent all faculty teaching remedial mathematics courses in community colleges in the United States, and the members of this organization do not represent all community college remedial mathematics faculty. Thus, it cannot be assumed the results would be the same for all faculty members across the U.S.; a threat to external validity. Additionally, a threat to internal validity, the survey could have non-response bias. The individuals who do not respond to the survey may have answered the survey questions differently than the individuals who do respond to the survey. The survey itself is a
limitation in that it is structured-response. Survey respondents did not have the ability to add information to the questions.

The criterion variable for this study was the use of best practices in teaching remedial mathematics. The author has determined through a literature review the best practices in remedial mathematics. The author’s determination of which practices are best is a threat to external validity. This study is examining only one remedial subject, mathematics, out of all of the remedial courses offered at the community college level. The study provides information about a small piece of the larger national problem, student matriculation in remedial coursework. Examining only one remedial subject is a threat to external validity.

**Glossary**

Academic support services – Services remedial education students receive outside of the classroom, such as tutoring, supplemental instruction, or a student success course (Rutschow & Schneider, 2011).

American Mathematical Association of Two-Year Colleges (AMATYC) – A national, professional organization dedicated to improving mathematics instruction in the first two years of college.

Best practices – “[O]rganizational, administrative, instructional, counseling, advising, and tutoring activities engaged in by highly successful developmental programs” (Boylan, 2002, p. 3).

College skills course – A course that teaches students how to take notes, study, take tests, manage time, and set goals (Zeidenberg, Jenkins, & Calcagno, 2008).
Course delivery format – The instructional format of the course, such as distance learning, CAI, or traditional (Zavarella & Ignash, 2009)

Institutional Policies or Procedures – Policies or procedures of the institution that relate to teaching remedial mathematics courses.

Learning community – A cohort of students, such as one created among the students enrolled in remedial courses (Scrivener, Bloom, LeBlanc, Paxson, Rouse, & Sommo, 2008; Weissman, Butcher, Schneider, Teres, Collado, & Greenberg, 2011).

Michigan Mathematical Association of Two Year Colleges (MichMATYC) – An affiliate of AMATYC, the American Mathematical Associate of Two-Year Colleges.

National Association for Developmental Education (NADE) – A nation-wide member organization aimed at improving the theory and practice of developmental education at all levels of the educational spectrum (http://www.nade.net).

National Center for Academic Transformation (NCAT) – An organization committed to the effective use of information technology, both to improve student outcomes and reduce the cost of higher education (NCAT, 2013)

Pedagogical techniques – The teaching practices an instructor uses over the course of the semester, such as in-class group work, group projects, and email communication.

Remedial Mathematics – “[I]nstruction for those who have not yet mastered the skills necessary for competency with mathematics at the college-level. These skills may include one or more of the following: arithmetic operations, math symbolism, geometry and measurement, functions, discrete math algorithms, probability and statistics, and deductive proofs (Arendale & Others, 2007, p. 29).
Supplemental Instruction (SI) – SI programs are targeted at courses that have a 30% or higher failure rate. Students who successfully complete the targeted course are trained to be SI leaders, who then hold study sessions for students outside of class (Zaritsky & Toce, 2006).

**Summary**

At this time, there are both nationwide and state-supported initiatives to improve remedial mathematics student learning outcomes. This study was conducted to determine community college institutional policies or procedures and available academic support services that may influence the instructor use of best practices. Instructor demographic characteristics and institutional characteristics were examined to determine whether these characteristics influence an instructor’s use of best practices. Lastly, the influence of the process that was used to train remedial mathematics faculty in best practices was investigated.

The results of the study could aid policymakers by educating them of the institutional policies and procedures that influence instructor use of best practices before they create policies that dictate the method remedial mathematics is taught at all institutions in the state or region. Administrators who allocate funds to the student services, academic services, and to faculty development can be informed as to the services and faculty development that are most effective in influencing instructor use of best practices in teaching remedial mathematics. Therefore, administrators are then able to subsidize what influences faculty use of best practices and reduce funds to practices that are not as effective. Finally, the study could inform faculty of the methods of staff development that could help them become more effective teachers. Philanthropic
organizations who generously give money to improve higher education opportunities for underserved populations can be better informed of institutions that have policies and procedures in place that influence instructor use of best practices in remedial mathematics. As a result, the philanthropic organizations can help subsidize those institutions.

**Overview of Upcoming Chapters**

The next chapter reviews the literature relevant to community college remedial education and best practices of teaching remedial mathematics from the institutional perspective and the teaching perspective. Chapter Three describes the methodological approach used in the study. Chapter Four gives the details and summarizes the findings of the study. Chapter Five offers observations about the significance of the findings of the study and proposes future research.
Chapter 2

Literature Review

This chapter presents a comprehensive review of the literature pertinent to this study. The major topics in this literature review focus on discovering the academic variables that influence instructor use of best practices in teaching remedial mathematics.

The first topic is a brief history of the development of the community college and its role as it relates to serving underprepared students through remedial coursework. The community college has evolved from an institution that once only provided freshmen- and sophomore-level of coursework to one offering remedial coursework, vocational training, courses for personal enrichment, and a transfer curriculum.

The second topic includes the definition of remedial coursework and discusses the types of students who enroll in remedial coursework. Research relating to remedial student success in remedial courses and graduation rates is also included.

The third topic is the estimated cost of remedial education, including the estimated costs to post-secondary institutions to provide remedial instruction and the loss of tax revenues and reduced quality of life for students if remedial coursework is not available. This section also covers state policies relating to remedial education in post-secondary institutions.

The fourth topic investigated is developmental theory and its importance to developmental education, along with best practices in remedial education from the perspective of institutional policies and procedures. The administrative structure of remedial education is discussed, along with the ramifications of mandatory testing and placement. Student support services, including counseling and learning communities, and academic support services, including Supplemental Instruction (SI), tutoring, college skills courses, and
course delivery format are explored. Developmental Theory and its application to course delivery format is included.

The fifth topic is institutional policies and procedures related to faculty development. Adult Learning Theory research is included to demonstrate how this theory may advance the aims of faculty development.

The sixth topic is faculty-student interaction. Faculty-student interaction takes place both inside and outside of the classroom. The classroom learning environment as it relates to the classroom practices and faculty-student interaction are explored, as well as outside the classroom faculty-student interaction.

The final topic is a critique of the literature and scholarly recommendations for research that links best practices to faculty-student interaction and remedial mathematics teaching methods.

**History of the Community College**

In 1922, the American Association of Junior Colleges defined a junior college as an “institution offering two years of instruction of strictly collegiate grade” (Cohen & Brawer, 2008, p. 4). Nineteenth-century scholars believed in the creation of junior colleges to provide freshmen and sophomore levels of education so that universities would not need to teach general education and, therefore, could focus on research and higher-level scholarship. Among the scholars supporting the creation of junior colleges were: Henry Tappan, president of the University of Michigan, 1851; William Mitchell, a University of Georgia trustee, 1859; and, William Folwell, president of the University of Minnesota, 1869. William Rainey Harper of the University of Chicago and David Starr Jordan, president of Stanford University, believed the junior college would provide
general education and vocational education to students through age 19 or 20. While the universities did not turn over the first two years of undergraduate work to junior colleges, junior colleges developed anyhow, filling a need in the higher education system (Cohen & Brawer, 2008).

By 1925, junior colleges began to provide vocational education in addition to college-level courses, becoming publicly supported, comprehensive, two-year institutions. Scholars postulate that junior colleges grew because of the increasing demand for higher education in the early 1900s. The percentage of high school graduates grew from 30% in 1924 to 75% in 1960, the same year that 60% of high school graduates entered college. Other researchers believe junior colleges grew out of the belief that all persons should have the opportunity for higher education, or a second chance at a higher education (Cohen, A., 2003; Cohen & Brawer, 2008).

As junior colleges were established, they became institutions that fostered civic pride within the communities they served, becoming centers that offered higher education in addition to cultural and recreational events. The junior college became a neighborhood institution that provided access to higher education for a broader population (Cohen & Brawer, 2008).

As federally funded highways were built in the 1920s, students in rural and suburban areas had access to the local junior college. In the 1950s and 1960s, junior colleges were established on the outskirts of major cities along these new highways, providing even greater access for students. When a junior college was established where there had not been one previously, the population of local students increased dramatically even by as much as 50% in some locations. Currently, 96% of students attending
community colleges are in-state residents, and the median commute for a community college student is 10 miles (Cohen & Brawer, 2008).

**Community College Curriculum**

When the junior college was established, its charge was to provide freshmen and sophomore levels of education, including general education, which, in turn, prepared students for junior and senior levels of education provided by universities. Universities could rely upon junior colleges as buffer institutions to help poorly prepared students improve and, consequently, to better prepare students who enrolled in universities (Cohen, A., 2003; Cohen & Brawer, 2008).

By the 1970s, the terms *junior college* and *community college* were interchangeable. Community colleges offered vocational education, job training, and non-credit continuing education, in addition to freshmen and sophomore levels of undergraduate education. Community colleges took advantage of federal monies available through the Vocational Education Acts of the 1960s, as well as funds available for specialized occupational programs. Community colleges also provided job training for specific local employers so that employers had a trained workforce. The community college also prepared persons for entry-level, technical jobs in business and industry with the associate of applied science degree. Supporting the premise of life-long learning, non-credit courses were made available for persons to learn a new skill, to make connections with other individuals, or to pursue activities of personal interest (Cohen & Brawer, 2008).

A community college is now defined to be “any institution regionally accredited to award the associate in the arts or the associate in science as its highest degree” (Cohen,
A., 2003, p. 5). Through the years, the purpose of the community college expanded to become the “neighborhood institution” (Cohen, A., 2003, p.16). Community colleges are supported by local communities through property taxes and state monies and provide open access for all students, vocational training, a transfer curriculum, and community education and developmental education (Cohen, A., 2003).

Because of their open admission policies and lower tuition rates, community colleges make higher education accessible to a more diverse population of students. Adult students may attend part-time to improve job skills or retrain for a new career. Students with weak academic skills have the opportunity to improve these skills with the aid of the community college. The community college provides remedial or developmental coursework for students who lack the proficiency to begin college-level courses.

**Remedial or Developmental Coursework**

All public, two-year community colleges and 74% of public four-year colleges and universities offer remedial courses (Snyder, Dillow, & Hoffman, 2009). While there is no universally accepted definition for remedial or developmental coursework, the Integrated Postsecondary Education Data System (IPEDS) defines remedial coursework as education “designed for students deficient in the general competencies necessary for a regular postsecondary curriculum and educational setting” (National Center for Education Statistics [NCES], 2013). Scholars define remedial or developmental courses as courses that cover material in reading, writing, or mathematics below college-level work (Bahr, 2008a; Breneman & Haarlow, 1998; Merisotis & Phipps, 2000; Phipps, 1998). Astin points out remedial students are students who score the lowest on tests
administered by an admissions office (Phipps, 1998). Remedial placement tests and cut-off scores vary by institution and by state. Remedial education and developmental education are used interchangeably in the literature. Remedial implies students need to acquire certain skills before they can succeed at the postsecondary level. Developmental hints that the student is still in the process of learning or has room to grow. Practitioners have a tendency to use developmental, while policymakers use the term remedial (Parker & Bustillos, 2010). For this investigation, remedial and developmental are used interchangeably.

**Remedial Course Enrollment**

Remedial or college-preparatory education has been a part of higher education since Harvard College opened in the 17th century. Harvard provided tutoring in Greek and Latin for under-prepared students. As enrollment in higher education grew, so did the need for remedial instruction. Land-grant colleges established programs for under-prepared students in the 19th century. In 1849, the University of Wisconsin offered the first remedial education programs in reading, writing, and arithmetic. By the end of the 19th century, more than 40% of first-year students were enrolled in remedial classes. After World War II, the GI Bill made it possible for people to attend college who would not have been able to in the past, increasing the need for remedial coursework (Breneman & Haarlow, 1998; Merisotis & Phipps, 2000; Phipps, 1998).

Advocates for remedial coursework believe remediation is a necessary part of post-secondary education, as there will always be adult students who enroll in college to retrain for a different career, to improve their skills, or to advance their careers (Breneman & Haarlow, 1998; Choy, 2002). Others believe remedial education provides
an opportunity for weak students to improve their academic skills. Remediation gives students a second chance, especially students who are first-generation college students, minorities, or students from lower socioeconomic backgrounds (Calcagno, Crosta, Bailey, & Jenkins, 2007; Education Commission of the States [ECS], 2008; Jenkins & Boswell, 2002; McCabe, 2000; Merisotis & Phipps, 2000). State policymakers believe too much money is spent on remediation in higher education. Critics argue that higher education duplicates K-12 education, and that taxpayers are paying for a student to earn a high school education twice (ECS, 2008; McCabe, 2000). Other critics believe students are encumbered by remedial classes that do not count toward a degree and drop out of college completely (Calcagno et al., 2007).

As enrollment in post-secondary institutions has increased, so has the demand for remedial courses. Both traditional and non-traditional students are enrolling in remedial classes. Adelman (2006) found that approximately 41% of college students enroll in a remedial class at some time during their undergraduate coursework. Researchers have found enrollment in community college remedial classes has increased 45% from 2000 to 2003 for first-year students (Parsad & Lewis, 2003; Provasnik & Planty, 2008). NCES reported the percentage of first-year students who enrolled in a remedial course in 2003-2004 was approximately 35%, increasing to 36% in 2007-2008. Remedial course enrollment rates are higher for first-year undergraduates attending a community college – 41% in 2003-2004 and 42% in 2007-2008 (NCES, 2012). Remedial mathematics has the highest rate of enrollment among the typical remedial courses of reading, writing, and mathematics, with 15% of all first-year undergraduates enrolling in remedial mathematics
in 2003-2004 and 18% of first-year students attending a public, two-year community college (NCES, 2012).

First-year remedial course enrollment is of great importance because researchers believe the first year of college is the most critical to success and degree attainment (CCCSE, 2004; Kuh, 2009; Kuh et al., 2008). Typical failure rates in entry-level community college classes are 50-60% (Twigg, 2009). Bahr (2007) reports only 25% of the community college students who enroll in remedial mathematics eventually succeed in college mathematics.

The Office of Program Policy Analysis and Government (OPPAGA) (2007), analyzed Florida Department of Education data of First Time in College (FTIC) students who began at a community college from 2000-2001 to 2003-2004. A little more than 29% of students who needed remediation earned an associate degree in five years, while almost 40% of students who did not need remediation earned an associate degree in five years (OPPAGA, 2007). In 2007, OPPAGA reported that 2% of FTIC students who entered a Florida community college in 2000-2001 and who needed remediation had earned an associate degree by 2003-04, and almost 56% of remedial students were still enrolled in a community college or had earned an associate degree or a certificate by 2003-04 (OPPAGA, 2007).

The National Educational Longitudinal Study (NELS:88) tracked students who graduated from high school in 1992 for 8 ½ years. Students who enrolled in remedial classes at a community college had significantly lower graduation rates than non-remedial students. Controlling for family background and high school academic
preparation, remedial students graduated at almost the same rate as non-remedial students (Attewell et al., 2006).

Similarly, NELS:88 students enrolling in multiple remedial classes (more than three) did not have significantly lower graduation rates when high school academic preparation was controlled. Students who enrolled in remedial courses had a slightly higher rate of degree attainment than students with similar backgrounds compared to students who did not take remedial courses (Attewell et al., 2006).

McCabe (2000) reported that half of community college remedial students enroll in 6 semester hours or fewer of remedial courses, while more than 80% take 12 semester hours or fewer of remedial coursework, averaging 7.7 credit hours, or the equivalent to one-fourth of a college year. Similarly, other studies have found remedial students enroll in an average of one or two remedial courses, or approximately seven semester hours. As a result, it takes remedial students one to two semesters longer to graduate (Attewell et al., 2006; Kolajo, 2004; Shults, 2001).

Kolajo (2004) conducted a study with students attending Cecil Community College in Maryland. He found it took two semesters longer to earn an associate degree when the student needed two or more remedial courses. If a student needed one remedial class, the student earned an associate degree in the same length of time it took a non-remedial student.

If students are required to take remedial classes to improve their skills, it will take longer to earn a credential. Some critics of remedial education argue students will get bogged down in taking remedial classes that do not count toward a degree. Students will get discouraged and drop out of college altogether (Attewell et al., 2006).
Remedial Mathematics Enrollment

The National Association of Developmental Education (NADE) defines remedial mathematics as

instruction for those who have not yet mastered the skills necessary for competency with mathematics at the college-level. These skills may include one or more of the following: arithmetic operations, math symbolism, geometry and measurement, functions, discrete math algorithms, probability and statistics, and deductive proofs (Arendale & Others, 2007, p. 29).

In 2003-2004, approximately twice as many students were enrolled in remedial mathematics at public two-year institutions than were enrolled in remedial reading, and almost three times the number of students enrolled in remedial English (Provasnik & Planty, 2008). Bahr (2007) conducted a longitudinal study from the fall of 1995 to spring of 2001 of approximately 55,000 college freshmen enrolled in a California-based community college. He found that 53% of students who need remediation in mathematics and writing remediate successfully. If a student was deficient in mathematics, reading, and writing, the student had only a 33% chance of remediating successfully. Bahr defined successful remediation as a student passing a college-level class after completing a remedial course.

In a later study, Bahr (2008a) found that community college students who remediated successfully in mathematics passed college-level mathematics at nearly the same rate as students who did not need remediation. In addition, both remedial and non-remedial students earned a credential or transferred at almost the same rate.

Calcagno and Long (2009) conducted a longitudinal study of nearly 100,000 first-time community college enrollees in Florida community colleges from the fall of 1997 to the fall of 2000. Statewide regulations in Florida require all students to take the Florida
College Entry Level Placement Test, with placement scores set by the state’s Board of Education. Students who score below cut-off scores for college-level work are required to take remedial classes. Calcagno and Long (2009) found that students who needed remedial reading had slightly lower passage rates in college-level English than students who did not need remedial reading. Students who needed mathematics remediation passed a college-level mathematics course at the same rate as students who did not need mathematics remediation. Credential attainment and transfer to a four-year institution rates were virtually the same for both remedial and non-remedial students.

Calcagno et al. (2007) compared remedial students by age in a study of first-time enrollees in a Florida community college from the fall to 1998 to the spring of 2004. They found older students needed more mathematics remediation than younger students. Older students and younger students needed writing and reading remediation at the same rate. The researchers found older students who needed remediation graduated at a little more than three-quarters the rate as older students who did not need remediation. Younger students who needed remediation were a little more than half as likely to earn a degree as younger students who did not need remediation. The researchers surmised that older students are not discouraged by remediation, as they persist in earning a degree. It may also be possible that older remedial students do not have significant academic deficiencies, but may need to brush up on basic skills.

Calcagno et al.’s (2007) results are encouraging. Their study shows remediation is somewhat effective in helping older students attain a degree. This is important in a depressed economy when record numbers of older students turn to colleges for retraining. NCES figures show that 53% of students enrolled in a two-year community college are
Sixty percent of the students enrolled in remedial classes are less than 24 years old, 33% work 35 or more hours per week, 40% receive some sort of financial aid, and 20% are married (ECS, 2008).

**Cost of Remediation**

Policymakers are scrutinizing the effectiveness of remedial education and the amount of money spent on developmental students and coursework. In 1998, Breneman and Haarlow estimated the national cost of developmental education was approximately $1 billion, or about 1% of the national higher-education revenue of $115 billion for fiscal year 1993-94. In 2011, Pretlow and Wathington used data from fiscal year 2004-05 in an effort to update the Breneman and Haarlow cost analysis. They found the national cost of developmental education had increased 13% from the 1998 figure to $1.13 billion. However, the cost of developmental education, as an expense, decreased to approximately 0.5% of the national higher-education revenue of $234.8 billion. While higher education revenue doubled, the cost of developmental education increased only 13% and, as of 2011, stood at one-half-of-one percent of the national higher-education budget.

The benefits of remedial instruction may seem marginal, compared to overall cost and success rates. McCabe (2000) reports that 80% of jobs require an education beyond high school. Merisotis and Phipps (2000) cited a Lehman Brothers’ report, which concluded that jobs requiring at least an associate degree will have a higher-than-average growth rate, and jobs that require less than an associate degree are expected to grow less than average. The report also stated a “knowledge based economy will require a more highly skilled, more adept, and more knowledgeable workforce” (Merisotis & Phipps,
Ten years later, the global economy still requires an educated workforce with postsecondary degrees or credentials (Pretlow & Wathington, 2011). President Obama (2009) has made education a priority during his administration, challenging all Americans to earn at least one year of postsecondary education and urging postsecondary institutions to not just enroll students, but to graduate them.

A college-educated population has social benefits. The benefits to society include “increased tax revenue, greater productivity, reduced crime rates, [and] increased quality of civic life” (Merisotis & Phipps, 2002, p. 79). The U.S. Bureau of Labor Statistics (BLS) (2012) reports that persons with some college earn 12.7% more than persons with only a high school diploma, that individuals with an associate degree earn 20% more, and that persons with a bachelor’s degree earn 65% more than persons with only a high school diploma. In addition, BLS (2012) projected that the fastest growing occupations from 2010-2020 require an associate degree or higher. Remedial students are less likely to transfer and earn a bachelor’s degree; however, students who earn an associate degree or certificate have a tendency to be employed in higher-wage, specialized careers (Kane & Rouse, 1999; McCabe, 2000).

McCabe (2000) believes the benefit of remedial coursework outweighs the cost. He reports that more than one million students enroll in remedial coursework each year, and that approximately half a million successfully complete the remedial coursework. Abraham (1998), using earning potential figures from the Census Bureau, estimated that if 30% of remedial students earn bachelor’s degrees, the federal and state tax contribution could be up to $87 billion collected over a lifetime of work. If these students were denied
remediation, the lifetime tax contribution drops to $43 billion. The estimated tax revenue benefits of students successfully remediating is worth the expense.

An educated population has social benefits in addition to increased tax revenue. Crime rates are lower, fewer people need public assistance, and individuals have an increased quality of life (McCabe, 2000; Phipps, 1998). The student who successfully completes remedial classes and earns a credential will be among the citizens contributing to society.

**Remedial Education Policy**

In 2002, at least 10 states had laws that prevented or limited remedial education at four-year, public institutions, and the City University of New York (CUNY) and California State University (CSU) systems were in the process of phasing out remedial instruction at their four-year institutions. When a student needed remediation, the student took courses at a community college (Jenkins & Boswell, 2002). Four-year institutions in Colorado, New Mexico, and Utah received no state funds for remedial courses. Massachusetts allowed four-year colleges to enroll up to 10% of students in remedial coursework; any percentage of students more than 10% were required to attend a community college. By 2005, students needing remediation in Louisiana had to attend a community college for remedial coursework, unless there was no community college in their geographic region (Jenkins & Boswell, 2002; Parker, 2007).

Since 2002, the number of states placing restrictions on remedial coursework has doubled. Currently, 21 states and CUNY have policies regarding remedial coursework. States that require students to complete remedial coursework at a community college include California, Colorado, Florida, Indiana, Nebraska, North Carolina, South Carolina,
Oregon, Tennessee, Texas, Virginia, and CUNY. Arkansas, Nevada, and Oklahoma will not fund remedial coursework or limit funding for remedial coursework at four-year institutions (Parker, 2007). In 2014, Ohio will limit state funding for remedial coursework at its public, four-year institutions. By the 2018 academic year, funding for remedial coursework to public, four-year institutions in Ohio will be eliminated. Students who need remediation will be expected to attend a community college to complete remedial coursework before enrolling in a four-year, public university (S.B. 311, 2005-2006). Florida, Mississippi, and Montana require specific placement test scores to determine if a student needs remediation. In addition, Oklahoma and Utah have policies mandating remedial coursework at the community college level; yet, if the four-year institution offers remedial courses, students must pay the cost of instruction, including physical plant and maintenance costs (Parker, 2007).

In May 2012, Connecticut passed legislation that completely eliminated remedial coursework from all post-secondary institutions, including community colleges, beginning in 2014. If an institution determines a student needs remediation, the institution may provide an intense, one-semester college readiness program in the semester prior to the semester in which the student enrolls in the institution. Otherwise, remedial courses are banned from post-secondary institutions. Institutions must embed any remediation within the corresponding entry-level course (Conn. Acts 12-40, 2012). An estimated 70% of students attending a Connecticut community college need at least one remedial class during their first year of enrollment (Fain, 2012).
Remedial Mathematics Initiatives

In 2010, Tennessee Board of Regents (TBR) (http://www.tbr.edu/schools/default.aspx?id=2650) created a policy for developmental studies; by 2013, all developmental education in reading, writing, and mathematics were to be redesigned using the National Center for Academic Transformation (NCAT) model in each of the 19 institutions under TBR regulation. The NCAT model uses self-paced, computer-assisted instruction utilizing internet-based software. The initiative is based on successful implementation of the NCAT model in four community colleges in Tennessee (Tennessee projects revolutionize developmental education, 2009). Additionally, the University System of Maryland plans to implement the NCAT model statewide that would include 50 courses over the next 3 years (University system of Maryland expands course redesign across the state, 2011).

Currently, the National Center for Developmental Education (NCDE) lists ten initiatives that support effective pedagogical techniques to teach remedial courses, including remedial mathematics. Three of the initiatives are supported by Tennessee, California, and Washington (www.ncde.appstate.edu/resources). The Michigan Community College Association has created a Michigan Center for Student Success, whose goals are to create a statewide database to share best practices for community college student success (Baldwin, 2011).

The number of states with policies regarding post-secondary remedial education has doubled over the last decade. State remedial policies vary from mandating students to enroll in community colleges, to complete remediation before entering the four-year institution, to states not funding remedial coursework at four-year institutions. Some
states require a certain placement test score or demand students pay the total cost of remedial course instruction or, in the case of Connecticut, banning remedial coursework of any type from all post-secondary institutions. A few states mandate the method in which remedial mathematics is taught.

**Best Practices in Developmental Education**

Part of President Obama’s (2009) American Graduation Initiative is for five million more Americans to earn a post high school degree or certificate by 2020, and community colleges are being called upon to help reach this goal. Because of this initiative, and because 41% of the more than 11 million students who attend a community college need remediation (NCES, 2012), it is imperative community college faculty and administrators utilize best practices in remedial education. For years, scholars have conducted research to determine the classroom pedagogical techniques, course delivery format, academic support services, student support services, and institutional practices that are most effective in remedial student success. A portion of the American Association of Community Colleges (AACC) position statement on remedial education states,

> effective remedial education programs provide educational experiences that begin at the student’s level of ability and development, build the academic and personal skills necessary to succeed in subsequent courses, and further strengthen the college’s standards of academic excellence. Remedial programs are comprehensive, assessing and addressing the academic and personal variables that affect student performance at every stop along the learning continuum (AACC, 2000, p. 1).

The following will summarize the findings in the literature that have been determined effective in aiding remedial student success, with an emphasis on best practices in remedial mathematics student success. The findings include an explanation
of developmental theory, institutional practices, student services support, academic services support, course delivery format, and classroom pedagogical techniques, and conclude with recommendations for best practices in faculty development among faculty who teach remedial mathematics.

**Developmental Theory**

Brothen and Wambach (2004) believe a remediation only approach is not an effective method of teaching underprepared students. A remediation only approach is teaching students basic skills, reading, writing, and mathematics. Instead, they believe developmental education would be more effective in that the whole student is developed, in contrast to the student only learning basic skills. Developmental theory is a theory for developmental education to develop the whole student, by accommodating individual student differences, along with structuring the learning environment to maximize the number of students who benefit. The whole student is developed through three aspects, self-regulation, demandingness, and responsiveness (Wambach, Brothen, & Dikel, 2000).

Self-regulation is defined by Zimmerman, Bonner, and Kovach as “self-generated thoughts, feelings, and actions that are directed toward attainment of one’s educational goals” (Wambach et al., 2000, p. 3). Instructors can help developmental students become independent learners by teaching course content along with time management, study skills, and independent learning. These skills will help the student succeed academically and later in life. Self-regulated students will be able to monitor their academic progress and advance through developmental coursework to attain their academic goals (Wambach et al., 2000).
Demandingness has its roots in the demands a parent makes on a child. An instructor can make demands on the developmental student. The demands are in the form of expectations for appropriate behavior and mastery of coursework. The demanding instructor requires the student to read, write, speak, and perform operations at a mastery level. If the student is to develop, the instructor needs to place requirements on the student and enforce these requirements (Wambach et al., 2000).

Responsiveness insists the instructor is responsive to the developmental student by delivering timely and useful feedback. The instructor must possess good listening skills and conflict resolution skills to work with a wide variety of students, along with developing teaching methods that accommodate the needs of underprepared students. In addition, a responsive instructor must be willing to initiate contact with the student (Wambach et al., 2000).

**Recommended Best Practices**

Researchers have shown best practices in remedial mathematics can be divided into two categories of responsibility – institutional polices or practices and classroom strategies. Institutional policies or practices are the elements of best practices that are implemented by the institution, and may include remedial education organizational structure, student testing and placement, learning assistance centers, supplemental instruction, mastery learning, course delivery format, and student advising and counseling. Classroom strategies are practices in which the instructor has control, such as use of technology, classroom and laboratory instruction, collaborative learning or small group activities, integration of mathematics study skills, or learning strategies in the classroom. Course delivery format could be classified under classroom strategies, if the
The instructor has a choice, or the course delivery format may be dictated by institutional or state policies (Bahr, 2008b; Bonham & Boylan, 2011; Phelps & Evans, 2006; Trenholm, 2006; Twigg, 2009; Vasquez Mireless, Offer, Ward & Dochen, 2011).

Institutional Practices

Institutional practices are the practices the institution follows to aid remedial student success. Researchers believe the administrative structure of remedial education plays a key role in student success. Remedial instruction within an institution is primarily structured in one of two ways, either through a separate or centralized remedial education department, or through individual academic departments (Boylan, 2002; Perin, 2005).

The centralized remedial department has an administrator and faculty dedicated to remedial instruction. A centralized remedial education department can be “highly coordinated” (Boylan, 2002, p. 8) in that all remedial courses, student support services, counseling, study skills courses, and academic support services, such as tutoring and learning laboratories, are provided by the same department. The department has an administrator who coordinates campus-wide developmental education efforts. A loosely coordinated remedial education department might include remedial courses in reading, writing, and mathematics, with a director or administrator managing the department, with academic support services and student support services responsibilities located in different departments (Boylan, 2002; Perin, 2005).

In a second type of structure, each academic department is responsible for its respective remedial courses, or the developmental education is “mainstreamed” (Perin, 2005, p. 262). For example, remedial mathematics is under the guidance of the
mathematics department, and English and reading remediation are governed by the English department. The faculty who teach remedial courses may also teach college-level courses in the same semester. Tutoring services, SI, and counseling are managed by academic support services and student support services (Boylan, 2002; Perin, 2005; Shults, 2001).

The research findings are mixed as to which developmental education organizational structure is most effective. Boylan (2002) cited several studies that show institutions with a centralized developmental education structure have stronger program performance than institutions without a centralized structure, in that students have higher post-developmental education pass rates on mandatory state exit exams, higher student retention, and higher developmental course passage rates. However, Boylan commented, other research findings indicate that variation in the centralization can be effective when there is an institutional commitment to the mission of developmental education.

Other research indicates both organizational structures—centralized and mainstreamed—have merit. Practitioners believe that through a centralized structure, students have easier access to developmental educators and the support services they need most. In addition, the developmental instructors are dedicated to the mission of remedial education and students. On the other hand, in a centralized structure, remedial students may feel stigmatized because they are enrolled in a separate department away from non-remedial students. Furthermore, remedial course instructors may feel isolated from their colleagues because they teach in a separate department (Boylan, 2002; Gerlaugh, Thompson, Boylan, & Davis, 2007; Perin, 2005).
Institutions whose developmental education programs are mainstreamed are believed as effective as centralized. Mainstreamed programs generally have faculty teaching both developmental courses and college-level courses. Because faculty teaches both levels, they know what is expected of remedial students in college-level courses. However, the faculty member who teaches both levels of courses also may not understand the unique needs of the developmental student. Academic support services and student services are not housed within the individual departments in the mainstreamed structure. Students who need these services may not seek them out due to the lack of proximity to developmental courses (Gerlaugh et al., 2007; Perin, 2005).

**Mandatory Placement**

Student testing and proper placement into the correct level of remedial mathematics is just as important to student success. Scholars believe mandatory placement tests without mandatory placement undermines student success, especially among under-prepared or remedial students (Fike & Fike, 2012). Developmental mathematics students who complete a developmental mathematics course during the first semester of enrollment have the same fall-to-fall retention rates and grade point averages (GPAs) as students who place into college-level mathematics. Students who test into developmental mathematics but do not enroll in developmental mathematics the first semester have lower GPA and fall-to-fall retention rates (Fike & Fike, 2012).

Maxwell, Hagedorn, Cypers, Lester, and Moon (2004) tracked students enrolled in remedial mathematics courses at urban community colleges. Students were placed into three categories: those who had enrolled in a remedial mathematics course based upon their placement test score; those who enrolled in a higher course than was recommended
by placement test score; and, those who enrolled in a lower course than recommended by placement test score. They found that students who enrolled in the course recommended according to their test score had higher rates of success than the other two student groups. The study found that proper placement is part of student success in remedial mathematics.

Alternatively, a study conducted at the Virginia Community College System with a cohort of students from 2004-2008 and their developmental course enrollment pattern found that students who were recommended to enroll in the highest level of remedial mathematics but who did not, succeed in college-level mathematics at approximately the same rate as students who did not place into a remedial mathematics course. However, students who successfully completed the highest level of remedial mathematics course, regardless of the level in which they started, succeeded in college-level mathematics at higher rates than students who did not need remediation (Jenkins, Jaggars, & Roksa, 2009).

**Student Services Support**

**Counseling.** Community colleges enroll a diverse population. Less than half of community college students are under 24 (the traditional college age), one-fifth are married with children, and 15% are single parents. Over half of the students are female, and about one-fourth are at the poverty level in terms of income (Provasnik & Planty, 2008). It has been established that as many as one-half of these students need remediation. It is necessary that counseling and comprehensive support services are in place to aid these students (Bailey, 2009). These services include academic and career counseling, job placement services, day care centers, and study skills workshops (Boylan,
In general, all such comprehensive support services aid developmental and non-developmental students alike (Boylan, 2002). Researchers have found developmental programs that have a comprehensive academic advising and counseling component influenced student success in remedial mathematics (Boylan, Bliss, & Bonham, 1997). In fact, Bahr (2008b) found academic advising had greater positive effect on underprepared students than it did on students who were academically prepared for college-level work. The impact was even greater on remedial mathematics students.

Levin, Cox, Cerven, and Haberier (2010) conducted a case study, examining promising programs in California community colleges, as identified by policymakers and community college presidents as best-practice programs. Levin et al. used the criteria to determine the best-practice program based on course passage rates, job placement rates, certificate or degree attainment rates, and student progress through instructional sequences. Santa Monica College in Southern California has a Latino Center Adelante Program focusing on African-American and Latino students. Students are tracked and referred to campus services and counselors to aid the students’ success. Counselors make frequent contact with the students and utilize “intrusive advisement” (p. 50). The counselors get to know the students, help the students learn time management, and help the students in balancing school, work, and homework obligations. Frequent, purposeful contact with these at-risk students has increased persistence and retention.

**Learning communities.** Community colleges are primarily commuter institutions where, by their very nature, students have little opportunity to interact with their peers outside of class. As such, the classroom is the student’s connection to academia and the
higher education experience (Boylan, 2002; Tinto, 1997). Learning communities for developmental students have had a positive impact on classroom success, retention, and earned-credit hours. Learning communities may include paired courses or a cohort of students registered in three or more courses linked by a common theme (Bailey, 2009; Boylan, 2002; Bueschel, 2009; Rutschow & Schneider, 2011; Tinto, 1997).

Examples of paired courses include a group of students registered for the same courses, i.e. developmental English paired with a college-level social science course. Faculty members teach each class, coordinate assignments and curricula, and reinforce courses objectives in both classes. Another type of pairing is the developmental courses reading and developmental English or developmental mathematics and a study skills course (Boylan, 2002; Bueschel, 2009; Malnarich, 2005; Raftery, 2005; Rutschow & Schneider, 2011; Weissman et al., 2011).

Raftery (2005) found students enrolled in paired courses of developmental reading and developmental English had greater course completion rates, improved attendance, and increased retention rates. Ninety percent of students enrolled in the paired courses returned the following quarter and persisted, on average, of five quarters. It was also noted students who were part of the learning community had a higher GPA in subsequent quarters in college-level courses compared to students who were not part of the learning community.

Similarly, Weissman et al. (2011) studied learning communities at two different community colleges in Texas that used paired courses, Queensborough Community College and Houston Community College. Houston Community College paired a developmental mathematics course with a study skills course, and Queensborough paired
a developmental mathematics course with a college-level course. The results of the study were similar: Learning community students passed developmental mathematics at a higher rate than non-learning community students. However, the learning community did not have a significant impact on cumulative credits earned or college persistence. At the end of the study, control-group students had completed as much developmental mathematics as learning-community students. The learning community had a positive effect on students during the semester, but the effects decreased in subsequent semesters.

Alternatively, a more structured learning community—a cohort of students enrolled in three or more courses with related content and a team of instructors—has been shown to have a positive effect on developmental students. In addition to students taking courses together, they meet outside of class in small groups to study or to complete course projects (Boylan, 2002; Tinto, 1997). In this learning-community model, students form friendships and develop a supportive network that involves them both socially and academically in the college environment, which leads to greater persistence and greater academic effort (Tinto, 1997).

Kingsborough Community College in Brooklyn, New York, created a learning community program in which freshmen students were assigned at random to a either a learning community group or a control group. Learning community students were enrolled in the same three courses: a developmental English or college-level English course; an academic course; and, a one-credit orientation course that included enhanced counseling, tutoring, and a voucher for textbooks. The control group received the college’s standard courses and services. Learning community students earned more credits during their first semester, moved faster through developmental English, and were
more likely to pass an English-skills assessment test required for graduation or transfer (Scrivener et al., 2008).

Six years later, a follow-up study was conducted at Kingsborough Community College with the same participants as the original learning community participants. Sommo and colleagues (2012) discovered that approximately 5% more of the learning community students had earned a degree than the control group. Researchers found the cost-per-degree-earned was less for learning community students than for control group students. It was noted that study participants were full-time and included both developmental and college-ready English students. The learning community had three linked courses and enhanced services that extended into the summer and winter. In addition, Kingsborough Community College administrators strongly supported the learning community model.

Learning communities are effective in improving student retention and success. Remedial students benefit from learning communities or cohorts of students. Students who must take multiple remedial courses can be grouped together so as to develop a sense of community and so as not to feel they are the only student in this situation. The community gives the student a sense of belonging (Malnarich, 2005). Tinto (1997) noted if students have a connection to the college, they are more likely to be retained.

**Academic Support Services**

**Supplemental instruction.** Boylan (2002) believes Supplemental Instruction (SI) is “the single most well documented intervention available for improving the academic performance of underprepared students” (p. 75). SI is a worldwide academic support program, providing assistance to students in classes that traditionally have a 30%
or higher failure rate or the course has combined 50% low grade and attrition rate (Malnarich, 2005). SI leaders are students who have successfully completed the high-risk class. They are trained to help students while being actively involved in their own learning. The SI leader attends the class, takes notes, and models good student characteristics. SI leaders also hold study sessions for classmates outside of class (Zaritsky & Toce, 2006). Attendance at SI sessions is voluntary, but the instructor can strongly encourage students to participate by offering extra credit.

Zaritsky and Toce (2006) found that students who attend SI sessions regularly earned approximately one grade higher than students who did not attend SI. Researchers have found SI aids not only in higher grades for students, but increased course retention and long-term retention. Students who participate in SI work collaboratively during SI sessions, developing valuable study strategies to apply in future coursework (Boylan, 2002). The premise of SI is to assist students in high-risk courses, instead of specifically targeting high-risk students.

**SI in remedial mathematics.** SI is a proven program that has positive effects on student success in high-risk courses, as well as high-risk students such as developmental mathematics students. Valencia Community College, Orlando, FL serves more than 43,000 students at six campus locations. An SI program was implemented in the lowest level developmental mathematics at the largest campus. Students who attended SI had a 52% course completion rate, compared to a 35% course completion rate for students who did not attend SI. Another campus had similar results: 45% of students who attended SI completed the lowest level of remedial mathematics, compared to a 25% completion rate for students who did not attend SI. Both campuses had similar GPA increases; students
who attended SI had 0.5 to 1.0 higher overall GPA than students who did not attend SI. The findings also concluded that students who attended SI had higher levels of confidence in their mathematical abilities and lower levels of test anxiety (Phelps & Evans, 2006).

SI provides remedial mathematics students a safe environment and a forum to connect with other students outside of class. However, researchers have found that SI has no impact on student performance in other courses, beyond the semester in which the SI was provided (Vasquez Mireless et al., 2011).

**Student success courses.** Remedial students enrolling for the first time in a community college are not only deficient in some basic skills, they are sometimes lacking in time management skills, study skills, and career goals. These non-academic skills are as necessary as the basic skills of reading, writing, and mathematics (Zeidenberg et al., 2008). A valuable student success course teaches students how to learn, by exploring different learning strategies and skills to enhance their motivation for learning. Students are taught to evaluate learning strategies to determine which strategies are most effective in meeting their individual needs. An important component of the student success course is to teach students how to employ strategies in both remedial and college-level courses. In addition, the course teaches students time management and self-discipline (Boylan, 2002).

All 28 community colleges in Florida offer a student success course called Student Life Skills (SLS). SLS is open to all students, but most community colleges require developmental students to enroll in SLS. In a study comparing students who completed SLS course with those who did not, researchers found SLS had a positive
impact on student retention and persistence to earning a degree from a community
college after five years. SLS students who were also remedial students had a slightly
higher persistence in the community college and transferred to one of Florida’s
universities more often than SLS completers who were not remedial students (Zeidenberg
et al., 2008).

Chaffey College, a large community college in the Los Angeles area, created a
College Success (CS) course. Probationary students were randomly assigned to CS or to
a control group of probationary students not enrolled in CS course. The course included
learning styles, time management, test preparation, skills assessment, and use of
resources. CS course students were expected to make five Success Center visits for
assistance with their course assignments. The success course had positive short-term
effects after two semesters. CS students earned more credits and were twice as likely to
be in good academic standing, as compared to the control group, although four years after
the study began, CS students and control group students had made comparable academic
progress. During the four years, only 7% of all the participants in the study had earned a
degree (Weiss, Brock, Summo, Rudd, & Turner, 2011).

The research results show a college skills course has at least a short-term effect on
credits earned and progression through developmental courses. Other scholars believe a
college skills course may aid students in persistence to earning a degree or transferring to
a four-year university (Rutschow & Schneider, 2011).

Course Delivery Format

Developmental courses are delivered in one of three main methods – lecture,
distance learning, and computer-assisted instruction (CAI) (Zavarella & Ignash, 2009).
The traditional lecture is the primary method of instruction in which the instructor delivers the course material by lecturing to the student while the student listens. Distance learning is a course delivered via the internet or some other electronic means. The student is not required to attend class on campus for the course. The course can be synchronous or asynchronous; either way the student uses electronic media to complete assignments and participate in the course (Walton-Radford, 2011). The third method of course delivery, CAI, is a course delivery format that requires the student to be on campus for the course while all or some of the course material is accessed and delivered through electronic means. For example, the student may submit homework assignments electronically or do homework using specific software relevant to the course. The student may be required to attend class, but all instruction is delivered via software in a self-paced format (Twigg, 2005; Zhu & Polianskaia, 2007).

**Distance learning.** In 2008, the percentage of undergraduates enrolled in distance learning was 20%, with 22% of students attending a public two-year community college enrolled in a distance learning course compared to 16% of undergraduates attending a four-year public institution. In 2006-2007, two-thirds of two- and four-year postsecondary institutions offered some form of distance education, including courses delivered completely online and courses delivered in a hybrid format, partially online and partially in-person. Sixty-one percent of the institutions offered courses delivered wholly online with asynchronous, internet-based courses the most frequently used (Parsad & Lewis, 2008).

Doherty (2006) found that students registered for distance education because they did not have time to attend an on-campus class due to personal or employment...
commitments. He also found the reasons students gave for dropping out or failing a distance learning course was employment, not enough time to complete the required coursework, and procrastination.

However, Muse (2003) completed a study that suggested community college students were successful in distance learning courses if they had a higher GPA, worked in a good study environment, were older students, believed their background had prepared them for a distance-education course, and were further along in their academic careers. Adult students who had a higher GPA, more course experience, and who were further along in their education had the most success in online courses. Younger students with less academic experience and lower self-confidence were at a higher risk of failing a distance-learning course. An additional reason for any student dropping or failing a distance course was difficulty with the technology working as it should, i.e. the course management software, computer, or required plug-ins did not work properly, leading to student frustration and a tendency to drop or fail the course.

**Computer-assisted instruction.** The National Center for Academic Transformation (NCAT) advocates redesigning the method by which entry-level courses are taught in postsecondary institutions. Most entry-level courses use a traditional lecture format. NCAT posits the lecture format is not effective, as the student is a passive note-taker in the lecture class (Twigg, 2005). NCAT (2005) supports changing entry-level, traditional lecture courses into structured, self-paced, active learning environments by using computer software or internet-based learning resources. Software and internet resources provide instant feedback and numerous opportunities for the student to practice and learn course objectives.
Tallahassee Community College (TCC), Tallahassee, FL, has the largest African-American student enrollment among Florida’s community colleges. TCC implemented CAI in its college composition course, whose annual enrollment was 3,000 students. The traditional format class was spent re-teaching students basic skills of grammar and mechanics, leaving little time for the writing process. More than 40% of students did not succeed, and many students needed to repeat the course. Interactive, online tutorials in grammar, basic skills, and reading comprehension were added to the course. A software package was used to diagnose student deficiencies and to create an individualized learning plan for each student. Class time was available for students to engage in the writing process. From these changes, the student success rate increased to approximately 68% (Twigg, 2009).

**Course Delivery Formats in Remedial Mathematics**

Numerous studies have compared the success rates of remedial mathematics students in the three course delivery formats – traditional lecture, CAI, and distance learning. Researchers have found that students pass remedial mathematics at approximately the same rates, regardless of course delivery format. Each format had advantages and disadvantages for the students. In addition, developmental theory has been shown to apply equally to lecture and CAI.

Zhu and Polianskaia (2007) found that, when given a choice, two-thirds of students enrolled in self-paced CAI, while the remaining third enrolled in traditional lecture. Students enrolled in a traditional lecture course passed at a slightly higher rate than students enrolled in CAI, however, CAI students had higher passage rates on the
state exit exam, an exam all remedial students must pass before beginning college-level work.

Spence and Usher (2007) found no significant difference in student passage rates in traditional lecture versus distance learning remedial mathematics courses. Non-traditional students had higher remedial mathematics passage rates in general, but not a significant difference in a one-course delivery format compared to the other. The researchers did find that students who rated themselves higher on a self-efficacy survey passed remedial mathematics at a higher rate than students who ranked themselves lower on the self-efficacy survey.

Jacobson (2006) compared a traditional lecture format course with a traditional lecture course that required the students to complete all homework assignments using computer software. The software coincided with the course textbook and included tutorials as well as homework problems. Students enrolled in the computer homework course believed they had learned more mathematics, but students in the lecture course consistently scored higher on the course exam.

Spradlin and Ackerman (2010) reached similar results. Students enrolled in a traditional lecture intermediate algebra course passed at the same rate as students in the same course supplemented with computer-based homework. In addition, they found female students outperformed male students, regardless of the course format.

Taylor (2008) analyzed students’ attitudes toward mathematics while enrolled in a self-paced CAI course or a traditional lecture course. Both groups of students were given a mathematics attitude pre-test and post-test. Students in the CAI course had slightly better attitudes toward mathematics at the end of the semester, whereas students enrolled
in the lecture format had worse attitudes toward mathematics than when they started the course.

Zavarella and Ignash (2009) reported a higher drop-out rate among students enrolled in remedial mathematics distance learning and CAI than for students enrolled in traditional lecture. They found that students who had prior experience with distance learning or computer-based courses were more likely to be successful in the distance learning or CAI-format remedial mathematics. Students who felt the distance learning or CAI-format remedial mathematics met their personal needs were more likely to complete the remedial mathematics course.

Cleveland State Community College (CSCC), Cleveland, TN, and Jackson State Community College, (JSCC) Jackson, TN, incorporated an NCAT, computer-assisted instruction model into their mathematics courses. CSCC redesigned basic mathematics, elementary algebra, and intermediate algebra into CAI courses. Completion rates in intermediate algebra rose from 57% to 74%, while completion rates in elementary algebra increased from 50% to 68% over one semester. Further, the increased student success in developmental mathematics led to a 42% increase in enrollment in college algebra (Squires, 2009). JSCC also implemented CAI into its remedial mathematics sequence. Students earning a C or better increased from 41% to 59% from the fall semester to the spring semester using the CAI environment over the traditional lecture format (Tennessee projects revolutionize developmental education, 2009).

Brown McCabe and Meuter (2011) conducted a study examining the relationship a distance learning course had with the Seven Principles. Students were asked to rank the Seven Principles in order of importance and rank the tools of the course management
software (CMS) they used the most. The researchers correlated the CMS tools with the Seven Principles. Students rated *communicates high expectations* and *cooperation among students* as the least important of the Seven Principles. Students also ranked *communicates high expectations* and *cooperation among students* as least helped by the CMS. Students ranked *student-faculty interaction* and *active learning* as the principles most enhanced by the CMS.

Kinney (2001) used developmental theory as a framework for comparing the types of developmental course delivery formats, lecture and CAI. He found developmental theory applied in both formats. In the lecture course the instructor primarily lectured, but gave the students opportunities to work together and the instructor provided the students with feedback. The students were expected to complete assignments and take exams as scheduled. The CAI course software explained the course concepts through multi-media and required the students to complete assignments using the software. The software provided immediate feedback to the students. The instructor was available to assist students as needed, and the students worked at their own pace.

Students were interviewed to determine if they developed their self-regulation skills. When students were asked which course format required good time management and study skills, the students responded equally for both formats. The students felt in both formats they needed good study skills and time management skills, but students enrolled in CAI felt they developed better study habits and time management skills than they would have if they were enrolled in a lecture course because the students were in control of their own learning (Kinney, 2001).
Demandingness was communicated to students in both formats by the course syllabi and assignment sheets that included assignment due dates, course procedures, evaluation methods, and course expectations. Students were expected to complete assignments using paper and pencil showing all work, regardless of the course format. In addition, students were expected to attend class and complete assignments by the due dates (Kinney, 2001).

Both course delivery formats demonstrated responsiveness. Students received feedback from the instructor during class and during office hours. Instructors also sent academic alerts to students who were falling behind or not making progress in both formats. The CAI software gave immediate feedback to the student as the student was using the software. In this format the instructor was available to give immediate feedback or assistance to the student (Kinney, 2001).

Kinney (2001) noted when Beginning or Intermediate Algebra courses are structured using developmental theory, whether it is lecture or CAI, there is no significant difference in the number of students who passed the course. There was not a significant difference in grades on the common final examination or passage rates of students in the two different course formats. Students who enrolled in college algebra after successfully completing developmental mathematics passed college algebra at the same rate as the students who did not need developmental coursework, regardless of the format of the developmental course.

**Remedial Mathematics Instructors**

Research shows that students who pass remedial mathematics, even students with multiple levels of mathematics deficiencies, have higher retention rates. In addition,
these students transfer to four-year institutions or earn a degree at rates similar to students who do not need mathematics remediation (Bahr, 2008a, 2008b, 2010; Calcagno et al., 2007; Fike & Fike, 2008; Hall & Ponton, 2005). Remedial mathematics is a gatekeeper course to college-level mathematics, college retention, and success. Hall and Ponton (2005) noted “not all students need to learn calculus; all students do need a comfortable level of mathematical ability that does not limit life-altering choices, such as the choice of major” (p. 28).

Many remedial mathematics instructors are highly qualified in the area of mathematics, but they are limited in their knowledge of teaching developmental mathematics. In addition, they are limited in their knowledge of the challenges and diverse backgrounds of the remedial mathematics’ student (Bonham & Boylan, 2011; Boylan, 2002; Brothen & Wambach, 2004; Highbee, Arendale, & Lundell, 2005; Smittle, 2003). Instructors who teach remedial mathematics need to realize the importance of remedial education and be committed to teaching these students. Remedial mathematics instructors not only teach mathematics, they teach self-esteem, study skills, and motivation for learning. The remedial instructor needs to learn there is an art to teaching remedial mathematics, as well as the mechanics of teaching remedial mathematics (Galbraith & Jones, 2006; George, 2010; Smittle, 2003). Therefore, it is necessary that remedial mathematics instructors use best practices in remedial mathematics education. If the instructor lacks experience or knowledge of best practices, the instructor needs training (Bonham & Boylan, 2011; Boylan, 2002; Brothen & Wambach, 2004; Grubb & Cox, 2005; Smittle, 2003).
Smittle (2003) believes Chickering and Gamson’s Seven Principles—student faculty interaction, cooperation among students, active learning techniques, give prompt feedback, emphasizes time on task, communicate high expectations, and respect diverse talents and ways of learning—apply to effective remedial education. While an instructor who follows the Seven Principles may need only encourage active learning for a non-remedial student to be successful, the remedial instructor needs to follow the Seven Principles and consciously structure active learning situations during class time, while teaching students to become independent learners.

AMATYC’s position statement regarding the qualifications of two-year college mathematics faculty recommends the minimal preparation of full-time or adjunct faculty possess a master’s degree in mathematics or related field with 18 semester hours of graduate courses, with at least six courses in graduate mathematics. However, the organization promotes a standard preparation for two-year mathematics faculty hold a master’s degree in mathematics, with at least 30 semester hours in graduate mathematics, and have mathematics teaching experience at the secondary or collegiate level. In addition, AMATYC recommends mathematics faculty continue their professional development throughout their careers, by attending conferences, further graduate coursework, reading journal articles, and participating in mini courses and webinars. Continual participation in professional development is critical for faculty to remain up-to-date in teaching mathematics (AMATYC, 2015a).

Faculty development. Newer community college faculty are more likely to teach remedial courses than senior faculty, but regardless of length of service to the institution, developmental faculty have a commitment to teaching developmental students and
believe in the idea of developmental coursework (Kisker & Outcalt, 2005). Remedial instructors want professional development to help them become better remedial course instructors (Kozeracki, 2005; Rouseff-Baker, 2002).

If faculty members are to improve their teaching methods and have a positive impact on student success, they need training in best practices of teaching developmental courses. Bailey, Jaggars, and Jenkins (2011) recommend institutions make student learning a campus-wide initiative, and that faculty across disciplines and services work together to make student learning a priority. The institution should provide opportunities for developmental instructors to gain knowledge of best practices of teaching developmental courses and developmental students. The institution needs to provide funding for instructors to attend conferences or workshops in best practices in developmental education (Boylan, 2002; Bonham & Boylan, 2011; U.S. Department of Education, 2005; Wallin, 2002; Vohryzek-Bolden, 2000). If it is not feasible for all remedial instructors to attend conferences or workshops, the institution can provide opportunities for peer-to-peer formal or informal mentoring.

AMATYC’s position statement strongly supports faculty development. The organization promotes every college should support professional development of its mathematics faculty. Faculty development is needed to improve instruction and students’ educational experiences. AMATYC posits colleges should provide faculty the opportunity to attend conferences, workshops, and college courses. The college should give release time so faculty can develop curriculum and develop innovative methods of instruction (AMATYC, 2015b).
Hopkins (2005) researched mentoring and its effects on community college faculty. The results indicated mentees prefer an informal mentoring structure with strong institutional support, as opposed to a formal structure with set meeting times and agendas. The mentees believed informal, but face-to-face, meetings benefitted their career development, as well as their social adjustment to the institution. Mentees preferred a peer mentor over a supervisor as a mentor.

Parkland College in Champaign, IL, has a Center for Excellence in Teaching and Learning that provides faculty development programs. The Center’s programs provide a means for new faculty to work with senior faculty from all disciplines to share ideas of best practices in teaching. Through the Center, faculty members have become involved in their own professional development and have taken ownership of institutional issues. An additional benefit of Center programs is faculty member talent development. In some cases, this talent development led to faculty becoming leaders and then promoted to department chair positions (Rouseff-Baker, 2002).

Continuous faculty development is necessary for community college faculty to keep up with changing technology and students, including special needs students (Wallin, 2002; Vohryzek-Bolden, 2000). But a systematic approach to faculty development is required to determine what works for the institution. Faculty should be encouraged to keep learning and improving their skills, with continuous improvement part of the faculty evaluation process (Wallin, 2002). The individuals in charge of faculty development, whether administrators or other faculty, should keep in mind that faculty members are themselves adult learners, and should be treated as such by using the literature that is
available on adult learners. Faculty members want their learning to be useful, and they want to integrate their new skills immediately into their classroom and daily lives.

Lawler (2003) created an Adult Learning Model for Faculty Development based on adult learning theory. She recommends six principles when creating a faculty development process: 1) create a climate of respect; 2) encourage active participation; 3) build on experience; 4) employ collaborative inquiry; 5) learn for action; and, 6) empower participants. In the context of teaching faculty, there needs to be a climate of respect. It should be recognized that faculty members are professionals, each with his or her unique learning style. The physical and social environment must be conducive to faculty learning. If faculty development is to be effective, faculty members must be active participants in the learning process – as active in their learning as they are in their teaching. As adults and adult learners, faculty members bring a wealth of experience in learning, and faculty development must build on this experience to make the learning experience positive. Faculty members are accustomed to working collaboratively with other faculty members. From this experience, collaborative inquiry should be incorporated into all faculty development opportunities.

One important principle of adult learning theory is that the adult learners want to apply what they are learning to their everyday lives. Learning for action means that, when creating faculty development opportunities, make the topics such that faculty members can apply them right away in their instructional process. The last piece of Lawler’s model is empower participants. The basis for faculty development is that change may occur. By extension, faculty members must feel empowered to change after the activity is over.
Vohryzek-Bolden (2000) wrote, “many instructors gain new knowledge and skills through trial and error, learning success through years of experience” (p. 16). Hansman (2001) agrees; learning about teaching happens over time and is shaped by instructor experiences inside and outside class, including interacting with students and other instructors. She suggests forming communities of practice – self-organized groups of people who share a common purpose and a desire to learn from one another. These communities serve two purposes, to share teaching strategies and experience with teaching methods, assignments, and classroom routines that improve student learning, and to create environment in which both new and experienced faculty members feel connected to each other and to the institution.

**Faculty-student interaction.** Faculty-student interaction is one of the Seven Principles and has been shown to have positive impact on student outcomes, whether the interaction is formal or informal. Tinto (1997, 2002) found faculty-student interaction in the classroom is vital to student success. Astin (1996, 1999) has shown faculty-student interaction plays a key role in student satisfaction of the college experience and earning a degree.

Thompson (2001) studied the importance of informal faculty-student interaction on community college students enrolled in science and mathematics courses. Informal faculty-student interaction is defined as the informal interaction between faculty and students outside of class. Students who had higher perceived levels of informal interaction with faculty had significantly higher educational gains in science and mathematics. The students perceived they put forth greater effort toward science and mathematics courses in which they had more informal faculty-student interaction.
Learning environment. Classroom interaction creates a learning environment that is as important to student learning as the faculty member is to the teaching. The faculty member creates the learning environment. Learning environments can be categorized as teacher-centered or learner-centered. Learner-centered environments are defined as environments in which instruction and learning are a joint effort between teacher and learner, with the focus on the individual learner. The instructor facilitates learning by providing an environment that engages the student. The teacher-centered environment is characterized as the teacher is the expert who conveys knowledge to the student primarily through lecture (Barrett, Bower, & Donovan, 2007).

Experts encourage multiple methods of instruction for developmental students, one of which is a shift to a learner-centered environment (Bonham & Boylan, 2011; Boylan, 2002; Fowler & Boylan, 2010; U.S. Department of Education, 2005). Astin (1999) points out instructors should focus on “achieving maximum student involvement and learning” (p. 526). Collaborative learning or structured peer collaboration is a method than can facilitate a shift in the learning environment to a more student-centered environment. Collaborative learning is an element of two of the Seven Principles, encourages cooperation among students and encourages active learning.

AMATYC’s Standards of Intellectual Development advocates students should be required to problem solve, learn mathematics through real world situations, and have the ability to connect mathematics to other disciplines. It is necessary for students to have the ability to read, write, and speak mathematics. In addition, it is essential for students to use appropriate technology to enhance mathematical thinking and knowledge. For students to accomplish this AMATYC recommends Standards for Pedagogy or
instructional standards faculty should follow. Mathematics faculty need to model appropriate use of technology and teach using multiple representations, numerical, graphical, symbolic, and verbal. Faculty ought to encourage collaborative learning requiring students to work together to communicate mathematics and build mathematical connections. At the same time, faculty have a duty to show the relevance of mathematics in students’ lives and make connections for the students between branches of mathematics and other disciplines (Cohen, D., 1995).

The American Mathematical Society (AMS) published a concept paper addressing issues of importance when teaching mathematics. The AMS has termed some of the practices when teaching mathematics “areas of agreement” (Ball et al., 2005, p. 9). The areas of agreement include expectations for students, as well as expectations for teachers. Students should be able to recall basic facts of addition and multiplication, calculators may be used as a tool, but calculator use must not impede the learning of basic facts. Students should be able to use basic mathematics algorithms such as solving linear equations. Students should understand the number meaning of fractions. Teachers need to teach mathematics using real world examples and need to determine the topics that should be taught through structured exploration or direct instruction. The teacher must not only be able to do the mathematics, the teacher must understand the mathematics, as well as be able to make complex topics accessible to all students (Ball et al., 2005).

Mathematics educators advocate students must be able to read, write, and discuss mathematics, in addition to doing mathematics (The Education Alliance, 2006). To aid students in this process, the instructor needs to structure the classroom so the student can
learn how to represent problems numerically, graphically, and with models. This is not sufficient; the instructor should design assessments that require the students to create their own multiple representations of the mathematical concepts. In the same vein as multiple representations, the mathematics instructor must transfer the mathematics to other disciplines by demonstrating to the students the use of mathematics in real-world contexts (Ball et al., 2005; DiMuro, 2006; Hodara, 2011b).

In addition, classroom use of manipulatives or hands on approach can aid students in developing an understanding of mathematical concepts. Calculators can be included in the broad definition of mathematical tools, but calculators must not be used in place of knowledge and fluency of basic facts (Ball et al., 2005; The Education Alliance, 2006; Van de Walle, Karp, & Bay-Williams, 2012).

Hodara (2011a) recommends structured peer collaboration for developmental mathematics students. Each student in the group is assigned a piece of a project, and all pieces must be completed for the project to be completed. Each student is expected to be able to explain how pieces of the project fit together, and how the group arrived at a solution. Requiring all students to complete a certain piece and have the ability to explain the solution ensures that no student is left out.

Goldstein, Burke, Getz, and Kennedy (2011) implemented structured collaborative learning in three intermediate algebra courses, and a fourth course was taught with its traditional method. At the end of the semester, there was no significant difference in student grades or completion rates between the collaborative structured courses and the traditional course. All students were then tracked the following semester, and college algebra grades and completion rates were analyzed. The college algebra
grades for students who had completed the collaborative structure earned one grade higher than students who had completed the traditional intermediate algebra course. The collaborative structure students earned grades comparable to students who did not place into the intermediate algebra course.

**Current Literature Assessment**

The literature is replete with research into methods that improve remedial student outcomes. Studies have examined institutional policies and procedures as they relate to remedial student outcomes, including student services, academic services, mandatory testing and placement, SI, tutoring, intrusive advising, learning communities, study skills courses, orientation, and the administrative structure of remedial education. More current research examines the influence of course delivery formats and the influence of remedial coursework on student retention. Research has studied classroom practices that lead to positive student outcomes. Specifically, studies have shown that students who are successful in remedial mathematics are more likely to remain in college or earn a degree or credential at rates similar to students who do not need remediation. These studies were based on data from a single state, a single institution, or a single remedial course.

The literature has also shown the validity of Developmental Theory as it relates to developmental mathematics students and the course delivery formats lecture and CAI. Both course formats can be structured to have the elements of self-regulation, demandingness, and responsiveness. When either format is used and the course is structured based on Developmental Theory, developmental students are equally successful in passing developmental mathematics and college-level mathematics.
Time and again, research has revealed the methods that aid in remedial student success, from institutional practices to classroom practices, and the benefits of that success. Remedial student success leads to increased educational opportunities. By extension, increased educational opportunities lead to greater, higher paying career choices, which, by extension, benefit communities through additional tax revenues. The social benefit of successful remedial education efforts is intuitively undisputable. At the same time, however, policymakers cut budgets for education, expect institutions to do more with less, and place mandates on the availability, cost, and delivery of remedial education, which accounts for only one half of one percent of the nation’s higher education budget.

As community colleges now enroll more than 40% of the students in America’s colleges and universities, researchers should continue to study the impact community colleges have on higher education (Pascarella & Terenzini, 2005). Scholars recommend studying all aspects of remedial education programs in detail, particularly remedial mathematics, to determine the factors that most influence student success (Fowler & Boylan, 2010; Lesik, 2007). On the whole, more research is needed on the influence of varying teaching and instructional methods and of faculty interaction with students both in and out of class (Barrett, Bower, & Donovan, 2007; Levin et al., 2010; Thompson, 2001).

The importance of developmental education is clear, especially development mathematics. Policymakers are mandating how much can be spent on developmental education, the institutions in which underprepared students may enroll in developmental courses, and, in some states, the methods by which developmental courses may be taught
and the cost of developmental courses, which are typically higher than the costs of other for-credit courses. At the same time these mandates are taking place, President Obama is challenging institutions to not only enroll students, but to graduate students.

This study needs to be conducted so that faculty voices can be heard. As institutions and faculty face shrinking budgets, expenditures on remedial education have to be effective. The objective of this study is to fill the literature gap by determining, from a nationwide survey of remedial mathematics instructors, the institutional environment that influences instructional methods identified in the literature as evidence-based best practices. Saxon & Boylan (2010) state about remedial education practitioners, “No one knows more about effective practices at the grass roots level than the professionals who have invested their careers in the field” (p. 36).

Conclusion

Among students needing remediation, developmental mathematics is the course students enroll in the most. There will always be a need for developmental mathematics courses for students who did not gain the skills in high school, and for adult students who turn to college to retrain for a different career or to improve their job status.

As such, research-based best practices in developmental education—especially developmental mathematics—is crucial. Scholars have differing opinions if developmental education should be housed in a separate department or administered by its subject-area department, but it is believed developmental education should be a campus-wide mission. Institutional policies and practices, such as intrusive-advising, SI, learning communities, study skills courses, course delivery format, and mandatory testing
and placement, have all been shown to have a positive impact on developmental mathematics students.

Developmental Theory and its three components, self-regulation, demandingness, and responsiveness, is a theory that seeks to develop the whole student. Developmental mathematics courses that are structured based on Developmental Theory have been shown to have equal student success rates, regardless of course delivery format lecture or CAI.

Individual instructor practices have an impact on developmental mathematics’ student success. Student-faculty interaction, whether inside or outside of class, has positive effects. A student-centered classroom environment, enhanced by structured collaborative activities, influences student learning. Course delivery format, distance learning, computer-assisted instruction, and traditional lecture all have their merits when it comes to positive developmental mathematics student outcomes.

Scholars agree best practices need to be utilized by institutions and faculty alike to help students gain the skills necessary to succeed in college-level coursework. If faculty need training in best practices for developmental mathematics, they should be given the opportunity through collaboration with senior faculty with more experience or through workshop and conference attendance. Regardless of how faculty learn how best to use best practices, they need to be involved in the process of deciding which training is appropriate.

Adult learning theory can be valuable in the context of faculty development. Community college faculty members who are involved in improving their teaching skills through interacting with colleagues as mentors have greater career satisfaction. As adult
learners, faculty members want the new skills they learned to apply to their everyday lives. At the same time, they want to be recognized as having valuable knowledge and experiences. Faculty professional development activities, such as mentoring and communities of practices, fit well with the concept of the faculty member learning new skills that can be applied to his or her daily life. Practitioners who create formal faculty development activities need to keep in mind the adult learning principles as well. The faculty must be able to participate in the learning process, and, as a result, feel empowered to change and to try their newly learned skills.

Not only is the use of best practices imperative for faculty to use for the benefit of the students, best practices benefit the institution as well. The number of states mandating that remedial coursework must be completed at the community college before a student enters a four-year institution doubled from 2001 to 2011. This implies more students who need remediation will enroll in community college.

This literature review presented best practices based on studies of single states, single institutions, or single courses. In identifying factors that influence instructor use of best practices, this study attempted to fill the gap by going directly to the source—remedial mathematics instructors from across the country—to determine what influences their use of best practices.

**Overview of Upcoming Chapters**

Chapter Three describes the methodological approach used in the study. Chapter Four gives the details and summarizes the findings of the study. Chapter Five offers observations about the significance of the findings of the research, and proposes future research.
Chapter 3

Methodology

The purpose of this study was to determine which community college environmental factors, if any, influence the use of best practices in teaching remedial mathematics among remedial mathematics instructors. The factors studied include: instructor demographics; institutional characteristics; institutional policies and procedures, specifically academic support services; student services; faculty development; and, the remedial mathematics course delivery format. This chapter includes the research questions, procedures, and method of data analysis. Astin’s I-E-O model was used as a basis for the step-wise blocked multiple regression format. How participants were chosen for this study, the survey used, and the process of survey administration are explained. The chapter concludes with the limitations of the study and a summary of the chapter.

Restatement of the Research Questions

1. What instructor demographics, if any, influence instructor use of best practices in remedial mathematics?

2. What institutional characteristics, if any, influence instructor use of best practices in remedial mathematics?

3. What institutional policies and procedures, if any, influence instructor use of best practices in remedial mathematics?

4. Which methods of faculty development, if any, influence instructor use of best practices in remedial mathematics?
Research Design

The study was a quantitative, non-experimental survey of convenience that examined the influence of instructor demographics, community college environment, and community college policies and procedures that influence an instructor’s use of best practices of teaching remedial mathematics. The researcher conducted a step-wise blocked form of multiple regression to determine which variables, if any, influenced instructor use of best practices.

A growing body of research points to methods that are considered best practices in teaching remedial students; however, research is lacking as to why an instructor may or may not employ these practices in the classroom. If there are variables that influence—or discourage—use of best practices, this information would be valuable both to community college administrators and faculty members alike. The study investigated predictor variables, such as instructor demographics, institutional policies and procedures, the administrative structure of remedial education at the community college, student support services, and academic support services. Faculty working conditions, such as the number of remedial and non-remedial credit/contact hours a faculty member is required to teach, and how professional development is utilized, are additional predictor variables that were studied.

The sample in the study represented community college faculty members who teach remedial mathematics and are members of the American Mathematical Association of Two-Year Colleges (AMATYC). The researcher obtained permission to survey AMATYC’s more than 2,500 members who hail from the United States and Canada. The survey was also sent to the members of the Michigan Mathematical Association of Two-
Year Colleges (MichMATYC). An email survey was sent to the individual members of AMATYC and MichMATYC in April 2014.

Data Analysis Framework

The data were analyzed using Astin’s I-E-O Model. Astin (2002) noted the model was developed for use with “natural experiments” (p. 28). Natural experiments study phenomena that are naturally occurring, in contrast to a true experiment that has a control group and a treatment group. The model explores the influence, if any, the input variables and environmental variables have on the outcome variable (Astin, 2002).

For the purpose of this study, the input variables were instructor demographics. The environmental variables taken into account were: institutional characteristics gathered from IPEDS data; institutional policies and procedures that related to student services and academic support services; faculty working conditions; institutional practices of faculty development; and, individual, faculty practices of professional development (see Figure 1). Table 1 identifies the variables used in this study by type – input or environmental.

A blocked form of step-wise multiple regression was used to analyze the relationships between the input, environment, and the outcome variable, instructor use of best practices. To examine the relationship between instructor demographics, institutional characteristics, institutional policies and procedures, and professional development on use of best practices, predictors were organized into sequential blocks. Astin & Sax (1998) recommend a forward, step-wise entry method with entry and removal tolerances. The regression analysis continues entering one variable at a time until the predictive power of the variables in the first block are exhausted. The regression
Analysis continues to the following blocks entering on variable at a time until the predictive power of the variables in the second environmental block are exhausted. The analysis continues in the same fashion for the next two blocks.

Block 1 included the input variables, instructor demographics, including \textit{degree, years of experience, years of experience teaching remedial mathematics}. The environmental variables made up blocks 2 through 4. Block 2 contained institutional characteristics gathered from IPEDS data, and included \textit{enrollment, percent of expenditures per student for instruction, percent of expenditure on research, percent of students receiving financial aid} and whether the institution has multiple campuses and is considered rural, suburban, or urban, commuter, or residential. Block 3 consisted of institutional policies and procedures pertaining to student services that are considered best practices – \textit{advising/counseling, orientation, and learning communities, tutoring, location of tutoring services}, and academic services that are considered best practices - \textit{faculty or student tutors, supplemental instruction, study skills course, mandatory placement, and administrative structure - remedial education, faculty working conditions, including course delivery format, number of credit hours or contact hours an instructor is required to teach, and required office hours.}

Block 4 included faculty development methods – \textit{professional conferences/workshops, professional remedial educators’ websites, webinars, graduate courses, reading journal articles, faculty development for remedial instructors organized by community college, informal collaboration with colleagues on campus, informal collaboration with off-campus colleagues, formal collaboration with colleagues on campus}. 

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Instrumentation and Procedures

Remedial mathematics was defined for respondents using the NADE definition. The survey asked respondents the format of their remedial mathematics courses and the pedagogical practices used to teach these courses using a structured response questionnaire. The survey included structured-response questions pertaining to the academic support services the institution provides remedial mathematics students, as well as questions relating to the remedial mathematics (see Appendix A for a copy of the survey).

Survey Instrument Rationale

The survey instrument was created based on a literature review of best practices in teaching remedial mathematics, including institutional policies and procedures that are deemed as best practices. In addition, faculty development activities that are used by institutions and faculty to train faculty in best practices in teaching are explored. Table 1 lists the questions that were used in the survey. Next to each question is the researcher(s) who has identified this as a best-practice approach in teaching remedial mathematics. The predictor variables, and the corresponding survey questions, along with the criterion variable instructor use of best practices in teaching remedial mathematics and its corresponding survey questions are listed in Table 2. The Seven Principles and the survey questions that correlate to the Seven Principles are detailed in Table 3.
**Data Collection Process**

The data for this survey was collected through an electronic survey using Qualtrics survey software. Because the data were collected electronically, there was an immediate construction of a data base (McMillan, 2007). The survey was sent to the email addresses of all AMATYC and MichMATYC members. It was determined an email survey was appropriate because survey participants are professionals who routinely use the internet (Alreck & Settle, 2004; McMillan, 2007). This sample was chosen for economy, and the sample population had the information the researcher is collecting. Furthermore, an online survey can be administered without interaction between the participant and the researcher, thus lowering the chance of bias and error that can occur when a participant is interviewed (Alreck & Settle, 2004; Dillman, 2009).
Table 1
Survey Questions with Corresponding References

<table>
<thead>
<tr>
<th>Question</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-3: Which academic services are available for remedial mathematics students on your campus?</td>
<td>Boylan, 2002; Malnarich, 2005; Zaritsky &amp; Toce, 2006</td>
</tr>
<tr>
<td>Q-4: How often do remedial mathematic students generally meet with academic counselors/advisors during the semester outside of class time?</td>
<td>Boylan, 2002; Levin et al., 2011</td>
</tr>
<tr>
<td>Q-5: Does your community college have a study skills course or college skills course?</td>
<td>Weiss et al., 2011; Zeidenberg et al., 2008</td>
</tr>
<tr>
<td>Q-6: Are new students given a placement test to determine the mathematics course in which they should enroll?</td>
<td>Fike &amp; Fike, 2012; Jenkins et al., 2009; Maxwell et al., 2004</td>
</tr>
<tr>
<td>Q-7: If a student is determined to need remedial mathematics, is enrollment in the remedial mathematics course optional, mandatory, or other?</td>
<td>Fike &amp; Fike, 2012; Maxwell et al., 2014</td>
</tr>
<tr>
<td>Q-8: Does your community college organize students into learning communities, a cohort of students enrolled in a block of courses?</td>
<td>Bailey, 2009; Boylan, 2002; Bueschel, 2009; Rutschow &amp; Schneider, 2011; Tinto, 1997</td>
</tr>
<tr>
<td>Q-9: Does your community college offer orientation to new students?</td>
<td>Boylan, 2002</td>
</tr>
<tr>
<td>Q-10: What is the administrative structure of developmental education at your community college?</td>
<td>Boylan, 2002; Perin, 2005</td>
</tr>
<tr>
<td>Q-11: The remedial mathematics tutors are faculty, students, or both?</td>
<td>Gerlaugh et al., 2007</td>
</tr>
<tr>
<td>Q-12: Where is the remedial mathematics tutoring located?</td>
<td>Boylan, 2002; Gerlaugh et al., 2007; Perin, 2005</td>
</tr>
</tbody>
</table>

Q-17: What is the format of the remedial mathematics course(s) you teach at your community college? Twigg, 2005; Walton & Reid, 2011; Zavarella & Ignash, 2009; Zhu & Polianaskaia, 2007

Q-18: Please rate the following statements as they apply to you as a remedial mathematics instructor. (dependent variable) Chickering & Gamson, 1987; Thompson, 2001; Tinto, 1997, 2002

Q-19: How frequently do you, as the remedial mathematics instructor, employ the following pedagogical techniques during the semester in your remedial mathematics courses? (Dependent variable) Astin, 1993; Barett et al., 2007; Bonham & Boylan, 2011; Boylan, 2002; Fowler & Boylan, 2010; Hodara, 2011; U.S. Dept. of Ed., 2005

Q-20: How familiar are you with the following methods of teaching mathematics? Ball et al., 2005; DiMuro, 2006; Hodara, 2011b

Q-21: How frequently do you, as a remedial mathematics instructor, require your students to do the following? Ball et al., 2005; DiMuro, 2006; Hodara, 2011b

After a thorough review of the literature, the researcher constructed a 29-question survey pertaining to instructor demographic characteristics and institutional policies and procedures as they relate to remedial students and remedial instruction. The survey included questions about course delivery format, faculty-student interaction, and classroom pedagogical techniques.

The arrangement of the blocks of variables was based on Astin’s I-E-O model. The model was used to determine the influence, if any, the input and environmental variables have on the output variable. Because the survey was not a true experiment with
random assignments made to a control group and to a treatment group, instructor
demographic characteristics were controlled for in the first block, the input block, to
attempt to statistically control for the bias of input variables on the environmental
variables.

Table 2

*Research Questions with Corresponding Survey Questions*

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Variable</th>
<th>Survey Question(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: What instructor demographics, if any, influence instructor use of best practices in remedial mathematics?</td>
<td>Predictor variable: Instructor demographics</td>
<td>Q-2, Q-13, Q-14, Q-15, Q-20, Q-25, Q-26, Q-27</td>
</tr>
<tr>
<td>2: What institutional characteristics, if any, influence instructor use of best practices in remedial mathematics?</td>
<td>Predictor variable: Institutional characteristics</td>
<td>Q-28, Q-29</td>
</tr>
<tr>
<td>3: What institutional policies and procedures, if any, influence instructor use of best practices in remedial mathematics?</td>
<td>Predictor variable: Institutional Policies and Procedures</td>
<td>Q-3 thru Q-12, Q-17, Q-22 thru Q-24</td>
</tr>
<tr>
<td>4: Which methods of faculty development, if any, influence instructor use of best practices in remedial mathematics?</td>
<td>Predictor variable: Methods of Faculty Development</td>
<td>Q-16</td>
</tr>
<tr>
<td></td>
<td>Criterion variable: Instructor use of best practices in teaching remedial mathematics</td>
<td>Q-18, Q-19, Q-21</td>
</tr>
</tbody>
</table>
### Table 3

*Seven Principles with Corresponding Survey Questions*

<table>
<thead>
<tr>
<th>Seven Principles for Good Practice in Undergraduate Education</th>
<th>Survey question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourages contact between students and faculty</td>
<td>Q-9, Q-18a, b, c, d, e, f, m, p</td>
</tr>
<tr>
<td>Develops cooperation among students</td>
<td>Q-3, Q-8, Q8a, Q-18g, Q-19b, d, e, f</td>
</tr>
<tr>
<td>Uses active learning techniques</td>
<td>Q-3, Q-5, Q-18b, d, e, f, g, Q-21</td>
</tr>
<tr>
<td>Gives prompt feedback</td>
<td>Q-18i, Q-19j</td>
</tr>
<tr>
<td>Emphasizes time on task</td>
<td>Q-18h, Q-19b, c, k</td>
</tr>
<tr>
<td>Communicates high expectations</td>
<td>Q-18h, n, Q-19l, Q-20</td>
</tr>
<tr>
<td>Respects diverse talents and ways of learning</td>
<td>Q-18k, o, Q-19b, c, d, e, g, h, i, j, k</td>
</tr>
</tbody>
</table>

### Survey Pilot

A pilot of the survey was conducted to ensure questions were clear and to eliminate weak or redundant questions. Conducting such a pilot contributes to survey validity (Slavin, 2007). In the pilot, a draft survey was sent to several full-time community college faculty who had remedial mathematics teaching experience. Recipients were asked to identify questions that needed clarification or revision and to report the length of time it took to complete the survey (Alreck & Settle, 2004; McMillan, 2008). Information as to how long the survey took to complete was aggregated and reported to recipients of the final survey instrument. Pilot survey
participants received the electronic link to the survey by email so that they were able to determine if the electronic link and the electronic survey worked properly (Dillman, 2009). Revisions to the survey were made based on the feedback from the pilot survey.

**Data Analysis Procedures**

The data were analyzed using a blocked form of stepwise, multiple regression. The criterion variable or dependent variable is instructor use of best practices of teaching remedial mathematics. A multiple regression line was calculated with the criterion variable—*instructor use of best practices in teaching remedial mathematics*—and the predictor variables, including instructor demographic characteristics, between-college characteristics, college policies and procedures as related to best practices of teaching remedial mathematics, and methods of faculty development. The rationale was college policies and procedures related to best practices are independent of a remedial mathematics instructor using best practices in teaching. Two of the Seven Principles, student-faculty interaction and active learning, have significant influence on student success (Astin, 1993; CCCSE, 2012; Kuh & Vesper, 1997). Requiring a student to represent a mathematical concept multiple ways, using manipulatives, and using tools such as a calculator or software also aids the student in developing an understanding of mathematics and its uses outside of the mathematics classroom (Ball, et al., 2005; The Education Alliance, 2006; Van de Walle, et al., 2012). A faculty member has individual control over the use of these three best practices. Thus, the study was an attempt to determine what environmental variables influence instructor use of best practices.

Best practices in teaching remedial mathematics is a broad construct that can be separated into three distinct groups: namely best practice behaviors, best practice
techniques, and best practice multiple representation and tool use. Each distinct category has its own merits and possibly its own unique set of predictors, different than the predictors that predict overall use of best practices. The best practice behaviors are best described as student-faculty interaction. The best practice techniques are the methods the instructor employs to encourage student learning. Lastly, the best practice multiple representation and tool use is the utilization of various representations of mathematical concepts through graphical, numerical, and real world analyses, in addition to using tools such as a calculator or software are valuable tools that increase student learning (see Table 6 for a complete list).

The researcher used SPSS Statistics version 20 for the Macintosh to analyze the data. The criterion variable instructor use of best practices in teaching remedial mathematics and its three subscales, best practice behaviors, best practice techniques, best practice multiple representation/tool use was recorded as a Likert scale, with responses ranging from frequently (4), occasionally (3), rarely (2), and never (1). The data were recorded as values, then the total value was recorded to represent the viewpoints of the respondents (Alreck & Settle, 2004). The predictor variables were grouped into blocks in the data analysis procedure, including input variables—instructor demographics (Block 1)—and environmental variables of institutional characteristics (Block 2), institutional policies and procedures related to academic support, and student support (Block 3), faculty development (Block 4) (see Table 4).
Table 4

*Input and Environmental Variables*

<table>
<thead>
<tr>
<th>Block and Variable Type</th>
<th>Variable Description</th>
</tr>
</thead>
</table>
| **Block 1: Input Variables-Instructor Demographics** | • Degree  
• Years of Experience  
• Years of experience teaching remedial math  
• Hours required to teach  
• Required office hours |
| **Block 2: Environmental Variables Institutional Characteristics** | • Enrollment  
• Multi-campus  
• Rural or urban  
• Commuter or residential  
• Amount spent on instruction  
• Financial Aid |
| **Block 3: Institutional Policies and Procedures** | • Advising/Counseling  
• Orientation  
• Learning Community  
• Tutoring  
• Location  
• Faculty or student tutors  
• Supplemental Instruction  
• Study skills course  
• Administrative structure-remedial education  
• Mandatory placement  
• Course delivery format |
| **Block 4: Professional Development** | • Professional conferences/workshops  
• Professional remedial educators’ websites  
• Webinars  
• Graduate courses  
• Reading journal articles  
• Faculty development organized by community college  
• Informal collaboration with colleagues on campus  
• Informal collaboration with off-campus colleagues  
• Formal collaboration with colleagues on campus |
Limitations of the Study

The study was limited because it only pertains to community college faculty members teaching remedial mathematics who are also members of AMATYC or MichMATYC. The results cannot be generalized to faculty teaching at four-year colleges and universities. The sample in the survey was a sample of convenience, the members of AMATYC and MichMATYC. Community college faculty who are not members of AMATYC or MichMATYC did not have the opportunity to respond to the survey, thereby introducing another limitation. There could also be non-response bias in that participants who responded to the survey may not share the same views as the individuals who did not respond to the survey. Although the survey was created based on a thorough literature review, the researcher created the survey of structured response questions, which may not have been an exhaustive list of all possible responses.

Summary

The chapter restated the survey questions of the factors that may influence an instructor’s use of best practices in teaching remedial mathematics at the community college, the criterion variable. A 29-question email survey was sent to 2,500+ AMATYC and MichMATYC members. Qualtrics software was used to create a data set. A blocked form of stepwise, multiple regression was used to analyze the data, based on Astin’s I-E-O model, to determine which predictor variables, if any, influence the criterion variable. The predictor variables studied were instructor demographics, community college environment, policies and procedures of the community college in the context of student services, academic support services, faculty working conditions, and faculty development. The administrative structure of developmental education at the community
college, and the methods faculty personally employ for professional development, were included as predictor variables. The study was limited because it was a sample of convenience, and because the survey questions were structured response questions.

**Overview of Upcoming Chapters**

Chapter Four gives the details and summarizes the findings of the study. Chapter Five offers observations about the significance of the findings of the study, and proposes future research.
Chapter 4

Results of Data Analysis

The results of data collection and analysis are presented in chapter four. The purpose of this study was to examine community college remedial mathematics instructor’s use of best practices in teaching remedial mathematics. Results of this study may be used to understand the variables that influence an instructor’s use of best practices. In addition, the results may be used to help inform administrator and remedial mathematics instructor training in best practices.

This chapter first describes the rationale for the study, the method that was used to collect the data and a description of the sample population to whom the survey was sent. A brief description of the theoretical framework, developmental theory, and the conceptual frameworks, Seven Principles for Good Practice in Undergraduate Education and Astin’s Input, Environment, Output Model are given. Descriptive statistics based on the data analysis follow. The descriptive statistics are delineated by each block of the data analysis model, instructor demographics (block 1), institutional characteristics (block 2), institutional policies and procedures (block 3), and professional development (block 4). Next, the inferential analysis is reported, beginning with a description and rationale of the criterion variable and its subscales, followed by the regression analysis results. Contributions of the variable blocks, based on the relative amount of variance explained by each step, are given. The chapter concludes with a summary of the data analysis by research question and an overview of chapter 5.
Overview

The rationale of this study was to determine which community college environmental factors, if any, influence the use of best practices in teaching remedial mathematics among community college remedial mathematics instructors. Literature pertaining to best practices for remedial mathematics students’ success abounds, but there is little evidence about the components that influence instructor use of these best practices in teaching remedial courses, in particular, remedial mathematics. After a thorough literature review of best practices in teaching remedial mathematics, the researcher constructed a 29-question structured response survey using Qualtrics survey software.

An email survey was sent to the members of AMATYC and MichMATYC. AMATYC is a nationwide association for advancing teaching mathematics at two-year colleges, and MichMATYC is a state affiliate of AMATYC. It was determined that an email survey was appropriate because the survey participants are professionals who routinely use the Internet (Alreck & Settle, 2004; McMillan, 2007).

The theoretical framework that guided the research was Developmental Theory. The goal of Developmental Theory is to serve different types of developmental students through an effective educational environment, based on the components of self-regulation, demandingness, and responsiveness (Wambach, Brothen, & Dikel, 2000). In addition, one of the conceptual frameworks utilized was Chickering and Gamson’s (1987) Seven Principles for Good Practice in Undergraduate Education. The purpose of the Seven Principles is to improve teaching and learning in colleges and universities. The second conceptual framework was Astin’s (2002) I-E-O Model.
Astin’s (2002) I-E-O Model was chosen because Astin commented the model was developed for use with “natural experiments” (p. 28). Natural experiments study phenomena that are naturally occurring, in contrast to a true experiment that has a control group and a treatment group. The model explores the influence, if any, that the input and the environmental variables have on the outcome variable (Astin, 2002).

Using the I-E-O Model predictor variables were organized into four blocks for the analysis. The input block contained instructor demographics and three separate environmental blocks -- institutional characteristics retrieved from IPEDS data, institutional policies and procedures, and faculty development. The output block contained the criterion variable, instructor use of best practices.

Following Astin’s I-E-O Model, a series of regression analyses were conducted to test the following research questions.

1. What instructor demographics, if any, influence instructor use of best practices in teaching remedial mathematics?
2. What institutional characteristics, if any, influence instructor use of best practices in remedial mathematics?
3. What institutional policies and procedures, if any, influence instructor use of best practices in remedial mathematics?
4. Which methods of faculty development, if any, influence instructor use of best practices in remedial mathematics?

In order to assess the influence of instructor demographics and environmental factors on the use of best practices, a blocked form of stepwise multiple regression analysis was conducted in which instructor demographics were entered in the first step
(block 1) and the environmental variables, were entered in subsequent blocks, including institutional characteristics (block 2), institutional policies and procedures (block 3), and faculty development (block 4). The following section further describes the method and analysis of the research survey.

**Methodology**

The researcher emailed 1,472 surveys using the email lists provided by AMATYC and MichMATYC accompanied by the introductory letter to the survey population (Appendix B). Three weeks later a reminder email was sent to the members with introductory letter to the survey population #2 (Appendix C). When the number of responses was below the required number of responses, the researcher attended a MichMATYC conference, and handed out 30 paper copies of the survey. Nineteen of the surveys were returned. A total of 1,502 surveys were distributed, and 306 were completed, for an overall response rate of 20.4%. The participants represented 37 states and 1 US Territory, Guam, 137 community colleges, and six 4-year institutions.

Twenty-two participants represented 18 community colleges in California, and 68 participants represented 16 community colleges and two 4-year institutions in Michigan. The states of New York and Illinois each had participants representing 9 community colleges by 14 and 11 individuals respectively. Appendix D lists the states that were represented in the survey responses, the number of institutions represented by the respondents, and the number of individuals responding to the survey.

Participants who did not teach remedial mathematics were excluded from the data analysis (N = 33), as well as the six respondents from 4-year institutions. Surveys that
were not complete were also excluded, resulting in a final sample size of 194. Full-time and adjunct faculty members were included in the analysis.

**Descriptive Analysis**

**Block 1: Instructor demographics.** The first block examined instructor demographics, as measured by nine questions, number of years experience teaching remedial mathematics, the number of years the instructor has taught at the community college level, the highest degree earned, full-time or part-time instructor, had taken courses in or were familiar with mathematics teaching methods, and had taken K-12 or adult teaching methods courses.

The number of years teaching remedial mathematics ranged from less than 1 to 50 years, with a mean of 14.40 years ($Mdn = 11.00$, $SD = 10.20$). The number of years teaching in a community college ranged from less than 1 to 46 years, with a mean 14.81 years ($Mdn = 12.00$, $SD = 10.05$). The majority of instructors had earned Master’s degrees, 69.2%, followed by PhD, 18.1%, and 3.8% held a Bachelor’s degree. More than 80% of the instructors were full-time instructors, and 72.9% of the participants had taken courses in methods of teaching mathematics. In addition, 65.3% had taken courses in K-12 or adult teaching methods.

**Block 2: Institutional characteristics.** The second block examined the characteristics of the community college, as measured by 11 questions. Community colleges were analyzed using IPEDS data and Carnegie classification. The community colleges in the sample were rural, urban, and suburban, 33.5%, 27.8%, and 38.8%, respectively. The mean percentage of students receiving Pell grant support was 39.2 ($Mdn = 39$, $SD = 11.97$), and the mean percentage of students receiving any type of
financial assistance was 51.47 ($Mdn = 50.00, SD = 13.91$). The mean number of full-time instructors was 189.58 ($Mdn = 163.00, SD = 129.48$) and the mean number of part-time instructors was 508.73 ($Mdn = 452.00, SD = 359.39$). The mean total student enrollment was 12,585 ($Mdn = 11,204, SD = 9064$). The variables type of institution, the percentages of students receiving Pell grant support, or any financial assistance, the percentage of full-time instructors, and the student headcount enrollment for each institution were assessed.

In addition, the proportion of the college funding allocated to academic support, institutional support, student services, instruction, public service and research were measured. Academic support received a mean percent of 10.47 ($Mdn = 10.00, SD = 6.13$), the mean percentage of institutional support was 15.56 ($Mdn = 15.00, SD = 5.71$), and the mean percentage for student services was 11.81 ($Mdn = 12.00, SD = 3.64$) of college funding. Instruction was the largest percentage of the budget, with a mean of 47.71% ($Mdn = 50.00, SD = 6.76$) and the smallest proportion of the budget was spent on public service, mean 1.61 ($Mdn = 1, SD = 2.02$) and research, mean .04 ($Mdn = 0.00, SD = .25$).

**Block 3: Institutional policies and procedures.** Block 3 used seventeen questions to assess the institutional policies and procedures governing the campus and instructors. The result of the descriptive statistics analysis indicated the average campus provided a variety of academic services to remedial mathematics students (supplemental instruction = 63%, structured learning assistance = 50.6%, video-based supplemental instruction = 50.6%, peer cooperative learning = 28.7%, peer-led team learning = 8.4%). In addition, 9.4% of the remedial mathematics tutoring was led by faculty, whereas
13.8% was led by student tutors; 53.6%, was led by both students and faculty tutors, and the remaining 23.2% provided tutoring by other means. At the same time, remedial students met with their academic counselors on average less than once per semester ($M = .29, Mdn = 0, SD = .46$).

Most (82.3%) institutions had study/college skills courses. For the colleges that had a study skills course, 14.3% required it for all students, 13.9% required it for all remedial students, 9.7% required it for students on academic probation, 11.8% required it for all students on academic probation and or all remedial students, and 34.2% required it for all students. The majority (93.2%) of community colleges gave placement tests to determine the courses in which the students should enroll. If it was determined the student needed to enroll in remedial mathematics, 19.8% of the institutions mandated the students enroll in the remedial mathematics course.

Approximately one-fifth (21.9%) of community colleges organized their students into a cohort group or learning community. Generally, institutions provided an orientation (86.9%) for new students. Thirty-four percent required all students to attend orientation, 37.9% responded it was optional for all students, and 9.2% required it for all remedial students.

The course delivery format of remedial mathematics varied. The most common formats for remedial mathematics courses were: traditional lecture (69.2%), on-campus self-paced computer-assisted instruction (43.5%), hybrid (35.9%), distance learning (28.3%), and 10.1% of institutions reported using other course formats. However, many colleges reported using multiple formats for the same remedial mathematics course.
Institutional policies relating to remedial mathematics instructors in terms of number of contact hours or credit hours required to teach, as well as the number of office hours the instructor was required to hold were analyzed. Instructors were required to teach a mean of 15.72 contact hours ($Mdn = 15$, $SD = 10.89$), and 13.02 credit hours ($Mdn = 15$, $SD = 5.21$). The instructors reported they were required to teach fewer remedial contact hours ($M = 13.53$, $Mdn = 9.00$, $SD = 14.69$), but notably less credit hours, ($M = 9.72$, $Mdn = 8.00$, $SD = 6.95$). The requisite mean number of office hours was approximately 5 per week ($M = 5.22$, $Mdn = 5.00$, $SD = 3.25$).

**Block 4: Professional development.** The fourth block used nine items that assessed the level instructors were participating in professional development. They were asked to report the activities they engaged in to become skilled in teaching remedial mathematics. Instructors responded on a 4-point Likert scale (1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Frequently) the extent they were engaged in the following activities: Professional conferences/workshops, professional remedial educator’s websites, webinars, graduate courses, reading journal articles, faculty development for remedial instructors, informal collaboration with on-campus colleagues, formal collaboration with on-campus colleagues, and informal collaboration with off-campus colleagues.

‘Frequently’ was defined as engaging in a practice at least once a week per semester. The item-total correlations for these nine items were all greater than .36, so these items were standardized and summed to form an index of faculty development, where higher scores indicated higher levels of faculty development ($\alpha = .78$).
Inferential Analysis

To assess the research questions, regressions were conducted with four distinct measures of best practices, including teaching techniques (e.g., I assign in-class group work, I assign out-of-class individual student work), the use of multiple representations/tool use (graphic or numerical use of concept, calculator, software use), behaviors associated with best practices (e.g., I regularly boost students’ self-esteem, I arrange the classroom so it is easy for the students to interact), and an overall composite measure of the three. Following the recommended analysis strategy of Astin & Sax (1998), these criterion measures were regressed on sequential blocks of predictors that assessed the predictive ability of instructor demographics, institutional characteristics, professional development and institutional policies and procedures (see Figure 1).

Missing Values

A large number of instructor demographics and environmental factors were included in the analyses of best practices in teaching remedial mathematics. In order to minimize the impact of missing data on the statistical power of the model, single imputation mean replacement was used for missing values. This replacement method was chosen because of its convenience, and the assumption that values in the predictors were missing completely at random (MCAR; Graham, 2009). Missing values affected up to 34.5% of the cases in the variables included in the regression model. However, when non-significant \((p > .10)\) predictors were dropped from the regression model as a result of the forward step-wise procedure, no more than 3.6% of significant predictors were missing. The inferential statistics reported reflect the use of mean replacement for predictor, but not criterion variables. The descriptive statistics reported in this analysis
do not reflect the replacement of missing values, due to the bias in variability introduced by the mean replacement technique (Field, 2009; Hayes, 1994; Tabachnick & Fidell, 2007; Warner, 2013).

**Criterion Variables**

There were three sets of survey questions, 33 items in total, which were designed to assess the extent that remedial mathematics instructors engaged in best practices. All items were measured using a 4-point scale (1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Frequently) in which respondents were asked to report the extent that they engaged in best practices when teaching remedial mathematics. *Frequently* was defined as engaging in a practice at least once a week per semester (see Table 6 for items). Item analysis revealed that the items assessing the use of best practices differed in their level of variability, therefore these items were standardized in order to increase the overall reliability of the criterion variables.

Best practices in teaching remedial mathematics is a broad construct that can be separated into three separate groups, namely best practice behaviors, best practice techniques, and best practice multiple representation and tool use. Each distinct category has its own merits and possibly its own unique set of predictors, different than the predictors that predict overall use of best practices. The best practice behaviors are best described as student-faculty interaction, which scholars have shown is beneficial for student success (Astin, 1993, 1996, 1999; Chickering & Gamson, 1987; Smittle, 2003; Thompson, 2001; Tinto, 1997, 2002). The best practice techniques are the methods the instructor employs to encourage student learning (Barret, Bower, & Donovan, 2007; Bonham & Boylan, 2010; Boylan, 2002; Fowler & Boylan, 2010; Hodara, 2011; US
Lastly, the best practice multiple representation and tool use is the utilization of various representations of a mathematical concepts through graphical, numerical, and real world analyses, in addition to, using tools such as a calculator or software, are valuable tools that increase student learning (Ball, et al., 2005; The Education Alliance, 2006; Vande Walle, Karp, & Bay-Williams, 2012).

The rationale for including these best practice behaviors, best practice techniques, and best practice multiple representation/tool use subscales is that by including these subscales there is more predictive accuracy in addressing certain aspects of best practices. This is important because it shows a) that not all best practices are related to the same predictors, and b) from a practical perspective, administrators or researchers might need to know which predictors are related to which outcomes. For example, if administrators feel as though they need to encourage their instructors to make better use of technology available to them for classroom use, yet there is a limited budget for faculty development, then the administrators need to know the best method for faculty development in the use of technology, whether it is attending conferences, participating in webinars, or encouraging collaboration with other faculty, while remaining fiscally responsible.

Therefore, it is important to analyze these scales separately because the predictors may differ between them. An overall measure of best practices is also useful, but may miss some of the detail that examining the best practices separately may provide. The empirical data that support analyzing the best practices as three separate categories is straightforward. As a group of measures the data possess acceptable internal validity ($\alpha=.70$), which suggests the individual categories of best practices are inter-related and
the scale is reliable. However, the subscales also possess high reliability and appear to measure distinct aspects of the criterion variable (see Table 5).

Table 5

*Correlation Matrix and Reliability of Criterion Variables*

<table>
<thead>
<tr>
<th></th>
<th>Behaviors</th>
<th>Techniques</th>
<th>Multiple Representation/Tool Use</th>
<th>Overall Best Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviors</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Techniques</td>
<td>.50</td>
<td>1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Multiple Representations/Tool Use</td>
<td>.52</td>
<td>.47</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>Overall Best Practices</td>
<td>.83</td>
<td>.81</td>
<td>.80</td>
<td>1</td>
</tr>
<tr>
<td>Cronbach’s Alpha</td>
<td>α = .75</td>
<td>α = .73</td>
<td>α = .74</td>
<td>α = .85</td>
</tr>
<tr>
<td>Number of Items</td>
<td>N = 16</td>
<td>N = 11</td>
<td>N = 6</td>
<td>N = 33</td>
</tr>
</tbody>
</table>

*Note.* All correlations are significant *p* < .05.

**Behaviors associated with best practices.** The first set of questions on the survey instrument asked instructors to report whether they engaged in a range of specific behaviors that were associated with best practices in teaching remedial mathematics.

There were 16 possible behaviors that each instructor could report, ranging from providing emotional support to individual students (e.g., I regularly boost students’ self-esteem) to arranging the physical layout of the classroom (e.g., I arrange the classroom so
it is easy for the students to interact). These items were standardized and summed to form a reliable scale \( (\alpha = .75) \) of best practice behaviors.

**Teaching techniques associated with best practices.** The second set of questions assessed the self-reported use of specific teaching techniques among instructors. There were 11 techniques listed that assessed both in-class (e.g., I assign in-class group work) and out-of-class practices (e.g., I assign out-of-class individual student work). These items were also standardized and summed to form a reliable scale of best practice teaching techniques \( (\alpha = .73) \).

**Concept representation and tool use associated with best practices.** The third set of questions consisted of 6 items that assessed the self-reported frequency that instructors required students to represent concepts with graphics, numbers, and with simulations, as well as the extent to which the instructors required students to use particular instruments, such as mathematics software, calculators, and manipulatives. These items were standardized and summed to form a reliable scale of concepts and tools related to best practices \( (\alpha = .74) \).

**Overall use of best practices.** While the three measures that were described in the preceding three paragraphs reliably measure different components of best practices, they were all sufficiently inter-correlated \( (r’s > .46, p-values < .01) \) to warrant combining the items from each scale to form an overall measure of best teaching practices \( (\alpha = .85) \). For a listing of all of the items that were included to create this criterion variable, see Table 6 and Figure 1.
Assessing the Research Questions

**Regression analyses.** To examine the relationship between instructor demographics, institutional characteristics, institutional policies and procedures, and professional development on the use of best practices, predictors were organized into sequential blocks corresponding with instructor demographics, institutional characteristics, institutional policies and procedures, and professional development. Consistent with the recommendations of Astin & Sax (1998), a forward, step-wise entry method with entry and removal tolerances of $p = .05$ and $p = .10$ respectively, was used within each block. Dichotomous and multi-level categorical variables were dummy coded into the appropriate number of variables and were regressed along with continuous variables on self-reported measures of best practices.

The survey data were analyzed using causal analytical modeling via blocked regression analysis (CAMBRA) a form of step-wise linear multiple regression. The predictor variables were entered by blocks based on the I-E-O model and the research questions. Input block variables were analyzed first. Astin (2002) commented “it is important to control for the effects of the inputs before attempting to assess the effects of the environmental characteristics” (p. 233). The variables corresponding to the three environmental blocks (Institutional Characteristics, Institutional Policies and Procedures, and Faculty Development) followed. Statistical Product and Service Solutions 20 (SPSS) software package was used to complete the step-wise linear regression analysis. Each of the 46-predictor variables was entered one at a time in the order they occurred in the model. The predictor variables entered the equation if they met the $p$-value entry criteria of .05. The regression analysis continued entering one variable at a time until the
predictive power of the variables in the first block was exhausted. The regression analysis then moved forward to the next block entering one variable at a time until the predictive power of the variables in the second environmental block were exhausted. The analysis continued in the same fashion for the next two environmental blocks. This method maximizes the $R^2$ (Astin, 2002).

What follows is a discussion of this analysis for each of the four self-reported measures of best practices.

**Behaviors associated with best practices.** Regression analysis showed six significant predictors of the 16-item measure of best practice behaviors ($\alpha = .75$). The variance inflation factor (VIF) ($>1.0 < 1.27$), tolerance ($<.98$) and condition index values ($<27$) indicated that multicollinearity was not likely to have biased the model. While no question within the institutional characteristics block predicted behaviors associated with best practices ($p$-values $>.05$), there were significant predictors in each of the remaining steps. The instructor demographic that was positively associated with best practice behaviors was self-reported familiarity of multiple representations of concepts, $\beta = .19, p = .007$. Related to institutional policies and procedures, the total number of supplemental learning services available to students, including supplemental instruction, structured learning assistance, video-based instruction, peer-led cooperative learning, and peer-led team learning was associated with increased best practice behaviors, $\beta = .18, p = .004$. Mandating remedial students to enroll in a study skills course, $\beta = .13, p = .031$, was also related to increased use of best practice behaviors. Professional development activities associated with increased best practice behaviors
were reading journal articles, $\beta = .24, p = .001$, and attending webinars, $\beta = .16, p = .020$ (see Table 7).

**Techniques associated with best practices.** To determine the predictors of best practice teaching techniques, the 11-item self-reported scale of teaching techniques ($\alpha = .73$) was regressed on the demographic and environmental predictors. Identical to the analysis of best practice behaviors, this regression model used forward stepwise entry into sequential blocks representing instructor demographics, institutional characteristics, institutional policies and procedures, and professional development.

This analysis revealed seven predictors of teaching techniques associated with best practices. The VIF ($> 1.0 < 1.31$), tolerance ($< .97$) and condition index values ($< 29$) indicated that multicollinearity was not likely to have biased the model. Among the instructor demographics block, the familiarity of multiple representations of concepts, $\beta = .17, p = .01$, and having taken a course in the teaching of mathematics methods, $\beta = .15, p = .018$, both predicted greater use of best practice teaching techniques. Results of this model show that while none of the questions within the institutional characteristics step predicted best teaching practices, $p$-values $> .10$, two items from the institutional policies and procedures block were significant. A mandatory requirement for students identified as needing assistance in mathematics to enroll in a remedial mathematics course, $\beta = .17, p = .005$, and the number of hours students spent meeting with their advisors, $\beta = .17, p = .010$, were positively related to best teaching techniques. Within the professional development block, having taken graduate courses, $\beta = .17, p = .013$, and reading journal articles, $\beta = .19, p = .005$, were both associated with increased self-reported best practices techniques (see Table 8).
Table 6

Criterion Variable Best Practices

<table>
<thead>
<tr>
<th>Best Practices</th>
<th>Variables</th>
</tr>
</thead>
</table>
| **Behaviors associated with best practices** | • I meet with students during posted office hours  
• I meet with students outside of posted office hours  
• I require individual students to meet with me during posted office hours  
• I communicate with students by email, social media, or telephone  
• I communicate with students individually on their academic progress  
• I informally counsel students outside of class  
• I arrange the classroom so it is easy for the students to interact  
• I enforce due dates for assignments as set forth in the syllabus  
• I use a variety of assessments to evaluate students  
• I use tests as the primary method of evaluating students  
• I determine educational objectives for each student  
• I provide students with knowledge  
• I serve as a resource person for students  
• I change instructional objectives in the course based on assessment of student learning  
• I regularly boost students’ self-esteem  
• I serve as a coach to students |

| **Teaching techniques associated with best practices** | • I assign in-class group work  
• I assign in-class individual student work  
• I assign out-of-class group work  
• I assign out-of-class group projects  
• I assign students to a semester-long group in which to work  
• I assign individual student out-of-class projects during the semester  
• I assign a mathematics-related research/essay during the semester  
• I have student-led lessons  
• I give low-stakes assessments  
• I assign out-of-class individual student work  
• I require mastery learning for each student |

| **Concept representation and tool use associated with best practices** | • Represent a concept graphically  
• Represent a concept numerically  
• Use real world examples to represent a concept  
• Use mathematics software  
• Use a calculator  
• Use manipulatives |

*Note.* All items were measured using a 4-point Likert scale (1=Never, 2=Rarely, 3=Occasionally, 4=Frequently)
Table 7

Behaviors Associated with Best Practices

<table>
<thead>
<tr>
<th>Block 1: Instructor Demographics</th>
<th>Final β</th>
<th>Step β</th>
<th>Final zero Order R</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Familiarity with multiple representations of a concept</td>
<td>.33</td>
<td>.33***</td>
<td>.19**</td>
<td>22.67***</td>
</tr>
<tr>
<td>2- Familiarity with multiple teaching technologies</td>
<td>.30</td>
<td>.21***</td>
<td>.11</td>
<td>15.71***</td>
</tr>
</tbody>
</table>

Block 3: Institutional Policies and Procedures

<table>
<thead>
<tr>
<th>Block 3: Institutional Policies and Procedures</th>
<th>Final β</th>
<th>Step β</th>
<th>Final zero Order R</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>3- Available Services</td>
<td>.27</td>
<td>.22**</td>
<td>.18**</td>
<td>14.49***</td>
</tr>
<tr>
<td>4- Mandatory enrollment in a study skills course for remedial students</td>
<td>.19</td>
<td>.16*</td>
<td>.13*</td>
<td>12.57***</td>
</tr>
</tbody>
</table>

Block 4: Faculty Development

<table>
<thead>
<tr>
<th>Block 4: Faculty Development</th>
<th>Final β</th>
<th>Step β</th>
<th>Final zero Order R</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>5- Reading Journal Articles</td>
<td>.39</td>
<td>.29***</td>
<td>.24**</td>
<td>15.14***</td>
</tr>
<tr>
<td>6- Attending Webinars</td>
<td>.30</td>
<td>.16*</td>
<td>.16*</td>
<td>13.83***</td>
</tr>
</tbody>
</table>

Note: *p < .05; **p < .01; ***p < .001

Multiple representation/tool use associated with best practices. The regression model revealed nine predictors of the six-item measure of multiple representations and tool use (α = 74) associated with best practices. The VIF (> 1.0 < 1.33), tolerance (< .98) and condition index values (< 30) for this model indicated that multicollinearity was not likely to have biased the model. Among the instructor demographics block, the familiarity of hands on learning and manipulatives, \( \beta = .23, p = \)
.01, and being familiar with multiple technologies, $\beta = .15, p = .030$, predicted increased use of multiple representations and tool use associated with best practices. The only significant predictor in the institutional characteristics block was the percentage of expenditures allocated to research which, surprisingly, was inversely related to best practices, $\beta = -.17, p = .005$. Within the institutional policies and procedures block, requiring remedial students to attend a study skills course, $\beta = .13, p = .028$, and attending a hybrid format course, $\beta = .14, p = .021$, were positively related to multiple representations and tool use associated with best practices. Within the professional development block, the use of professional remedial educator websites, $\beta = .17, p = .013$, and formal collaboration with colleagues on campus, $\beta = .19, p = .005$, indicated increased use of multiple representations and tool use associated with best practices (see Table 9).

**Overall use of best practices.** There were nine significant predictors of the overall measure of best practices ($\alpha = .85$). As with the previous analysis, VIF (> 1.0 < 1.33), tolerance (< .96) and condition index values (< 34) showed that multicollinearity was not likely to have biased the regression model. Within the instructor demographics block, self-reported familiarity with multiple representations of a concept, $\beta = .15, p = .02$, coursework in mathematics teaching methods, $\beta = .13, p = .030$, and familiarity with multiple technologies in teaching mathematics, $\beta = .15, p = .02$, all predicted increased use of best practices. There were no significant predictors of best practices associated with institutional characteristics ($p$-values > .10). However, within the institutional policies and procedures block, requiring remedial students to attend a study skills course, $\beta = .16, p = .006$, and availability of supplemental learning services offered to students, $\beta$
=.13, \( p = .025 \), were associated with increased best practices. Within the professional development block, reading journal articles, \( \beta = .26, \ p < .001 \), and informal collaboration with colleagues on campus, \( \beta = .14, \ p = .027 \), were associated with increased levels of self-reported best practices (see Table 10).

Table 8

*Teaching Techniques Associated With Best Practices*

<table>
<thead>
<tr>
<th>Block 1: Instructor Demographics</th>
<th>Final Zero Order ( R )</th>
<th>Step ( \beta )</th>
<th>Final ( \beta )</th>
<th>( F )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Familiarity with hands-on learning/manipulatives</td>
<td>.30</td>
<td>.30***</td>
<td>.12</td>
<td>18.77***</td>
</tr>
<tr>
<td>2. Coursework on teaching mathematic methods</td>
<td>.27</td>
<td>.22**</td>
<td>.15*</td>
<td>15.19***</td>
</tr>
<tr>
<td>3. Familiarity with multiple representations of a concept</td>
<td>.30</td>
<td>.22**</td>
<td>.17*</td>
<td>13.77***</td>
</tr>
</tbody>
</table>

Block 3: Institutional Policies and Procedures

| 4. Hours meeting with advisor outside of class time | .23 | .22** | .17** | 13.97*** |
| 5. Mandatory enrollment in remedial mathematics | .23 | .18** | .17** | 13.14*** |

Block 4: Professional Development

| 6. Reading Journal Articles | .39 | .24*** | .19** | 13.73*** |
| 7. Attending Webinars | .30 | .17* | .17* | 13.00*** |

*Note. \( p < .05 = *; \ p < .01 = **; \ p < .001 = *** \)
Table 9  
*Multiple Representations/Tool Use*

<table>
<thead>
<tr>
<th>Block/Step with Predictor Variable Entering</th>
<th>Final Zero Order R</th>
<th>Step $\beta$</th>
<th>Final $\beta$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1: Instructor Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Familiarity with hands on learning/manipulative</td>
<td>.37</td>
<td>.37***</td>
<td>.23</td>
<td>30.15***</td>
</tr>
<tr>
<td>2. Familiarity with multiple representations of a concept</td>
<td>.31</td>
<td>.21**</td>
<td>.13</td>
<td>20.29***</td>
</tr>
<tr>
<td>3. Familiarity with multiple teaching technologies</td>
<td>.16</td>
<td>.16*</td>
<td>.15*</td>
<td>15.24***</td>
</tr>
<tr>
<td>Block 2: Institutional Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Percentage of expenditures allocated to research</td>
<td>-.15</td>
<td>-.18**</td>
<td>-.17**</td>
<td>13.84***</td>
</tr>
<tr>
<td>Block 3: Institutional policies and procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Required attendance to study skills course for remedial students</td>
<td>.23</td>
<td>.20**</td>
<td>.13*</td>
<td>13.56***</td>
</tr>
<tr>
<td>6. Hybrid (vs. other) class formats</td>
<td>.17</td>
<td>.15*</td>
<td>.14*</td>
<td>12.61***</td>
</tr>
<tr>
<td>7. Required attendance to study skills course for all students</td>
<td>.09</td>
<td>.14*</td>
<td>.11</td>
<td>11.72***</td>
</tr>
<tr>
<td>Block 4: Professional Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Use of remedial educator websites</td>
<td>.33</td>
<td>.20**</td>
<td>.18**</td>
<td>12.12***</td>
</tr>
<tr>
<td>9. Formal collaboration with colleagues on campus</td>
<td>.32</td>
<td>.16*</td>
<td>.16*</td>
<td>11.75***</td>
</tr>
</tbody>
</table>

*Note: $p < .05 = *; p < .01 = **; p < .001 = ***$*
Relative Contributions of the Variable Blocks

As mentioned previously, the variables were entered into the step-wise linear multiple regression one at a time, based on their placement in the I-E-O Model. The criterion variable best practices was separated into three subscales, best practice behaviors, best practice techniques, and best practice multiple representation/tool use. These three subscales, as well as, overall best practices, were analyzed.

The amount of total variance in the criterion variable subscale best practice behaviors (e.g. I meet with students during posted office hours, I communicate with students by email, telephone or social media) explained by the final regression model was 29% using the cumulative adjusted $R^2$ ($p < .001$). Based on the analysis of the change in $R^2$ attributed to each block in the final model of best practice behaviors, Table 11 shows a summary of the relative contributions of each block in the total explanation of variance in best practice behaviors. The instructor demographic, familiar with multiple representations of a concept explained 11% of the change in $R^2$ variance. Reading journal articles (block 4 Faculty Development) accounted for 8% ($p < .001$) of change in $R^2$, followed by available services to students (e.g. SI, video based tutoring) explaining 5% ($p < .01$) of the change in $R^2$. Mandatory enrollment of remedial students in a study skills course, as well as attending webinars accounted for 2% of the change in $R^2$ ($p < .05$).
Table 10

*Overall Self-Reported Best Practices*

<table>
<thead>
<tr>
<th>Block/Step with Predictor Variable Entering</th>
<th>Final Zero Order $R$</th>
<th>Step $\beta$</th>
<th>Final $\beta$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Block 1: Instructor Demographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Familiarity with multiple representations of a concept</td>
<td>.38</td>
<td>.38***</td>
<td>.15</td>
<td>32.09***</td>
</tr>
<tr>
<td>2. Familiarity with hands on learning/manipulatives</td>
<td>.36</td>
<td>.26***</td>
<td>.11</td>
<td>24.44***</td>
</tr>
<tr>
<td>3. Coursework in mathematics teaching methods</td>
<td>.23</td>
<td>.16**</td>
<td>.13*</td>
<td>18.89***</td>
</tr>
<tr>
<td>4. Familiarity with multiple teaching technologies</td>
<td>.35</td>
<td>.17*</td>
<td>.13*</td>
<td>15.81***</td>
</tr>
<tr>
<td><strong>Block 3: Institutional Policies and Procedures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Required attendance to study skills course for remedial students</td>
<td>.23</td>
<td>.21**</td>
<td>.16**</td>
<td>15.53***</td>
</tr>
<tr>
<td>6. Hours meeting with advisor outside of class time</td>
<td>.26</td>
<td>.18**</td>
<td>.11</td>
<td>14.93***</td>
</tr>
<tr>
<td>7. Availability of supplemental learning services</td>
<td>.26</td>
<td>.13*</td>
<td>.13*</td>
<td>13.75***</td>
</tr>
<tr>
<td><strong>Step 4: Professional Development</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Reading journal articles</td>
<td>.46</td>
<td>.29***</td>
<td>.26***</td>
<td>16.09***</td>
</tr>
<tr>
<td>9. Informal collaboration with colleagues on campus</td>
<td>.30</td>
<td>.14*</td>
<td>.14*</td>
<td>15.16***</td>
</tr>
</tbody>
</table>

*Note:* $p < .05 = *$; $p < .01 = **$; $p < .001 = ***$

The amount of variance in the final model of the criterion variable subscale best practice techniques (e.g. I assign in class group work, - I have student-led lessons) explained by the final regression model was 30%, based on the cumulative adjusted $R^2 (p < .001)$. Table 12 shows a summary of the relative contributions of each block based on
the analysis of change in $R^2$ attributed to each block of variables in the final model best practice techniques. Familiarity with hands on learning/manipulatives (Block 1 Instructor Demographics) accounted for 9% of the change in $R^2$ variance. The instructor demographic coursework in mathematics teaching methods, the institutional policy and procedure requiring a student to meet with an advisor, and professional development variable reading journal articles explained 5% ($p < .01$) of the change in $R^2$ variance.

The third criterion variable subscale best practices multiple representations/tool use (e.g. calculators, software) amount of final variance by the final model was 33% ($p < .001$) using the final cumulative adjusted $R^2$. The final analysis of change in $R^2$ attributed to each block of variables in the final model of the third subscale best practices multiple representation/tool use, Table 13 shows a summary of the relative contributions of each blocked based on the analysis of change in $R^2$. The instructor demographic familiarity with hands on learning/manipulatives accounted for 14% change in $R^2$ ($p < .001$). The institutional policies and procedures required attendance in a study skills course for remedial students, and required attendance in a study skills course for all students both explained 4% of the change in $R^2$ ($p < .01$) variance. In addition, faculty development use of remedial educators’ websites accounted for 4% of the $R^2$ ($p < .01$) variance. The institutional characteristic percentage of expenditures allocated to research was 3% of the change in $R^2$ ($p < .01$).

The criterion variable overall use of best practices amount of total variance explained by the final regression model was 40%, using the cumulative adjusted $R^2$ ($p < .001$). Familiarity with multiple representations of a concept accounted for 14% change in $R^2$ ($p < .001$). Reading journal articles explained 7% of the change in $R^2$ ($p < .001$),
followed by the instructor familiarity with hands on learning/manipulatives explaining 6% of the change in $R^2$ ($p < .001$). Institutional policy and procedure variable required attendance in a study skills course for remedial students accounted for 4% of the change in $R^2$ ($p < .01$). Table 14 shows the summary of the relative contributions of each block of variables based on the analysis of change in $R^2$.

Table 11

*Best Practices Behaviors: Incremental Contributions to $R^2$ by Predictor*

<table>
<thead>
<tr>
<th>Block 1: Instructor Demographics</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Familiarity with multiple representations of a concept</td>
<td>.11**</td>
<td>.10***</td>
</tr>
<tr>
<td>2. Familiarity with multiple teaching technologies</td>
<td>.04*</td>
<td>.13***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 3: Institutional Policies and Procedures</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Available Services</td>
<td>.05**</td>
<td>.17***</td>
</tr>
<tr>
<td>4. Mandatory enrollment in a study skills course for remedial students</td>
<td>.02*</td>
<td>.19***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 4: Faculty Development</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Reading Journal Articles</td>
<td>.08***</td>
<td>.27***</td>
</tr>
<tr>
<td>6. Attending Webinars</td>
<td>.02*</td>
<td>.29***</td>
</tr>
</tbody>
</table>

*Note: $p < .05 = *; p < .01 = **; p < .001 = ***$*
Table 12

*Best Practices Teaching Techniques: Incremental Contributions to $R^2$ by Predictor*

<table>
<thead>
<tr>
<th>Block 1: Instructor Demographics</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Familiarity with hands-on learning/manipulatives</td>
<td>.09***</td>
<td>.08***</td>
</tr>
<tr>
<td>2. Coursework on teaching mathematic methods</td>
<td>.05**</td>
<td>.13***</td>
</tr>
<tr>
<td>3. Familiarity with multiple representations of a concept</td>
<td>.04**</td>
<td>.17***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 3: Institutional Policies and Procedures</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Hours meeting with advisor outside of class time</td>
<td>.05 **</td>
<td>.21***</td>
</tr>
<tr>
<td>5. Mandatory enrollment in remedial mathematics</td>
<td>.03**</td>
<td>.24***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block 4: Professional Development</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Reading Journal Articles</td>
<td>.05**</td>
<td>.28***</td>
</tr>
<tr>
<td>7. Attending Webinars</td>
<td>.02 *</td>
<td>.30***</td>
</tr>
</tbody>
</table>

*Note. $p < .05 = *; p < .01 = **; p < .001 = ***$*
Table 13

*Multiple Representations/Tool Use: Incremental Contributions to $R^2$ by Predictor*

<table>
<thead>
<tr>
<th>Block/Step with Predictor Variable Entering</th>
<th>$\Delta R^2$</th>
<th>Cum adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1: Instructor Demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Familiarity with hands on learning/ manipulative</td>
<td>.14***</td>
<td>.13***</td>
</tr>
<tr>
<td>2. Familiarity with multiple representations of a concept</td>
<td>.04*</td>
<td>.17***</td>
</tr>
<tr>
<td>3. Familiarity with multiple teaching technologies</td>
<td>.02*</td>
<td>.18***</td>
</tr>
<tr>
<td>Block 2: Institutional Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Percentage of expenditures allocated to research</td>
<td>.03**</td>
<td>.21***</td>
</tr>
<tr>
<td>Block 3: Institutional policies and procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Required attendance to study skills course for remedial students</td>
<td>.04**</td>
<td>.25***</td>
</tr>
<tr>
<td>6. Hybrid (vs. other) class formats</td>
<td>.02**</td>
<td>.27***</td>
</tr>
<tr>
<td>7. Required attendance to study skills course for all students</td>
<td>.04**</td>
<td>.28***</td>
</tr>
<tr>
<td>Block 4: Professional Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Use of remedial educator websites</td>
<td>.04**</td>
<td>.32***</td>
</tr>
<tr>
<td>9. Formal collaboration with colleagues on campus</td>
<td>.02*</td>
<td>.33***</td>
</tr>
</tbody>
</table>

*Note: $p < .05 = *; p < .01 = **; p < .001 = ***$*
Table 14

**Overall Self-Reported Best Practice: Incremental Contributions to $R^2$ by Predictor**

<table>
<thead>
<tr>
<th>Block/Step with Predictor Variable</th>
<th>$\Delta R^2$</th>
<th>Cum. adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1: Instructor Demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Familiarity with multiple representations of a concept</td>
<td>.14***</td>
<td>.14***</td>
</tr>
<tr>
<td>2. Familiarity with hands on learning/manipulatives</td>
<td>.06***</td>
<td>.20***</td>
</tr>
<tr>
<td>3. Coursework in mathematics teaching methods</td>
<td>.03*</td>
<td>.22**</td>
</tr>
<tr>
<td>4. Familiarity with multiple teaching technologies</td>
<td>.02*</td>
<td>.24***</td>
</tr>
<tr>
<td>Block 3: Institutional Policies and Procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Required attendance to study skills course for remedial students</td>
<td>.04**</td>
<td>.27***</td>
</tr>
<tr>
<td>6. Hours meeting with advisor outside of class time</td>
<td>.03**</td>
<td>.30***</td>
</tr>
<tr>
<td>7. Availability of supplemental learning services</td>
<td>.02*</td>
<td>.32***</td>
</tr>
<tr>
<td>Step 4: Professional Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Reading journal articles</td>
<td>.07***</td>
<td>.39***</td>
</tr>
<tr>
<td>9. Informal collaboration with colleagues on campus</td>
<td>.02*</td>
<td>.40***</td>
</tr>
</tbody>
</table>

*Note: $p < .05 = *; p < .01 = **; p < .001 = ****

**Summary of Data Analyses by Research Question**

The following paragraphs report the results of the data analyses by each research question.
Question 1: What instructor demographics, if any, influence instructor use of best practices in remedial mathematics? The data analysis revealed instructors who were familiar with multiple representations of a concept were more likely to engage in best practice behaviors. Instructors were more likely to use best practice techniques if they had coursework in mathematics teaching methods. Instructors who were familiar with hands on learning and manipulatives were associated with the best practice multiple representation/tool use. The instructor demographics that were associated with overall use of best practices were instructors who were familiar with multiple representations of a concept, had coursework in mathematics teaching methods, and were familiar with multiple technologies (see Table 15).

Question 2: What institutional characteristics, if any, influence instructor use of best practices in remedial mathematics? The data analysis revealed the only institutional characteristics that influenced instructor use of best practices was the percentage of expenditures allocated to research. The percentage of expenditures allocated to research was inversely related to the best practice multiple representation/tool use. The other institutional characteristics that were analyzed were not found as significant predictors of overall best practices or the subscales best practice behaviors, and best practice techniques.

Question 3: What institutional policies and procedures, if any, influence instructor use of best practices? The data analysis revealed institutions that offered supplemental learning services such as supplemental instruction, structured learning assistance, video-based instruction, peer-led cooperative learning, and peer-led team learning as well as mandatory remedial student enrollment in a study skills course were
associated with instructors use of best practice behaviors and overall use of best practices. Institutions that required remedial students to enroll in a remedial mathematics course and the number of hours remedial students met with advisors were associated with instructor use of best practice techniques. Finally, institutions that had hybrid remedial mathematics courses and had mandatory remedial student enrollment in a study skills course were associated with instructor use of the best practice multiple representation/tool use (see Table 16).

**Question 4: Which methods of faculty development, if any, influence instructor use of best practices in remedial mathematics?** The data analysis revealed faculty who read journal articles as a method of faculty development were associated with engaging in best practice behaviors, techniques, and overall use of best practices. In addition, faculty who participated in webinars were more likely to engage in best practice behaviors, whereas faculty who had taken graduate courses were more likely to use best practice techniques. Informal collaboration with colleagues on campus influenced faculty use of overall best practices. However, faculty who engaged in best practice multiple representation/tool use was associated with use of professional remedial educator’s websites and informal collaboration with colleagues on campus (see Table 17).

**Summary**

Chapter 4 presented a rationale for the study, and the method that was used to collect the data, which was an email survey sent to the members of AMATYC and MichMATYC. A brief description of the theoretical framework Developmental Theory was given. The study was also based on two conceptual frameworks, Seven Practices for
Good Practice in Undergraduate Education, and Astin’s I-E-O Model of data analysis. Descriptive statistics were delineated by each block of the data analysis, input block Instructor demographics (block 1), environmental blocks Institutional Characteristics (block 2), Institutional Policies and Procedures (block 3), and Professional Development (block 4). The inferential analysis began with a description and rationale of the criterion variable overall best practices and its subscales, best practice behaviors, best practice techniques, and best practice multiple representation/tool use. The regression analysis results followed, and the chapter ended with a summary of the data analysis by research question.

Table 15

*Instructor Demographics Influencing Instructor Use of Best Practices*

<table>
<thead>
<tr>
<th>Instructor Demographics</th>
<th>Behaviors</th>
<th>Techniques</th>
<th>Multiple Representation Tool Use</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

111
Table 16

*Institutional Policies and Procedures Influencing Instructor Use of Best Practices*

<table>
<thead>
<tr>
<th>Institutional Policies and Procedures</th>
<th>Behaviors</th>
<th>Techniques</th>
<th>Multiple Representation Tool Use</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Services</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Remedial Students Study Skills Course</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Meeting with Advisor</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mandatory Placement Remedial Math</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hybrid Course Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Students Study Skills Course</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Table 17

Methods of Faculty Development Influencing Instructor Use of Best Practices

<table>
<thead>
<tr>
<th>Professional Development</th>
<th>Behaviors</th>
<th>Techniques</th>
<th>Multiple Representation Tool Use</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Journal Articles</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Webinars</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial Educators’ Websites</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Formal Collaboration with Colleagues</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Informal Collaboration with Colleagues</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Overview of Chapter 5

Chapter Five offers observations about the significance of the findings of the study and proposes future research.
Chapter 5

Discussion, Recommendations, and Conclusions

Chapter 4 presented the results of this study’s regression analysis that tested this study’s research questions. This chapter outlines a summary of the study, including the purpose, the theoretical framework, the conceptual frameworks, and the method in which the data were collected. Significant predictors of the criterion variables are listed. Next, a detailed discussion of the data analysis is followed by implications for theory and practice. The chapter ends with limitations of the study, recommendations for future research, conclusions, and a chapter summary.

Summary of the Study

Approximately 41% of college students enroll in remedial coursework at some point in their college career (Adelman, 2006). In 2007-2008, 42% of first-year undergraduate students attending a community college enrolled in remedial coursework. Remedial mathematics has the highest enrollment among the typical remedial courses of reading, writing, and mathematics (NCES, 2012). The purpose of this nationwide study was to investigate what influence, if any, instructor demographics, institutional characteristics, faculty development methods, and institutional policies and procedures have on instructor use of best practices in remedial mathematics. Remedial mathematics was chosen because, as stated, it is the most common subject in which students need remediation.

The theoretical framework that guided this study was Developmental Theory. Developmental Theory is based on the premise of developing the whole student through three concepts—self-regulation, demandingness, and responsiveness (Wambach et al.,
Zimmerman et al. (Wambach et al., 2000) define self-regulation as “self-generated thoughts, feelings, and actions that are directed toward attainment of one’s educational goals” (p. 3). Demandingness has its roots in the demands a parent makes on a child. An instructor makes demands on the student in the form of appropriate behavior and by requiring the student to read, write, speak, and perform operations at a mastery level (Wambach et al., 2000). Responsiveness requires the instructor to be responsive to students through such abilities as listening, resolving conflicts, initiating contact with students, and developing teaching methods that accommodate the needs of underprepared students (Wambach et al., 2000).

Two conceptual frameworks guided the study. The first was Chickering and Gamson’s (1987) Seven Principles for Good Practice in Undergraduate Education. The second was Astin’s I-E-O data analysis model.

The Seven Principles are: 1) encourage contact between students and faculty; 2) develop cooperation among students; 3) use active learning techniques; 4) give prompt feedback; 5) emphasize time on task; 6) communicate high expectations; and, 7) respect diverse talents and ways of learning. The instructor structures the classroom by requiring students to actively do mathematics through in-class group work, outside-of-class group projects, a self-paced CAI format, or via a distance learning environment. Regardless of the method, the student is actively involved in the learning process with peers and faculty while actively gaining mathematics skills.

The second conceptual framework was Astin’s (2002) I-E-O Model – Input, Environment, Output. The data were analyzed using a blocked form of step-wise regression. Astin developed this model to use with “natural experiments” (Astin, 2002,
A natural experiment studies phenomena that naturally occur, in contrast to a true experiment that has a control group and a treatment group. The model explores the influence, if any, the input and environmental variables have on the outcome variable. For the purpose of this study, the input block was instructor demographics, and the three environmental blocks were institutional characteristics, faculty development, and institutional policies and procedures. The output block contained the criterion variable – instructor use of best practices.

The data were collected via a structured response survey developed by the researcher, based on a literature review of institutional policies and procedures considered best practices, such as supplemental instruction, tutoring, learning communities, study skills courses, orientation, advising, and testing and placement procedures. Instructor behaviors, classroom techniques, and specific methods of teaching mathematics through multiple representations of concepts, and use of tools such as manipulatives, calculators, or software were considered best practices included in the survey. The survey also contained questions pertaining to other methods faculty employ to learn about best practices, as well as questions relating to respondent demographics.

The survey was sent to 1,502 members of AMATYC and MichMATYC by email or paper. A total of 306 surveys were returned, for a response rate of 20.4%. After removing data from participants who did not complete the survey or teach remedial mathematics at a community college, 194 surveys remained.

Regression analysis revealed nine significant predictors of overall use of best practices. The subscales best practice behaviors had six significant predictors, best
practice techniques had seven significant predictors, and best practice multiple representation/tool use had nine significant predictors.

Nine predictor variables influenced instructor use of the criterion variable overall best practices. Four of these predictor variables were from Block 1, instructor demographics.

The criterion variable subscale best practice multiple representation/tool use had nine predictor variables. Blocks 1 and 3 each had three variables influencing the criterion variable subscale. Next, seven predictor variables influenced the criterion variable subscale best practice techniques. Three of these variables originated from Block 1. Lastly, the criterion variable subscale best practice behaviors was influenced by six predictor variables, two each from Blocks 1, 3, and 4. The findings are discussed in detail in the following section.

Discussion of the Results

Block 1 – Instructor demographics. This study’s first research question examined what influence, if any, instructor demographics had on instructor use of best practices in remedial mathematics. As input variables, instructor demographics included: full-time or adjunct instructor; had taken courses in K-12 teaching methods or adult teaching methods; familiarity with methods of teaching mathematics; number of years teaching at the community college; number of years teaching remedial mathematics at the community college; and, highest degree earned.

The amount of variance explained by instructor demographics in the criterion variable overall best practices was 24%. Familiarity with multiple representations of a concept, familiarity with hands-on learning/manipulatives, coursework in mathematics
teaching methods, and familiarity with multiple teaching technologies were the instructor demographics that were significant predictors of overall best practices.

The amount of variance explained by instructor demographics in the first subscale of the criterion variable—best practice behaviors—was 13%. Familiarity with multiple representations of a concept and familiarity with multiple teaching technologies were significant predictors of best practice behaviors. The instructor demographics familiarity with hands-on learning/manipulatives, coursework on mathematics teaching methods, and familiarity with multiple representations of a concept explained 17% of the variance in the criterion variable subscale best practice techniques.

Lastly, the amount of variance explained by instructor demographics for the criterion variable subscale best practice multiple representation/tool use was 18%. Familiarity of hands-on learning/manipulatives, familiarity with multiple representations of a concept, and familiarity with multiple teaching technologies were the specific instructor demographic predictor variables.

Data analysis revealed instructor demographics had an influence on overall best practices as well as each subscale, best practice behaviors, best practice techniques, and best practice multiple representation/tool use. Familiarity with multiple representations of a concept and coursework in mathematics teaching methods were predictors of best practice techniques and overall best practices. Descriptive data revealed more than 70% of participants had taken courses in mathematics teaching methods. A typical mathematics teaching methods course has multiple representations of a concept as part of its curriculum. The professional organizations AMATYC and AMS and scholars alike (Ball et al., 2005; Cohen, D., 1995; DiMuro, 2006; Hodara, 2011b; The Education
Alliance, 2006) advocate use of multiple representations as methods of teaching mathematics.

Overall use of best practices had an additional predictor variable, familiarity with multiple teaching technologies. Multiple technologies include use of calculators, mathematics software, and spreadsheets. It is not surprising mathematics instructors would be familiar with at least calculator use in teaching mathematics. AMS recommends the use of calculators as a tool with mathematics instruction, but calculator use should not replace knowledge of basic facts (Ball et al., 2005). AMATYC recommends the use of multiple technologies when teaching mathematics (Cohen, D., 1995). Many survey participants reported that remedial mathematics courses were delivered in multiple formats, including on-campus, self-paced, computer-assisted instruction (CAI) (43.5%), hybrid (35.9%), and distance learning (28.3%). Because of the various methods in which remedial mathematics courses are delivered, it is not surprising that remedial mathematics instructors would be familiar with multiple technologies when teaching mathematics.

The best practice multiple representation/tool use was predicted by the instructor demographic familiar with hands-on learning or use of manipulatives. Multiple representation/tool use best practices was tested by a Likert scale that asked how frequently instructors required students to represent a concept graphically, represent a concept numerically, use real-world examples to represent a concept, use mathematics software, use a calculator, and use manipulatives. Frequently was defined as once a week during the semester. This predictor represented the instructor’s familiarity of hands-on learning/manipulatives; the instructor is extending familiarity of these practices
to classroom use as recommended by scholars and professional organizations alike. Using multiple representations and tools creates a learner-centered environment that engages students (Astin, 1999; Bonham & Boylan, 2011; Boylan, 2002; Fowler & Boylan, 2010; U.S. Department of Education, 2005).

The subscale *best practice behaviors* (e.g., *I meet with students during posted office hours, I communicate with students by email, social media, or telephone*) is a component of student-faculty interaction known to impact student success (Astin, 1993, 1996, 1999; Chickering & Gamson, 1987; Smittle, 2003; Thompson, 2001; Tinto, 1997, 2002). The predictor variable was *familiarity with multiple representations of a concept* (e.g., graphically, numerically, real-world). AMATYC, AMS, and scholars encourage multiple representations of a concept (Ball et al., 2005; Cohen, D., 1995; DiMuro, 2006; Hodara, 2011b; The Education Alliance, 2006). It is curious that this is the only predictor of best practice behaviors. Perhaps the instructor is familiar with multiple representations of a concept through his/her own educational experience. The descriptive data revealed almost 70% of respondents held master’s degrees and approximately 18% held doctoral degrees. The survey did not ask participants to name the subject of their degree. If a participant’s degree was in mathematics or a related area, but not mathematics education, the instructor may not have had courses in teaching mathematics. Researchers have commented that many remedial mathematics instructors are highly qualified in the area of mathematics, but may be limited in their knowledge of teaching remedial mathematics (Bonham & Boylan, 2011; Boylan, 2002; Brothen & Wambach, 2004; Highbee et al., 2005; Smittle, 2003). Vohryzec-Bolden (2000) and Hansman (2001) note many instructors learn about teaching through trial-and-error and interaction with students and
other instructors. Remedial mathematics instructors whose degree is in mathematics or a related field, by the nature of their degree, would be familiar with representing mathematical concepts numerically, graphically, and in a real-world context.

**Block 2 – Institutional characteristics.** This study’s second research question examined what institutional characteristics, if any, influence instructor use of best practices in remedial mathematics. As an environmental block, institutional characteristics were arrived at using IPEDS data and Carnegie Classification. All institutions in the data analysis were community colleges classified as rural, urban, or suburban. Specifically, the data analyzed included: percentage of students receiving a Pell Grant or any type of financial aid; percentage of full-time versus part-time instructors; and, student enrollment. The percentage of the institutional budget allocated to academic support, institutional support, student services, instruction, public service, and research were measured.

Surprisingly, no institutional characteristic was a significant predictor of the overall use of best practices or the subscales, *best practice behaviors* and *best practice techniques*. One institutional characteristic—*percentage of expenditures allocated to research*—was the only predictor variable that influenced the criterion variable subscale *best practice multiple representation/tool use*. However, the relationship was negative. The amount of variance explained by this predictor variable was 3%. This finding may be spurious, as only 4 of the 137 community colleges represented in the survey reported a percentage of budget spent on research. All four institutions reported 2% or less of the budget was allocated to research. The IPEDS budget categories were academic support, instructional support, student services, instruction, public service, research, and other.
This result could be caused by the method of replacing missing data with the mean value. If the result was not spurious, perhaps the institutions that allocated resources for research impress upon instructors the use of funds for mathematics software and calculators and do not require students to use manipulatives.

Results of this block may assure policymakers and administrators alike that, regardless of the percentage of budget allocated to instruction and academic services or whether the institution is large and urban or small and rural or whether students hail from a lower or higher socioeconomic background, these characteristics have no influence on instructor uses of best practices in remedial mathematics.

Block 3 – Institutional policies and procedures. This study’s third research question examined what influence, if any, institutional policies and procedures had on instructor use of best practices in remedial mathematics. As an environmental block, institutional policies and procedures that were part of the analysis included such academic services as SI, video-based supplemental instruction, tutoring, academic counseling, study skills course, mandatory or optional placement testing, learning communities, orientation, and course delivery format, and policies and procedures related to faculty working conditions, such as contact hours taught and the required number of office hours. The amount of variance explained by the institutional policies and procedures in the criterion variable overall best practices was 9%. The individual significant predictors were required attendance in a study skills course for remedial students, hours meeting with advisors outside of class time, and availability of supplemental learning services.
The amount of variance explained by the institutional policies and procedures predictor variables *availability of supplemental learning services* and *mandatory remedial student enrollment in a study skills course* in the criterion variable subscale *best practice behaviors* was 7%. The second criterion variable subscale *best practice techniques* amount of variance explained by the institutional policies and procedures significant predictor variables *hours meeting with advisor outside of class* time and *mandatory enrollment in remedial mathematics* was 8%. The amount of variance explained by the institutional policies and procedures in the criterion variable subscale *best practice multiple representation/tool use* was 10%. Specifically, the predictor variables that were significant predictors of the criterion variable were *required attendance in a study skills course for remedial students*, *hybrid course format*, and *required attendance in a study skills course for all students*.

Data analysis revealed institutional policies and procedures influenced instructor use of overall best practices, as well as all three subscales. *Required attendance of remedial students in a study skills course* and *availability of supplemental learning services* were predictors of instructor use of overall best practices and best practice behaviors. Study skills courses not only teach students study skills, they cover time management, test preparation, use of resources, and career goals. Required attendance in a study skills course has proven valuable in helping students persist in earning a degree (Boylan, 2002; Rutschow & Schneider, 2011; Weiss et al., 2011; Zeidenberg et al., 2008). When an institution requires remedial students to attend a study skills course, it shows the institution is serious not only in providing remedial coursework, but in providing remedial students the skills they need to succeed in other college courses.
(Zeidenberg et al., 2008). At the same time, institutions that consistently provide funding for training students, such as SI and peer tutoring leaders, and that provide the space for these activities to occur utilize nationally known and proven best practices (Boylan, 2002; Phelps & Evans, 2006; Vasquez Mireless et al., 2011; Zaritsky & Toce, 2006). It appears institutions dedicated to providing the resources for a study skills course for all remedial students and resources for supplemental learning services influence instructors to engage in best practice behaviors and overall best practices. If instructors believe the institution is committed to best practice policies and procedures with respect to supplemental learning services and mandatory study skills course enrollment for remedial students, they may follow the institution’s example and engage in best practice behaviors as well as overall best practices themselves (see Table 6).

Further, instructor use of best practice techniques are positively influenced by institutional policies and procedures that require students to meet with an advisor outside of class and to enroll in a remedial course based upon test scores. This is supported by research that shows institutions that require students to meet with an advisor during the semester outside of class influence student success in remedial mathematics (Boylan, 2002; Boylan et al., 1997). Bahr (2008b) found academic advising had a greater positive impact on remedial students than non-remedial students. Other researchers found institutions that require students who test into remedial mathematics to enroll in a remedial mathematics course have greater student success (Fike & Fike, 2012). Maxwell et al. (2004) and Jenkins et al. (2009) found institutions that require students to enroll in remedial mathematics courses have greater success in college-level mathematics than students who did not need remediation.
Students may not be enthusiastic about taking a remedial mathematics course if required by the institution. However, instructors know this and can create a class environment that engages students in coursework. Best practice techniques include such classroom activities as in-class group work, student-led lessons, and out-of-class individual work (see Table 6 for a complete list). Astin (1999) notes instructors should create an environment to achieve “maximum student involvement and learning” (p. 526). Other researchers believe collaborative learning and multiple methods of instruction lead to student success (Bonham & Boylan, 2011; Boylan, 2002; Fowler & Boylan, 2010; Hodara, 2011b; Goldstein et al., 2011; U.S. Department of Education, 2005).

The third subscale, best practice multiple representation/tool use, was influenced by two institutional policies and procedures, the requirement that all students attend a study skills course and the availability of a remedial mathematics course in a hybrid format that combines lecture with computer-assisted instruction. The value of a study skills course for remedial students was previously discussed, but such courses benefit all students. Study skills courses teach time management and self-discipline techniques that help students with all college courses and are invaluable to community college students seeking a degree or transferring to a four-year institution (Boylan, 2002; Rutschow & Schneider, 2011; Zeidenberg et al., 2008).

The nature of a hybrid remedial mathematics course requires the instructor to use mathematics software at a minimum. Descriptive statistics show that 69.2% of remedial courses are lecture-based, 43.5% are self-paced, 35.9% are hybrid, 28.3% involve distance learning, with 10.1% reporting other. It is interesting that the hybrid format influenced instructor use of multiple representation/tool use. Perhaps instructors who
teach a hybrid-format course structure it so that students must seek out real-world examples from the internet or require students to graphically represent concepts using spreadsheet software as recommended by AMATYC (Cohen, D, 1995), AMS (Ball et al., 2005), The Education Alliance (2006), and other scholars (DiMuro, 2006; Hodara 2011b; Van de Walle et al., 2012). Multiple representation/tool use is another example of engaging the student in coursework.

**Block 4 – Faculty development.** This study’s final research question examined what influence, if any, faculty development had on instructor use of best practices. As an environmental block, the professional development activities analyzed were: attendance at professional conferences/workshops; use of professional remedial educators’ websites; webinars; graduate courses; reading journal articles; faculty development for remedial instructors through informal collaboration with on-campus colleagues; and, formal collaboration with on-campus colleagues. Survey participants were asked to rate these on a Likert scale—1=Never, 2=Rarely, 3=Occasionally, 4=Frequently—with frequently defined as once a week.

The amount of variance explained by faculty development in the criterion variable overall use of best practices was 9%. Reading journal articles and informal collaboration with on-campus colleagues were the two-predictor variables influencing the criterion variable. Reading journal articles and attending webinars were the two-predictor variables that influenced the criterion variable subscale best practice behaviors. The amount of variance explained by the predictor variables was 10%. These same variables—reading journal articles and attending webinars— influenced the second criterion variable subscale best practice techniques. However, the amount of variance
explained was slightly less at 7%. The amount of variance explained by faculty development in the third criterion variable subscale best practices multiple representation/tool use was 6%. The specific faculty development variables were use of professional remedial educators’ websites and formal collaboration with on-campus colleagues.

Kozeracki (2005) and Rouseff-Baker (2002) comment that remedial instructors aspire to become better instructors through professional development. To improve the value of their instruction, AMATYC (2015) recommends faculty attend conferences, take further graduate courses, read journal articles, participate in mini-courses, and attend webinars.

Data analysis revealed the faculty development method reading journal articles influences overall best practices, best practice behaviors, and best practice techniques. Lawler (2003) states that if faculty development is to be effective, faculty must be active participants in the learning process. Faculty members who regularly read journal articles for professional development are clearly active participants in the learning process. Attending webinars is another faculty development method that shows faculty members are active participants in the learning process. Attending webinars for their own development also influences instructor use of such best practice behaviors as communicating with students by email, social media, or telephone and meeting with students during and outside of class.

Use of professional remedial educators’ websites influenced instructor use of the best practice technique multiple representation/tool use. It is not surprising that instructors learn about multiple representations and using various tools to teach
mathematics utilizing remedial educators’ websites. The instructor demographics

familiarity with multiple representation of a concept, familiarity with multiple teaching
technologies, and familiarity with hands-on learning/manipulatives were significant
predictors in different combinations of influencing best practice behaviors, best practice
techniques, best practice multiple representation/tool use, and overall best practices. This
may imply instructors are already familiar with these tactile teaching methods and use
professional remedial educators’ websites to expand upon their knowledge and to
incorporate these methods in the classroom.

Formal collaboration with on-campus colleagues also influences instructor use of
best practice multiple representation/tool use. Lawler’s (2003) Adult Learning Model for
Faculty Development includes the recommendations build on experience, employ
collaborative inquiry, and empower participants. Hansman (2001) suggests forming
communities of practice, self-organized groups of people who share a common purpose
and desire to learn from each other. Faculty members who teach remedial mathematics
are a natural community of practice. From the data analysis, when instructors have time
set aside to formally collaborate, they learn from each other how to use and implement
mathematics software, calculators, and manipulatives. In addition, through formal
collaboration, instructors learn ways in which students may represent mathematical
concepts graphically, numerically, and apply concepts to real-world situations.

The data analysis also revealed informal collaboration with on-campus colleagues
influenced instructor use of overall best practices. As stated, faculty members are
accustomed to working together. Study respondents’ years of experience teaching
remedial mathematics ranged from less than 1 year to 50 years ($Mdn = 11.00$). It seems
quite likely remedial mathematics instructors share their ideas with colleagues with more experienced instructors sharing classroom techniques, ideas, and approaches that are effective—and not effective—with their inexperienced colleagues. Hansman (2001) and Vohryzek-Bolden (2000) noted that learning about teaching takes time. Teaching is shaped by experiences both inside and outside the classroom, including interacting with students and instructors and experimenting with techniques and approaches through trial and error. On the other hand, faculty who are just beginning their careers as remedial mathematics instructors may be recent graduates with new ideas to share with their more experienced colleagues. Kisker and Outcalt (2005) found newer faculty members are more likely to teach remedial mathematics than senior faculty.

**Implications for Theory**

This study is guided by the theoretical framework, Developmental Theory, a theory for developmental education to develop the whole student by accommodating individual student differences, along with structuring the learning environment to maximize the number of students who benefit. Under Development Theory, the student is developed through self-regulation, demandingness, and responsiveness. Self-regulation is defined as the student regulating his/her behaviors to become an independent learner. Demandingness is defined as the instructor demanding the student to read, write, speak, and perform operations at a mastery level. Responsiveness insists the instructor is responsive to the developmental student by delivering timely, useful feedback and by initiating contact with students (Wambach et al., 2000).

The overall best practices in this study and its subscales represent the components of Developmental Theory. For example, *I meet with students during posted office hours*
and *I communicate with students by email, social media, or telephone* are examples of best practices that reflect the responsiveness component. The instructor who helps the student to develop self-regulation or to become an independent learner can be described by the best practices *I have student-led lessons, I assign out-of-class individual group work* and exercises that require the student to use manipulatives, a calculator, or mathematics software. Demandingness can be represented by the best practices multiple representation/tool use, represent a concept graphically or numerically, represent a concept with a real-world example, or assign a mathematics-related research essay.

Overall best practices are used by instructors regardless of course delivery format. Kinney (2001) found lecture and CAI remedial mathematics courses applied to Developmental Theory equally. However, this study’s data analysis found the hybrid course format had the greatest influence on instructor use of best practice multiple representation/tool use. The hybrid course format coincides with the demandingness component of Developmental Theory. When instructors engage in overall best practices, they develop the whole student, the very goal of Developmental Theory.

From this study, the methods used by faculty to improve their teaching skills and to learn about best practices coincide with adult learning theory. Faculty members read journal articles, participate in webinars, access professional remedial educators’ websites, and collaborate both formally and informally with on-campus colleagues so as to increase their knowledge of overall best practices. Faculty choose resources that make learning meaningful and apply these skills in the classroom and in students’ everyday lives, similar to the findings of Kozeracki (2005), Lawler (2003), Rouseff-Baker (2002), Vahryzek-Bolden (2000), and Wallin (2002).
As discussed in Chapter 2, the Seven Principles for Good Practice in Undergraduate Education was one of the conceptual frameworks guiding this study. Overall best practices applied to all of the Seven Principles. Data analysis showed that remedial instructors structure their classes with components of the Seven Principles, which coincides with Smittle’s (2003) research.

The second conceptual framework used in this study was Astin’s (2002) I-E-O Model. From Astin, the goal of higher education is to “enhance the educational and personal development of its students and faculty” (p. 21). Faculty engaged in best practices develop students at the same time they develop their own talent through faculty development. Data analysis results follow along the same lines as Astin’s (2002) results of a pretest. Astin found “pretests are more highly correlated with outcome post-tests than any other input or environmental variable” (p. 65). If a pretest is not available, a “parallel measure” (p. 65) is acceptable. In the case of this study, instructor demographics are “fixed attributes” (p. 70) that will not change and were the parallel measure used in place of a pre-test for this study.

This study’s data analysis showed the influence of the input block, instructor demographics, on overall best practices and each subscale accounted for the highest variance in all models. Block 1 influenced the overall best practices model 24% out of 40% total variance. Block 1 influenced best practice behaviors 19% out of 29% total variance in the model. Block 1 influenced best practice techniques 17% out of 30% total variance in the data analysis model. Lastly, Block 1 influenced best practices multiple representation/tool use 18% out of the 33% total variance in the data analysis model.
Implications for Policies and Procedures

This section discusses in detail the institutional characteristics analyzed and their influence or lack of influence on the criterion variable. Next, the institutional policies and procedures as related to faculty working conditions are discussed. The supplemental learning services available to students, requirements that students enroll in a study skills course, academic advising, mandatory testing, placement in remedial mathematics courses, and course delivery format are discussed, along with their influence on the criterion variable and implications of the influence on policy and practice. Analysis of faculty development methods found to influence the criterion variable follow. Next, the implications for practice as based on the criterion variable subscales best practice behaviors, best practice techniques, and best practice multiple representation/tool use, along with overall best practices, is discussed with suggestions for practice. The section concludes with a summary of contributions to practice.

Remedial mathematics faculty working conditions. The number of remedial and non-remedial credit hours or contact hours instructors are required to teach was analyzed. Instructors are required to teach 15 median credit and contact hours with a median 9 contact hours or a median 8 credit hours of remedial coursework. In this study, contact hours or credit hours worked were not significant predictors, either positively or negatively, of overall best practices or its three subscales. This result is significant. It appears instructors are not required to teach too many credit hours of non-remedial or remedial coursework that they do not have the time or energy to utilize best practices. One explanation could be that instructors teach less contact or credit hours of remedial coursework and are committed to helping these students succeed.
Supplemental learning services. The supplemental learning services institutions made available for students are recognized best practices (Boylan, 2002; Phelps & Evans, 2006; Vasques Mireless et al., 2011; Zartisky & Toce, 2006) and influence instructor use of overall best practices and best practice behaviors. Supplemental instruction is a proven method to aid student success. The community colleges in this study also offer video-based SI, peer cooperative learning, and peer-led team learning. All of these are forms of student interaction that engage the student in the learning process and, by extension, engage faculty in best practice behaviors and student-faculty interaction. SI leaders or peer leaders interact with faculty teaching the respective course. If administrators want more student-faculty interaction, they can encourage faculty to add SI services to their classes, and provide both the funds and space to expand the SI program. If budget constraints limit SI or peer-led team learning, the institution could record and upload sessions to the college’s website, YouTube, or to the college’s course management system so that more students would benefit.

Study skills course. More than 80% of institutions represented by this study had a study skills course, but only 14.3% required the course for all students, and 13.9% required the course for all remedial students. Institutions that require all remedial students to enroll in a study skills course influence instructor user of overall best practices and best practices behaviors. In addition, institutions that require both remedial and non-remedial students to enroll in a study skills course influence instructor use of best practices multiple representation/tool use. Researchers have shown the value of a study skills course not only for remedial students, but non-remedial students as well (Boylan, 2002; Rutschow & Schneider, 2011; Weiss et al., 2011; Zeidenberg et al., 2008). Perhaps
institutions that require all students to enroll in a study skills course by policy influence instructor use of best practice multiple representation/tool use because the institution has the resources and space available for all students to enroll in a study skills course. The institution may have enough funds to purchase and install mathematics software for student use. If software and computer facilities are available, it seems reasonable that instructors would use them in remedial mathematics. If computer facilities are available, it is easier for instructors to assign work that requires students to numerically and graphically represent mathematics concepts, as well as use the internet to search for real-world examples of mathematical concepts.

However, institutions that require remedial students to enroll in a study skills course appear to have more influence on instructor use of best practices as this policy influences instructor use of overall best practices, best practice behaviors, and best practice multiple representation/tool use. Institutions that require only remedial students to enroll in a study skills course may not have the personnel or resources to offer study skills courses for all students. Zeidenberg et al. (2008) found that when both remedial and non-remedial students enroll in a college skills course, remedial students have a slightly higher persistence rate than non-remedial students taking the study skills course. Other scholars found that a study skills course has short-term effects on progression through developmental courses (Rutschow & Schneider, 2011; Weiss et al., 2011). Perhaps this reasoning influences the institutional policy.

If the institution is committed to helping remedial students succeed by requiring them to enroll in a study skills course, this commitment may influence instructors to engage in best practice behaviors and overall best practices. Communicating with
students about their academic progress or counseling students inside and outside the classroom—student-faculty interaction—is a relatively low cost best practice. Requiring students to numerically or graphically represent mathematical concepts does not necessarily require college resources. This type of assignment could be given to students to complete on their own time if the institution’s budget does not allow for extra software and computer resources.

**Academic advisors.** Institutions that require remedial mathematics students to meet with academic advisors outside of class influence instructor use of overall best practices and best practice techniques. Counseling and advising services are valuable to a diverse population of community college students (Bailey, 2009; Provasnick & Planty, 2008). Bahr (2008b) found academic advising had the greatest impact on remedial mathematics students. Levin et al. (2010) determined counselors who made frequent contact with at-risk students increased student persistence and retention. If the institution employs separate personnel as academic advisors, then the institution is allocating funds to support students. This could influence instructors to engage in overall best practices and best practice techniques.

Alternatively, the remedial mathematics instructor may serve as the academic advisor or provide counseling in general to students. Instructors who engage in overall best practices serve as a resource person for students and informally counsel students. Students may feel more comfortable with their instructor and value the instructor’s advice. The best practice techniques of group projects, student-led lessons, and mastery learning coincide with the Seven Principles (Chickering & Gamson, 1987) of cooperation among students and active learning techniques.
**Mandatory placement.** Institutions that require students who test into remedial mathematics to enroll in a remedial mathematics course influence instructor use of best practice techniques. Research has shown that students who are required to enroll in the remedial mathematics courses they test into have higher GPAs, higher retention rates, and equal if not better success rates in college-level mathematics courses compared to non-remedial students (Fike & Fike, 2012; Jenkins et al., 2009; Maxwell et al., 2004). In spite of this, data analysis shows that while 93.2% of institutions represented in this study give placement tests, only 19.8% of these institutions mandate students who test into remedial mathematics to enroll in the course. Instructors know if their institutions require a remedial mathematics course, so they create an environment that engages students in their own learning, consistent with the Seven Principles (Chickering & Gamson, 1987).

Yet again, institutions that require students to enroll and successfully complete remedial mathematics are serious about student academic success. Research has shown that students who successfully pass remedial mathematics—even students with multiple levels of mathematics deficiencies—earn a degree or a credential or transfer to four-year institutions at rates similar to students who do not need remediation (Bahr, 2008a; 2008b, 2010; Calcagno et al., 2007; Fike & Fike, 2008; Hall & Ponton, 2005). Remedial mathematics instructors know their courses are gatekeeper courses students need to pass to meet their goals (Hall & Ponton, 2005). Instructors follow the lead of their respective institutions and engage in best practice techniques.

**Course delivery format.** Among the remedial course delivery formats—lecture, self-paced CAI, distance learning, and hybrid—the hybrid format influenced instructor use of best practices multiple representation/tool use. The other three formats had no
influence on whether an instructor engaged in overall best practices or any of its three subscales. In light of this evidence, organizations, policymakers, and administrators should proceed cautiously. Currently, the National Center for Academic Transformation advocates self-paced CAI for all remedial courses, especially remedial mathematics (Twigg, 2005, 2009). The Tennessee Board of Regents requires all remedial coursework delivered by the NCAT model (Tennessee projects revolutionize developmental education, 2009), and The University System of Maryland is in the process of implementing the NCAT model statewide (University System of Maryland expands course redesign across the state, 2011).

Results of research based on the NCAT model are favorable in terms of students passing remedial courses—remedial mathematics in particular—and later passing a college-level mathematics course (Tennessee projects revolutionize developmental education, 2009). However, little is known about student retention and degree attainment among students who complete remedial mathematics using this method. Statewide policies that mandate the method in which remedial mathematics is taught could have ramifications on degree attainment and transfer rates to four-year institutions.

While only 7 participants (3.6%) in this study taught at community colleges in Tennessee or Maryland, 43.5% of survey participants report their institution deliver remedial mathematics via the NCAT model. It is possible that self-paced CAI courses restrict faculty use of best practices. One would expect the self-paced element would influence an instructor to use best practice behaviors, such as I serve as a resource person, I serve as a coach, etc. Instructors who are mandated to use the self-paced CAI either by state or institutional policy will need to find a balance or to make an effort to
utilize best practices in spite of the course delivery format. Even though the method in which the remedial mathematics course is delivered is mandated, the instructor can engage in best practices.

**Professional development.** As outlined in Chapter 2, effective remedial education is necessary so that students may earn a degree or credential. The Bureau of Labor Statistics (2012) projects the fastest growing occupations from 2010-2020 will require an associate degree or higher, which in turn leads to higher earning potential. A college-educated population has the social benefits of increased tax revenue, reduced crime rates, and increased quality of life (Merisotis & Phipps, 2002). President Obama’s American Graduation Initiative (2009) calls for five million more Americans to earn a degree or certificate by 2020. Community colleges can help Americans to reach this goal. Among the 11 million students who attend community colleges, approximately 41% need remediation (Atwell et al., 2006; Parsad & Lewis, 2003; Provasnick & Planty, 2008). As a result, it is essential that community college administrators and faculty utilize best practices in remedial education, especially remedial mathematics.

Faculty professional development activities were analyzed to determine if any particular activity influenced instructor use of best practices. This study found that reading journal articles influenced best practice behaviors, best practice techniques, and overall best practices. For comparison: participating in webinars only influenced best practices behaviors; use of professional remedial educators’ websites and formal collaboration with on-campus colleagues influenced the best practice multiple representation/tool use, and, informal collaboration with on-campus colleagues influenced instructors to engage in overall best practices.
At first glance, it is surprising that professional conference attendance did not influence instructors to engage in best practices. One possible explanation is that shrinking institutional budgets are preventing instructors from attending professional conferences due to the cost. If this is the case, it appears instructors are choosing lower cost methods to develop professionally. Institutions with limited conference and travel budgets could allocate funds for one person to attend a conference, and this person could be given time during the semester to formally collaborate with other remedial instructors. The conference attendee could also conduct on-campus workshops, sharing ideas s/he learned at the conference.

This type of collaboration does not have to be the only formal collaboration between colleagues. The institution could set aside one or two hours per week when mathematics courses do not meet, allowing instructors time in their weekly schedules to discuss and share ideas. Because no mathematics courses would be scheduled, adjunct faculty, if available, could also participate in this formal collaboration. In this study, formal collaboration influenced instructors to use the best practice multiple representation/tool use. Instructors need more than a one-time demonstration to learn how to use mathematics software, graphics calculators, and mathematics-related manipulatives. Instructors need time to experiment with these tools themselves. Instructors can share the types of lessons and assignments they utilize to require students to represent mathematical concepts graphically, numerically, and in real-world contexts.

Webinars could be a low-cost alternative to conference attendance. Professional organizations sometimes offer low-cost webinars or webinars free to members. Instructors should be strongly encouraged or required, as part of their job responsibilities,
to be a member of at least one professional organization in their subject area. If the cost of membership in a particular professional organization is prohibitive, or the institution believes adjunct faculty should have access to the professional organization, the institution should purchase an institutional membership so that multiple faculty members could access webinars for little or no cost.

Remedial educators’ websites, in general, are free for everyone to use and can be accessed at any time. There are professional organizations that are dedicated to improving remedial instruction, such as the National Association of Developmental Education and the National Center for Academic Transformation. Institutions could provide space on their course management system for instructors to share links to the websites they have found helpful. In addition, a discussion board could be created for instructors to share comments about the links. The discussion board could also serve as a forum for informal collaboration for faculty, which, as identified in this study, is a significant predictor of overall best practices.

A second tactic for an institution to encourage informal collaboration is provide space for a faculty lounge with a coffee pot, microwave, refrigerator, tables, chairs, and possibly soft seating. Experienced and non-experienced faculty can share ideas from teaching techniques to resolving student issues, as well as discuss institutional policies and procedures. The lunch hour is the perfect time for faculty to socialize in a faculty lounge and share ideas. The institution should not schedule any classes or meetings during the lunch hour to give faculty this time to collaborate. Faculty teaching remedial and non-remedial mathematics, as well as faculty teaching other subjects, can share ideas in the faculty lounge. The faculty lounge could house discarded academic journals from
library holdings that are relevant to faculty who utilize the lounge. Current copies of publications such as the _Chronicle of Higher Education_ could be in the lounge as well.

A faculty lounge would be a resource for adjunct faculty between classes to grade papers or collaborate with full-time faculty. More than 80% of this study’s participants teach full-time, but the IPEDS institutional characteristics data results indicated the mean number of part-time instructors was approximately three times more than the mean number of full-time instructors. Administrators would want adjunct faculty to teach as effectively as full-time faculty and have the same opportunities to collaborate with other faculty. When journals are readily available in the faculty lounge, it would seem reasonable adjunct faculty would start reading journal articles to learn about best practices.

**Implications for Practice**

As discussed in Chapter 2, there are institutional policies and procedures and instructor methods that are considered best practices. From 2001 to 2011, the number of states that require students who need remediation to complete this instruction at a community college before enrolling in a four-year institution has doubled. Policymakers are also scrutinizing the cost of remedial coursework. Administrators have a responsibility to students to provide effective remedial education using best practice policies and procedures, just as instructors have a responsibility to utilize proven best practices inside and outside the classroom and in their own professional development. This study examined overall best practices and three separate subscales, *best practice behaviors*, *best practice techniques*, and *best practice multiple representation/tool use*. The implications of this study, on each subscale, are addressed in turn.
Best practice behaviors. The results of this study showed the instructor demographics familiarity with multiple representation of a concept and familiarity with multiple technologies as well as the availability of institutional academic support services, such as SI and peer-led cooperative learning, influence instructor use of best practice behaviors. An institutional policy that requires all remedial students to enroll in a study skills course, instructor participation in webinars, and reading journal articles also influenced instructors to use best practice behaviors.

As a result, an institutional policy requiring all remedial students to enroll in a college skills course may need to be enacted. This policy change may require either hiring faculty to teach the course or shifting current teaching assignments. Hiring additional faculty is always a budgetary concern. However, scholars have shown requiring a study skills course for remedial students influences student retention and success, and higher retention rates lead to higher college revenues.

To further encourage best practice behaviors, the library or remedial education department budget may need to be increased to purchase additional academic journals, which regularly showcase research that pertains to best practices. If the college already subscribes to academic journals, they should be readily available, and instructors need to be encouraged to read them. If the college subscribes to electronic copies of the journals, administration needs to make sure full-time and adjunct remedial mathematics faculty know how to access these journals electronically both on and off campus.

As mentioned previously, webinars can be a low-cost method of faculty development. Administration can encourage webinar participation by providing space for faculty to participate in webinars and links to such webinars in the course
management software. Administration may also require faculty to participate in a certain number of webinars per academic year or encourage webinar participation through performance incentives or be given a small stipend after completing a certain number of applicable webinars. In this study, instructor familiarity with multiple representations of a mathematical concept and familiarity with multiple teaching technologies influence best practice behaviors. When hiring new faculty members, whether full-time or adjunct, candidates could be asked about their familiarity with multiple representations of a mathematical concept and their familiarity with multiple teaching technologies, such as mathematics software. Familiarity with these methods should be crucial in the decision to hire.

**Best practice techniques.** This study found that instructors familiar with multiple representations of a concept, hands-on learning, and instructors whose backgrounds show coursework in teaching mathematics methods influence best practice techniques. Institutional policies that require students to meet with an advisor and that mandate enrollment in remedial mathematics based upon testing also influence instructor use of best practice techniques. The faculty development methods *reading journal articles* influenced instructors to engage in best practice techniques. Best practice techniques are identified as three of the Seven Principles, develop cooperation among students, use active learning techniques, and respect diverse talents and ways of learning.

For administrators to encourage instructors to engage more often in best practice techniques, at least two institutional policies would be necessary. First, students should be required to meet with an advisor outside of class during the semester. This study showed that, on average, students met with an academic advisor less than once per
semester ($M = .29, Mdn = 0$). As institutions already employ academic counselors or advisors, this policy change may not have a large impact on the budget – except to possibly increase revenue through increased student retention. If the advisor group is relatively small, additional advisors may need to be hired. If academic advisors are not teaching faculty, they could be available on a walk-in basis during the college’s hours of operation. If academic advisors are teaching faculty, students could be required to meet with an academic advisor before being allowed to register for classes. This requirement could be intrusive to the extent the student is not allowed to drop a class without first speaking to an academic advisor. Alternatively, students could be required to meet with their academic advisors to obtain their semester grades at the end of the semester.

A second policy that may need to be created or changed is mandatory enrollment in remedial mathematics for students who test into it. This study found that while more than 93% of institutions give students a placement test, fewer than 20% of institutions require students to enroll in a remedial mathematics course. This is a peculiar finding in that 21 states have policies regarding remedial coursework and at least 15 states require remedial classes to be completed at the community college level. For institutions that adopt this policy, additional instructors may need to be hired. However, in considering such a policy change, administrators should be mindful that students who complete remedial mathematics earn a degree or credential and have retention rates similar to students who do not need remediation (Atwell et al., 2006; Calcagno & Long, 2009; OPPAGA, 2007).

Parallel to best practice behaviors, reading journal articles influenced instructor use of best practice techniques. Methods institutions could utilize to encourage reading
journal articles were discussed in the Best Practice Behaviors section. In addition administrators could designate part of the faculty development budget for graduate coursework, given that the instructor demographic coursework in mathematics teaching methods influenced best practice techniques. Administration could place very specific guidelines on the kind of graduate coursework that applied. For example, some institutions offer graduate courses that focus on teaching in the community college and teaching mathematics to adults. Furthermore, administration could reimburse faculty only after the course was completed, so as to encourage successful completion.

**Best practice multiple representation/tool use.** This study found that familiarity with multiple representations of a concept, multiple teaching technologies, and hands-on learning were the instructor demographics that most influenced best practice multiple representation/tool use. In addition, institutional policies and procedures that require all students to enroll in a college skills course, not just students who require remedial education, and the hybrid course delivery format influence instructor use of this best practice subscale. The professional development activities use of professional remedial educators’ websites and formal collaboration with on-campus colleagues also influenced instructor use of multiple representation/tool use.

The literature is mixed as to which method of remedial education course delivery is most effective. However, as this study found, administrators contemplating a change in remedial mathematics course delivery should consider the hybrid course format, as it influenced instructor use of best practice multiple representation/tool use more so than the lecture only, distance learning, or self-paced CAI formats.
For their part, administrators may want to encourage instructors to engage in the best practice multiple representation/tool use, including having students: represent concepts graphically and numerically; use real-world examples; and, use mathematics software, calculators, and manipulatives. Instructors whose demographics influence this best practice should be asked to lead formal collaborative activities. These lead instructors could share the professional remedial educator websites they refer to for their own development. The college’s course management system should dedicate space to share these links and to comment on these websites. At the same time, the institution may need to change policy in that this study found that requiring all students to enroll in a college skills course influenced instructor use of the best practice multiple representation/tool use. If the budget does not permit this requirement, in the least, all remedial students should be required to enroll in a study skills course.

**Overall best practices.** For community college administrators interested in improving the use of overall best practices at their institution, this study found four instructor demographics, three institutional policies and procedures, and two professional development activities by which to do so. The instructor demographics that influence overall best practices were *familiarity with multiple representation of a concept*, *familiarity with multiple technologies*, *familiarity with hands-on learning*, and *coursework in mathematics teaching methods*. Institutional policies and procedures that influence instructor use of overall best practices were *availability of supplemental learning services* and policies requiring all remedial students to enroll in a study skills course and to meet with an advisor outside of class during the semester. The professional
development activities that influence overall best practices were reading journal articles and informal collaboration with on-campus colleagues.

It is not surprising that use of overall best practices is influenced by the four instructor demographics mentioned above. Instructors familiar with these methods most likely will employ these methods when engaging in overall best practices.

Of interest is the fact the number of years of teaching remedial mathematics did not influence overall best practices. This study’s participants’ years of experience in teaching remedial mathematics ranged from less than one year to more than 50 years, with a mean of approximately 15 years and a median of 12 years ($SD = 10.05$). By this analysis, instructors are in the middle of their careers. One might expect instructors with more experience would engage more often in best practices than less experienced instructors. Or conversely, instructors with less experience are younger and possibly recent graduates, willing to put in the time and effort it takes to engage in best practices. Another possible explanation as to why years of experience did not influence overall best practices is faculty with less teaching experience share new ideas with more seasoned faculty, while more experienced faculty share the best practices they have been using for years with newer faculty through informal collaboration – a predictor of overall best practices.

Reading journal articles was the second method faculty used to learn about overall best practices. Quite possibly, both newer faculty and more experienced faculty share ideas they have read in journal articles pertaining to best practices over lunch or in hallway discussions between classes.
Additionally, the institutional policies and procedures of the availability of supplemental learning services for students, requiring all remedial students to enroll in a study skills course, and requiring students to meet with an academic advisor outside of class influenced instructors to utilize overall best practices. Institutions that employ research–proven best practices to aid in student success set the precedent for all instructors, regardless of years of teaching experience, to engage in overall best practices.

**Contributions to practice.** Results of this study can influence instructor use of particular best practices through improved practices at institutions offering advanced degrees and through policies and procedures at community colleges.

Institutions that offer advanced degrees or curriculum in mathematics instruction or general teaching at the community college level can use this research to structure courses or degree programs using the methods that influence community college remedial mathematics instructors’ use of overall best practices or its three subscales. In hiring, when administrators face the dilemma of two otherwise equally qualified candidates, one deciding factor may be the candidate who has had coursework in mathematics teaching methods at the graduate or undergraduate level. The candidate also could be asked specifically about his/her familiarity with multiple representations/tool use, familiarity with hands-on learning/manipulatives, and familiarity with multiple representations of a concept.

In addition, administrators should review their institution’s policies and procedures. Results of this study indicate instructors at institutions that require at least all remedial students to enroll in a college skills course influence instructors to engage in overall best practices, best practice behaviors, and best practice multiple
representation/tool use. While it appears to be standard practice to give students placement tests upon entering college, not all institutions require students who test into remedial mathematics to enroll in a remedial mathematics course. The literature has shown mandating testing and placement is effective for student success. This study found that institutions with a mandatory placement policy influence instructor use of best practice techniques. Mandatory course enrollment may require hiring additional staff to teach study skills and remedial mathematics courses. Hiring more faculty members has budget implications. The institution may also need to allocate more physical space for these additional courses.

Administrators can be assured the supplemental learning services their institutions offer influence instructors to engage in best practice behaviors and overall best practices. Scholarly research on academic advising has also been shown to influence remedial student success. The results of this study show academic advising influenced instructors to engage in best practice techniques and overall best practices. However, this study also found that students meet with academic advisors less than once a semester. Administrators, academic advisors, and faculty need to examine the institutional policies and procedures associated with advising. Any policy changes could have budgetary implications. For example, the institution may have academic advisors in place or teaching faculty could serve in the academic advising role. If the institution has a collective bargaining agreement, it may need to be altered to include academic advising as a part of the responsibilities of faculty members. The academic advisor job duties may need to be examined to determine if a change is required, or if a change in student policies is needed that would require students to meet with an academic advisor during
the semester. At a minimum, the literature has shown academic advising aids remedial student success. The results of this study revealed institutions requiring academic advising influence remedial mathematics instructors to engage in best practice techniques and overall best practices.

**Recommendations for Future Research**

**Alternative populations.** This research was conducted with members of AMATYC and MichMATYC, professional organizations dedicated to improving mathematics teaching and learning at the community college level. The same survey could be distributed to remedial mathematics community college instructors who are not members of either organization. The survey could also be sent to remedial mathematics instructors at four-year institutions.

Alternatively, the survey could be sent to community college remedial mathematics instructors in Tennessee and Maryland. At this time, the Tennessee Board of Regents and the University System of Maryland require remedial mathematics to be taught in a self-paced, CAI format. The predictor variables in terms of instructor demographics, institutional characteristics, institutional policies and procedures, and faculty development could vary greatly in community colleges where remedial mathematics is mandated by a state governing board. There may be variables that negatively influence use of overall best practices or its subscales.

More than 80% of study respondents teach full time. Results of the data analysis could be quite different if the survey was conducted with adjunct faculty only. The institutional characteristics of the data analysis revealed the rate of adjunct faculty to full-time faculty was almost 3:1. The instructor demographics and faculty development
predictor variables may be quite different for adjunct faculty, especially the methods
adjunct faculty use to learn about best practices. It is possible adjunct faculty are not as
familiar with overall best practices or its three subscales.

A similar survey could be sent to remedial reading and remedial English
instructors at the community college level. Adelman (2006) found approximately 41% of
all college students enroll in remedial coursework at some point during their
undergraduate years. Other researchers have found the number of undergraduates
enrolling in remedial coursework of any kind is increasing (NCES, 2012). With at least
21 states requiring all remedial coursework to be completed at the community college
and the U.S. Bureau of Labor Statistics (2012) predicting the greatest job growth will
occur in fields that require a college degree, all remedial instructors should be engaged in
best teaching practices.

**Academic advising.** This study found that institutions in which students meet
with an academic advisor outside of class influence overall best practices and best
practice techniques. Future researchers might explore whether advisors are professional
staff or teaching faculty. In either case, questions could be asked as to whether remedial
mathematics students are required to meet with an academic advisor prior to registering
for classes in subsequent semesters, or if there is any type of intrusive advising, as
recommended by Levin et al. (2010). Questions could be asked about academic advising
policies and the method academic advising is carried out at the particular institution.

**Study skills course.** This study revealed that most (82.3%) institutions offer a
study skills course, and 13.9% require it for all remedial students. The policy requiring
all remedial students to enroll in a study skills course influenced overall best practices
and two of its subscales, *best practice behaviors* and *best practice multiple representation/tool use*. Future research may ask who teaches the study skills course, as such courses may be taught by remedial mathematics instructors, remedial instructors from other subject areas, or it may be team-taught. Future researchers may also inquire as to the level of collaboration between study skills course instructors and remedial mathematics instructors, and whether instructors collaborate on course assignments.

**Collaboration.** The results of this study indicated the type of administrative structure of remedial education did not influence instructor use of best practices. Remedial mathematics faculty could collaborate with faculty teaching remedial courses in other subject areas, leading to a mainstreamed but coordinated remedial education effort (Boylan, 2002; Perin, 2005).

This study’s results indicated formal collaboration with on-campus colleagues influenced instructor use of best practice multiple representation/tool use, while informal collaboration with on-campus colleagues influenced overall best practices. Further research into collaboration may be in order. For example, is the collaboration a result of formal or informal mentoring (Hopkins, 2005) or have communities of practice (Vohryzek-Bolden, 2000) formed intentionally or by chance? Furthermore, do remedial mathematics faculty collaborate with other mathematics faculty, faculty from other disciplines, or remedial faculty from reading or English? Finally, perhaps socializing in a faculty lounge over lunch or between classes is the most effective form of faculty collaboration.
Qualitative Study

A qualitative study could be conducted based on the email survey. Faculty members could be interviewed regarding their use of best practices and each of its subscales. Perhaps through a qualitative study, adjunct faculty members’ use of best practices could be separated from full-time faculty members. In addition, faculty members could be asked how they specifically develop the self-regulation component of Developmental Theory of the remedial student.

Limitations of the Study

As with other studies of its type, this study has limitations. The results of this data analysis cannot positively indicate a cause-and-effect relationship between instructor demographics, the community college environment, and instructor use of best practices in teaching remedial mathematics.

The questionnaire was sent to members of AMATYC and MichMATYC, a sample of convenience, out of all U.S.-based community college remedial mathematics instructors. Therefore, the results cannot be generalized to all community colleges or all remedial mathematics instructors. In addition, AMATYC and MichMATYC are committed to improving teaching and learning in community college mathematics; membership may indicate the instructor is dedicated to using best practices in teaching mathematics.

Another limitation lies in the location of respondents. Although the survey was a nationwide survey and 137 community colleges were represented, 35% of participants represented Michigan-based community colleges, perhaps the result of AMATYC’s
Michigan section being surveyed as well. As a result, the data may be skewed based on the large number of responses from only one state.

Non-response bias may also be present in the results. Survey recipients who did not respond to the survey may have answered questions differently than those who did respond, possibly changing the results.

Although the questionnaire used in this study was constructed based on a literature review, the survey did not contain an exhaustive list of predictor variables or criterion variables. The researcher who created the survey has been teaching mathematics at the community college level for more than 20 years. It is possible some unintentional bias may have occurred.

The survey instrument itself had limitations. As a structured response survey, participants did not have the opportunity to respond to open-ended questions or to add comments. Also, a number of incomplete surveys were received. When possible, the missing data were replaced with the mean value, but mean value replacement was not employed for the criterion variables. As such, incomplete surveys may have influenced the data analysis. In addition the survey analyses were based on less than 200 complete surveys out of the over 300 surveys that were returned.

As a final limitation, the phrase, best practices, was not used in either the survey’s introductory letter or the survey questions. The predictor variables and criterion variables were self-reported. It is possible that respondents chose socially acceptable responses, such as I regularly boost student’s self-esteem or I serve as a coach to students instead of I provide students with knowledge.
Contributions to the Literature

This study attempted to find empirical evidence of the influence of the community college environment on instructor use of best practices in teaching remedial mathematics, along with studying the faculty development methods used by individuals to learn about best practices. This study connected the theoretical framework Developmental Theory (Wambach et al., 2000) with the conceptual framework Seven Principles for Good Practice in Undergraduate Education (Chickering & Gamson, 1987). Developmental Theory is based on the premise the instructor is developing the whole student. The results of this study add to the Developmental Theory literature by delineating best practices faculty use to develop the whole student as it relates to the Seven Principles, thereby adding to the Seven Principles’ literature as well.

The second conceptual framework, Astin’s (2002) I-E-O Model, traditionally used with research in undergraduate student education, provided the method of data analysis of this survey based on community college remedial mathematics faculty. This research extends the I-E-O Model for use with practitioners.

Faculty, administrators, policymakers, and philanthropic organizations can use this research to make informed decisions as to the methods faculty use to learn best practices and the institutional policies and procedures that influence faculty to use best practices or its three subscales. Administrators can make informed budgetary decisions as to which methods of faculty development should be funded and explore lower cost alternatives based on this research. Because overall best practices were analyzed along with three separate subscales, administrators can determine the policies and procedures
and faculty development methods that influence a particular type of best practice in remedial mathematics education.

Conclusions

Numerous studies relate to effective methods of teaching remedial mathematics, as well as research that demonstrates best practice institutional policies and procedures that aid in remedial student retention and success. Currently, policymakers are scrutinizing the methods remedial coursework is being delivered and the cost of remedial coursework in general, as well as the length of time it takes a remedial student to earn a degree or credential. At least 21 states have policies in place regarding the ways in which remedial coursework is taught, or policies that require students to complete remedial coursework at a community college before they enroll in a four-year college or university.

At the same time, President Obama (2009) is challenging five million more Americans to earn a post-high-school degree or credential by 2020, which is in line with the U.S. Bureau of Labor Statistics (2012) prediction that fields with the most job growth by 2020 will require an associate’s degree or higher. Community colleges are being called upon to help Americans attain this goal. It is estimated that 41% of the more than 11 million students who attend a community college need remediation, with remedial mathematics the most common course students need (NCES, 2012).

In light of these demands, this study bridges the gap in understanding community college instructor use of best practices in teaching remedial mathematics. First, this study’s data analysis proved two assumptions false. The first such assumption—that instructor use of best practices in teaching remedial mathematics is influenced by years of
teaching—was proven false in that best practices are used almost intuitively by remedial mathematics faculty, irrespective of their tenure. The second assumption—that institutional characteristics influence instructor use of best practices—is just as intriguing. Regardless of whether the institution was small and rural, large and urban, or had a limited budget for supplemental learning services or instructor salaries, regardless of these institutional features, remedial mathematics instructors engage in best practices at the classroom level. From this study’s results, one important conclusion is that, no matter the institution’s location or financial health or the faculty’s experience or tenure, remedial mathematics instructors employ best practices for the benefit of student success, testimony to the tenacity, creativity, and values of community college remedial mathematics instructors to ensure successful outcomes.

Second, this study also revealed institutional policies and procedures can support instructor use of best practices in the classroom. Institutions that provide supplemental learning services for students, require remedial students to enroll in a study skills course, and require mandatory placement testing and enrollment in remedial mathematics courses influence instructors to engage in classroom best practices. The funds institutions allocate to such supplemental learning services as SI, tutoring, or placement test administration shows a real return on remedial mathematics student outcomes and influence instructors to engage in classroom best practices.

Third, this study’s data analysis provides direction for post-secondary institutions responsible for teaching the next generation of remedial mathematics educators. Instructor familiarity with multiple representations of a concept, multiple technologies, and hands-on learning/use of manipulatives influenced instructor use of best practices
and, by extension, student success. Instructors who had taken coursework in mathematics teaching methods also influenced use of best practices. Educators teaching the next generation of remedial mathematics instructors need to incorporate use of manipulatives in teaching mathematics along with requiring future instructors to create lessons that include manipulative use, lessons that require multiple representations of a concept, and lessons that require use of multiple technologies in the mathematics methods coursework or the coursework in teaching the adult learner. The future instructors need time to become familiar with these methods through collaboration with peers.

Finally, this study’s data analysis revealed remedial mathematics instructors grow and learn professionally throughout their careers. They continue to read professional journals, participate in webinars, access remedial educators’ websites, take graduate courses, and both formally and informally collaborate with on-campus colleagues to learn best practices in teaching remedial mathematics. These instructors are driven by a passion to help their remedial students to succeed.

Summary

This chapter outlined a summary of the study and its purpose to determine, if any, the influence of the community college environment has on instructor use of best practices in teaching remedial mathematics. Secondly, the theoretical framework and conceptual frameworks were discussed. Thirdly, discussion of the results by block and the amount of variance by each predictor variable were given as they related to each of this study’s four research questions. The implications of the data analysis results as related to the study’s theoretical framework and two conceptual frameworks followed.
The institutional policies and procedures analyzed relating to faculty working conditions, supplemental learning services, study skills courses, academic advising, mandatory testing and placement, course delivery format and their influence on the criterion variable and implications for practice were summarized. Recommendations for future research were given along with the limitations of the study. The chapter concluded with contributions to the literature, lessons learned, and a chapter summary.
References


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Appendix A

Community College Best Practices in Remedial Mathematics Survey

The National Association of Developmental Education’s (NADE) defines remedial/developmental mathematics as “instruction for those who have not yet mastered the skills necessary for competency with mathematics at the college-level. These skills may include one or more the following: arithmetic operations, math symbolism, geometry and measurement, functions, discrete math algorithms, probability and statistics, and deductive proofs”

Q2 Q-1: Do you teach any remedial mathematics courses as defined above?
- Yes
- No

Q3 Q-2: I am a
- full-time instructor
- part-time (adjunct) instructor

Q4 Q-3: Which academic services are available for remedial mathematics students on your campus? (mark all that apply)
- Supplemental Instruction
- Structured Learning Assistance
- Video-based Supplemental Instruction
- Peer Cooperative Learning
- Peer-led Team Learning
- Other (please specify): ____________________
Q30 Q-4: How often do remedial mathematics students generally meet with academic counselors/advisers during the semester outside of class time?

☐ Number of meeting(s) ____________________
☐ Don't Know

Q6 Q-5: Does your community college have a study skills course or college skills course?

☐ Yes
☐ No
☐ Don't Know

Q7 Q-5a: The study skills/college skills course is (mark all that apply)

☐ required for all students
☐ required for all remedial students
☐ required for all students on academic probation
☐ optional for all students
☐ don't know
☐ other (please specify): ____________________

Q8 Q-6: Are new students given a placement test to determine the mathematics course they should be enrolled in?

☐ Yes
☐ No
☐ Don't Know

Q9 Q-7: If a student is determined to need remedial mathematics, is enrollment in the remedial mathematics course

☐ Optional
☐ Mandatory
☐ Don't Know
Q10 Q-8: Does your community college organize students into Learning Communities (a cohort of students enrolled in a block of courses)

- Yes
- No
- Don't Know

Q11 Q-8a: How are the Learning Communities organized? (mark all that apply)

- Field of study
- Remedial students
- Honor students
- Student athletes
- Ethnic groups
- Other (please specify): ____________________
- Don't Know

Q12 Q-9: Does your community college offer orientation to new students?

- Yes
- No
- Don't Know

Q13 <P>Q-9a: Is the orientation</P>

- mandatory for all students
- optional for all students
- other (please specify): ____________________
- don't know

Q14 Q-10: What is the administrative structure of remedial education at your community college?

- Remedial courses are administered by a Remedial Education Department
- Remedial courses are administered by the subject area department
- Other (please specify): ____________________
- Don't know
Q15 Q-11: The remedial mathematics tutors are

- faculty
- students
- both
- other (please specify): ____________________
- don't know

Q16 Q-12: Where is the remedial mathematics tutoring located? (mark only one)

- Close proximity to the remedial mathematics classrooms
- In a different building other than the remedial mathematics classrooms
- Student Union or Student Center
- Multiple locations
- Other (please specify): ____________________
- Don't know
Q31 Q-13: Have you ever taken a course(s) in K-12 teaching methods?

☐ Yes
☐ No

Q32 Q-14: Have you ever taken a course(s) in mathematics teaching methods?

☐ Yes
☐ No

Q33 Q-15: Have you ever taken a course in adult teaching methods?

☐ Yes
☐ No
Q17 Q-16: What activities have you engaged in to become skilled in teaching remedial mathematics?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Frequently</th>
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<tbody>
<tr>
<td>a. Professional conferences/workshops</td>
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<td>b. Professional remedial educators’ websites</td>
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<td>c. Webinars</td>
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<td>d. Graduate courses</td>
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<tr>
<td>e. Reading journal articles</td>
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<td>f. Faculty development for remedial instructors organized by community college</td>
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<td>g. Informal collaboration with colleagues on campus</td>
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<td>h. Informal collaboration with off-campus colleagues</td>
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<tr>
<td>i. Formal collaboration with colleagues on campus</td>
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Q18 Q-17: What is the format of the remedial mathematics course(s) you teach at your community college? (mark all that apply)

- Distance learning (the student does not come to campus)
- On-campus, self-paced, computer-assisted instruction
- Hybrid (lecture and computer assisted)
- Traditional lecture
- Other (please specify): ________________
Q19 Q-18: Please rate the following statements as they apply to you as a remedial mathematics instructor. Frequently is defined as at least once per week during the semester.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Never</th>
<th>Rarely</th>
<th>Occasionally</th>
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<tbody>
<tr>
<td>a. I meet with students during posted office hours</td>
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<td>b. I meet with students outside of posted office hours</td>
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<td>c. I require individual students to meet with me during posted office hours</td>
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<td>d. I communicate with students by email, social media, or telephone.</td>
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<td>e. I communicate with students individually on their academic progress</td>
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<td>f. I informally counsel students outside of class</td>
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<td>g. I arrange the classroom so it is easy for the students to interact</td>
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<td>h. I enforce due dates for assignments as set forth in the</td>
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<td>syllabus</td>
<td>i. I use a variety of assessments to evaluate students</td>
<td>j. I use tests as the primary method of evaluating students</td>
<td>k. I determine educational objectives for each student</td>
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</tbody>
</table>

182
Q20 Q-19: How frequently do you as the remedial mathematics instructor employ the following techniques during the semester in your remedial mathematics courses? Frequently is defined as at least once per week during the semester.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. I assign in-class group work</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>b. I assign in-class, individual student work</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>c. I assign out-of-class group work</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>d. I assign out-of-class group projects</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>e. I assign students to a semester-long group in which to work</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>f. I assign individual student, out-of-class projects during the semester</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>g. I assign a mathematics related research/essay during the semester</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>h. I have student-led lessons</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>i. I give low-stakes assessments</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>j. I assign out-of-</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>class individual student work</td>
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<tr>
<td>k. I require mastery learning for each student</td>
<td></td>
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</tbody>
</table>
Q33 Q-20: How familiar are you with the following methods of teaching mathematics

<table>
<thead>
<tr>
<th>Method</th>
<th>Not at all familiar</th>
<th>Somewhat familiar</th>
<th>Very familiar</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Multiple representations of a concept (graphically, numerically, real world)</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>b. Multiple technologies (mathematics software, calculator, spreadsheets)</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>c. Hands on learning/use of manipulatives</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Q34 Q-21: How frequently do you as a remedial mathematics instructor require your students to do the following (Frequently is defined by at least once per week during the semester.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Represent a concept graphically</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. Represent a concept numerically</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c. Use real world examples to represent a concept</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d. Use mathematics software</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e. Use a calculator</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f. Use manipulatives</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Q21 Q-22: How many contact hours or credit hours are you required to teach during the semester?

Contact hours: 
Credit hours:

Q22 Q-23: How many contact hours or credit hours of remedial mathematics courses do you typically teach during the semester?

Contact hours: 
Credit hours:
Q24 Q-24: How many office hours are you required to schedule during a typical week of the semester?

Hours:

Q23 Q-25: How many years have you taught remedial mathematics at the community college level?

Years:

Q25 Q-26: How many years have you taught at the community-college level?

Years:

Q26 Q-27: What is your highest degree earned?

☒ Associates
☒ Bachelors
☒ Masters
☒ Doctoral or Professional Degree

Q27 Q-28: What is the name of the community college where you currently teach?

Q28 Q-29: Where is/are the community college located?

City:
State:
Appendix B

Introductory Letter to Survey Population

Dear Community College Colleague:

I received your contact information through a formal request with the American Mathematical Association of Two Year Colleges and the Michigan Mathematical Association of Two Year Colleges. I am inviting all members of AMATYC and MichMATYC to complete the attached survey as part of my doctoral research project *The Influence of the College Environment on Community College Remedial Mathematics Instructors Use of Best Practices in Remedial Mathematics.*

The purpose of my study is to determine the institutional policies and procedures that influence instructor use of practices in teaching remedial mathematics. The second purpose is to determine how an instructor becomes skilled at these practices in teaching remedial mathematics. Your input will provide valuable information on institutional policies and procedures that are research based best practices in remedial education and their influence on instructor use of classroom practices.

By clicking [here](#), you will find a questionnaire soliciting information about your community college policies and procedures as well as your classroom practices. In addition, you will be asked the methods you use for faculty development. The survey should take you less than 15 minutes to complete, and I am not asking for your name, social security number, or any other personal information. All the information obtained will be kept strictly confidential and the data will only be reported in the aggregate. Your choice to complete the questionnaire is voluntary. If you would like a copy of the survey results, please contact me at the email address below.

As for my background, I am a doctoral student in the Higher Education Administration Program at the University of Toledo and have taught remedial mathematics at Monroe County Community College, Monroe, Michigan for 20 years.

Please contact me with questions regarding my research at kshepherd@monroeccc.edu or contact my dissertation chair, Dr. Ron Opp at ron.opp@utoledo.edu.

Sincerely,

Kathleen Shepherd
Ph.D. Candidate, University of Toledo, Higher Education Administration Program
Professor of Mathematics, Monroe County Community College
734.384.4132 (o) or 517.605.0010 (c)
Appendix C

Introductory Letter to Survey Population #2

Dear Community College Colleague:

I am inviting all members of AMATYC and MichMATYC to complete the attached survey as part of my doctoral research project The Influence of the College Environment on Community College Remedial Mathematics Instructors Use of Best Practices in Remedial Mathematics.

The purpose of my study is to determine the institutional policies and procedures that influence instructor use of various practices in teaching remedial mathematics. The second purpose is to determine how an instructor becomes skilled at these practices in teaching remedial mathematics. Your input will provide valuable information on institutional policies and procedures that are research based best practices in remedial education and their influence on instructor use of classroom practices.

By clicking on the link below, you will find a questionnaire soliciting information about your community college policies and procedures as well as your classroom practices. In addition, you will be asked the methods you use for faculty development. The survey should take you less than 15 minutes to complete, and I am not asking for your name, social security number, or any other personal information. All the information obtained will be kept strictly confidential and the data will only be reported in the aggregate. Your choice to complete the questionnaire is voluntary. If you would like a copy of the results, please contact me at the email address below.

Please contact me with questions regarding my research at kshepherd@monroeccc.edu or contact my dissertation chair, Dr. Ron Opp at ron.opp@utoledo.edu.

Sincerely,

Kathleen Shepherd
Ph.D. Candidate, University of Toledo, Higher Education Administration Program
Professor of Mathematics, Monroe County Community College
734.384.4132 (o) or 517.605.0010 (c)
Appendix D

States, Number of Institutions, and Number of Participants

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Institutions</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
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<tr>
<td>Arizona</td>
<td>7</td>
<td>8</td>
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<tr>
<td>California</td>
<td>18</td>
<td>22</td>
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<tr>
<td>Colorado</td>
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<tr>
<td>Florida</td>
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<td>Guam</td>
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<tr>
<td>Hawaii</td>
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