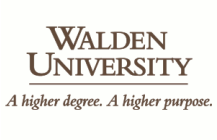

2017

Predicting Success of Developmental Math Students

Isaac Martinez
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Walden University

College of Education

This is to certify that the doctoral study by

Isaac Martinez

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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Walden University
2017

Abstract

Predicting Success of Developmental Math Students

by

Isaac Martinez

MSA, Embry-Riddle Aeronautical University, 2009

BS, Wayland Baptist University, 2001

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

August 2017

Abstract

Addressing the needs of developmental math students has been one of the most challenging problems in higher education. Administrators at a private university were concerned about poor academic performance of math-deficient students and sought to identify factors that influenced students' successful progression from developmental to college-level coursework. The purpose of this retrospective prediction study was to determine which of 7 variables (enrollment in a college success course, math placement results, frequency of use of the developmental resource center, source of tuition payment, student's age, gender, and race/ethnicity) would be predictive of success in developmental math as defined by a final course grade of C or higher. Astin's theory of student involvement and Tinto's theory of student retention formed the theoretical framework for this investigation of 557 first-year students who entered the university during Fall 2013 and Fall 2014. Binary logistic regression analysis was performed. Successful completion of the university's college success course as well as enrollment in introductory/intermediate algebra or intermediate algebra were significant predictors of success in remedial math courses. In addition, the lower the level of developmental math a student was placed in and engaged with, the higher the probability of success in the course. These findings were used to create a policy recommendation for a prescriptive means of ensuring students' early enrollment in developmental math courses and engagement with university resources, which may help students overcome barriers to success in developmental math and lead to positive social change for both the students and university through higher retention and graduation rates.

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Dedication

Completing my doctoral degree was a monumental milestone in my life, which I could have not reached without the inspiration and wisdom given to me by my Lord and Savior Jesus Christ. My appreciation also goes out to my family for their love, patience, and understanding throughout this chapter in my life. However, I would be remiss if I did not single out the one person who selflessly gave her all without reservations to see me succeed; I am referring to my loving wife Conchy. I was able to draw from her strength when my own was insufficient; I drew encouragement, when doubt clouded my mind, and faith, when the end seemed so far away. For this and countless reasons, I dedicate this study to her. Her selfless actions facilitated my earning of a doctoral degree in Education. In return, she will forever have my gratitude, my respect, and my admiration. By the way . . . those neck and shoulder massages were priceless!

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I would like to take this opportunity to thank my Committee Chairperson, Dr. Vicki L. Underwood, for her guidance and leadership throughout this doctoral capstone project. Her knowledge of scholarly research helped me push through one of the biggest challenges I have ever encountered. My hat is off to you!

I am also appreciative of my Committee Member, Dr. Nancy B. Walters for her input and assistance with my study. Finally, I would like to thank my University Research Reviewer, Dr. Andrea M. Wilson. Her collaboration made it possible for me to complete this journey. I am truly grateful and I wish you all the best in future endeavors.

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Section 1: The Problem

The acquisition of fundamental skills in math and the role they play in the academic development of students have been topics of discussion for higher education administrators during the past 2 decades (Barnes, 2012; Brown, 2014). When and how these skills are acquired can affect not only developmental students, but the institution and the economy as a whole. According to Abraham, Slate, Saxon, and Barnes (2014), the amount of resources earmarked toward the remedial education of underprepared students is not only imposing a financial burden on institutions, but is restricting the global competitiveness of the United States. This concern has increased over the years to the point of attracting national attention. In response to this challenge, President Obama asserted that math and science education needed to be made a national priority if the country were to be ready for the demands of a 21st-century economy (Cortes, Nomi, & Goodman, 2013).

The adequacy of math skills is a growing concern among administrators and educators across the higher education landscape. Scientific fields of study such as engineering and technology degrees regularly employ high levels of math in their curricula, which demand that the fundamental skills of students entering these fields be stronger from the beginning (Miller, 2017). Calculus, for example, continues to pose a challenge for engineering students who, in many cases, are scoring below the 50th percentile (Hieb, Lyle, Ralston, & Chariker, 2015). When these students are accepted into college, the concern for math adequacy becomes greater as their skills are immediately put to the test. Engineering students continue to experience difficulties with

calculus that stem primarily from poor study skills and an inability to apply their math knowledge to solve engineering problems (Tolley, Blat, McDaniel, Blackmon, & Royster, 2012).

Okimoto and Heck (2015) asserted that the lack of student preparedness for college-level coursework has proven to be a significant barrier to degree completion. Over 40% of college freshmen complete at least one remedial mathematics course during their academic tenure (Harwell, Dupois, Post, Medhanie, & LeBeau, 2013). Although colleges and universities have not reached a national consensus on how to assess prerequisite knowledge or how to place students into developmental coursework, there is growing concern about adequate mathematics preparation, especially in science, technology engineering, and math disciplines (Prather & Bos, 2014). Koenig, Schen, Edwards, and Bao (2012) found that inadequate math preparation and a lack of understanding of the engineering discipline are contributors to student failure.

Although many students enter higher education ill-prepared for college-level math, some strides have been made to improve their ability to persist (Bettinger, Boatman, & Long, 2013). The Center for Community College Student Engagement (2014) suggested that there is a relationship between the successful completion of at least one developmental course when the student earns a C or better and improved student outcomes. However, getting students to seek help with their knowledge deficiencies and to proactively engage with available interventions is an ongoing challenge for educators. Prather and Bos (2014) found that three out of 10 developmental education students never enroll in developmental courses and less than 50% of those who enroll complete

the entire course sequence. Despite the challenges resulting from poor student involvement, scholars have shown that institutionally mandated developmental interventions may be in the best interest of students (Fike & Fike, 2012). To improve the effectiveness of an intervention, it is important to ascertain which factors are most influential to the success and persistence of developmental students.

The Local Problem

The site for this study was a 4-year institution in the Southeastern United States known hereafter as Premier Technical University (PTU). PTU is an accredited university equipped to award degrees at the associate, baccalaureate, masters, and doctoral levels (Office of Institutional Research, 2015b). The university employs an open admissions policy and is composed of multiple campuses. Its main campus served over 5,500 students (Office of Institutional Research, 2015b) and that campus was the focus of this study.

Between 2012 and 2014, PTU's main campus experienced a 7.5% growth in enrollment, peaking at over 5,500 students (Office of Institutional Research, 2015a). Although the enrollment growth was accepted as a positive indicator for the institution, the number of students exhibiting math deficiencies also increased by 2% (Office of Institutional Research, 2015a). Between 2007 and 2013, 1,898 students, representing 36% of the first-year students entering PTU, placed at a math level below the requirements established by their chosen degree plans (Office of Institutional Research, 2015a). Out of the nearly 1,900 students who placed below the appropriate math level, only 59% of students (n = 1,120) opted to voluntarily take the developmental math

courses they were placed in during their first semester. The remaining 41% never enrolled, delayed their enrollment into developmental math courses until after their first semester, or dropped out of school. Of the 1,120 students who opted to take remedial math courses, almost one-third received a grade of D, failed, withdrew, or audited their developmental courses (Office of Institutional Research, 2015a). Cafarella (2014) asserted that a significant number of higher education institutions have experienced difficulties with the academic success rates of students in developmental math. This phenomenon has prompted discussions among administrators at the local university about ways to mitigate the problem.

PTU requires new first-year students to be tested via an admissions-mandated assessment system called the Math On-line Evaluation (MOE). The MOE was developed in the spring of 2006 by math professors at the university after testing and rejecting the use of nationally-normed placement tests that were found to lack the ability to accurately assess the math prerequisite knowledge required for success at PTU (Associate Dean of Operations, personal communication, July 23, 2015). The newly developed MOE was tested in the fall of 2006 and finally implemented for institutional use in the fall of 2007 (Associate Dean of Operations, personal communication, July 23, 2015). Since then, the MOE has been the official placement test used by PTU to evaluate math prerequisite knowledge.

Not every student is required to take the MOE. Students with SAT/ACT scores above the criterion and veterans are given the option of taking the assessment. After designated first-year students take the MOE, the results are used to place them into the

appropriate developmental math course that will help them progress through their chosen academic degree plan. If a math deficiency is identified, immediate enrollment into the appropriate remedial math course is not compulsory, but highly encouraged by the assigned first-year advisor. This established process for every new student who does not meet the prerequisite knowledge to enter college-level math courses normally takes place before the start of the first semester.

The remedial math courses offered by PTU are introductory/intermediate algebra, intermediate algebra, and precalculus essentials. Although these courses are credit-bearing, the credit attained is not applicable to any degree in the catalog. Every math developmental course carries a compulsory grade requirement of a C or better in order to qualify as satisfactory progress, which is a requisite for enrollment into subsequent coursework. Although first-year advisors make it a priority to recommend enrollment in developmental instruction during the first semester, students are free to enroll into other degree-related courses that do not remediate their math deficiencies. Students have this option because the institution does not have a policy that prescribes compulsory enrollment into developmental education courses at the time when the need is identified.

Although many math deficient students opt to enroll in developmental instruction, their lack of performance in these courses has become a reoccurring cycle every semester. By the time the semester reaches the early grade reporting period, which commonly occurs 5 weeks into the fall or spring semesters, approximately half of these remedial math students begin to show signs of difficulty in their progress. Their attendance becomes poor, and their grades begin to drop. According to the executive

director for student academic support (personal communication, June 29, 2015), this is when first-year advisors are prompted to encourage these students to engage with an additional intervention plan made available by the institution's Academic Advancement Center (A^2). One of the purposes of the intervention plan is to help developmental math students overcome barriers to success.

The intervention, which includes a choice of face-to-face or blended tutoring sessions, is designed to accommodate the scheduling constraints of the student. If a student's schedule cannot accommodate all planned face-to-face interactions with a tutor, a blended tutoring session can be scheduled to combine part-time, face-to-face tutoring with part-time, online tutoring instruction. This gives the student more flexibility to participate in the intervention via a custom schedule designed to fit their needs. A written contract between the student and the first-year advisor is drawn to add validity to the agreement. This is done despite the fact that students are aware that their participation is not mandatory. The core objective of the tutoring sessions is to address the deficiency encountered in developmental instruction and to help the students overcome any barrier that may prevent them from being successful. Tutor assignment and student attendance is tracked by PTU's A^2 center, while the academic progress of every student is monitored by a cadre of first-year advisors (Executive Director for Student Academic Support, personal communication, March 20, 2015).

Presently, one-third of the students who voluntarily enroll in remedial math courses are not passing, which delays their ability to progress into subsequent college-level math courses. Many of these failures may be attributed to poor attendance or a lack

of student involvement (Executive Director for Student Academic Support, personal communication, March 20, 2015). Failing, withdrawing, auditing, or dropping a developmental course not only slows the progress of remedial math students, but also carries the collateral effect of lowering their cumulative grade point averages (GPAs) to unacceptable levels. According to the local institution's executive director for student academic support, earning a bad academic standing with the institution leads to a chain of long-term negative consequences. First, it has the potential to change the academic status of a student to probation, which restricts the student's ability to participate in a number of scholastic activities. Second, it hinders a student's ability to secure financial aid, forcing the student to rely on personal loans, or other sources that ultimately increases student debt. Finally, it extends the student's timetable to degree completion, which affects the student's motivation to persist in the chosen degree program (Tyson, 2012). Developmental students may not be cognizant of why the events happened. Hughes, Gibbons, and Mynatt, (2013) asserted that students who display a lack of support-seeking behavior, such as not completing remedial course work or choosing to postpone their involvement with developmental education, do so often unaware of the consequences that may follow.

University officials are concerned about the poor academic performance of students with math deficiencies and are requesting evidence on which factors are predictive of their academic progression from developmental math to regular coursework. They intend to use this information to help develop strategies and interventions that can aid developmental math students during their first year (Executive Director for Student

Academic Support, personal communication, June 29, 2015). The purpose of this study was to determine which of seven factors are predictive of the success of students in developmental math.

Rationale

Nationally, over 40% of college first-year students enter higher education inadequately prepared and complete at least one developmental math course during their academic career (Harwell et al., 2013). The percentage of students in need of developmental math at PTU coincides with the national trend. Brown (2014) concluded that being proficient in a range of fundamental skills relevant to math is necessary if students are to be successful in college. It is common for scientific and technical fields of study, such as engineering and career technical degrees, to employ higher levels of math that require fundamental skills. When new students enter these types of fields possessing math deficiencies, they are faced with a barrier that can affect their academic progress (Okimoto & Heck, 2015). Not possessing the necessary math skills at this point only exacerbates the problem. It obligates the institution to assess the students' prerequisite knowledge, dedicate resources to implement intervention programs, and remediate the students' deficiencies to improve their chances for success.

PTU is a scientific and technical institution, and remedial education continues to be the primary method for helping students categorized as underprepared for college-level coursework progress toward successful degree completion (Brown, 2014; Li et al., 2013). Although the initial assessment of prerequisite knowledge has been institutionally mandated since 2007, state legislators instituted a change in 2013 that has the legislative

power to exempt groups of students from being assessed. Students who had entered ninth grade in any of the state-supported public schools or students who had served as active duty members of the United States Armed Services were given the option of taking the assessment test or enrolling into developmental education if they so desired (Senate Education Committee, 2014). The Center for Postsecondary Success (2015) reported that administrators across the state have realized that students in this cohort who decided not to take developmental education after being advised to do so were more likely to fail developmental or college-level courses. Brothen and Wamback (2012) claimed that students who started remedial math, but chose not to persist in the course, ended with lower GPAs than students who had completed their developmental math courses.

Cafarella (2014), who studied the reasons why students lack success in developmental mathematics, also found that poor attendance was a key contributing factor to this phenomenon. Bonet and Walters (2016) also asserted that "better attendance contributes higher grades" (p. 229). According to the PTU Office of Institutional Research (2015b), between 2008 and 2013, poor attendance was found to be a contributing factor behind many of the failures in developmental math courses. The majority of these students' cumulative GPAs were affected, which led to a number of negative consequences that placed them in jeopardy of not being able to graduate on time (Executive Director for Student Academic Support, personal communication, June 29, 2015). Cafarella (2014) found that students with high absenteeism experienced lower success rates, which also affected their motivation to persist.

Scholars have found that developmental education students lost their motivation

to persist and withdrew from school after feeling that their efforts had only resulted in a waste of time and money (Krumrei-Mancuso, Newton, Kim, & Wilcox, 2013; Tyson, 2012). The high attrition rate of PTU's developmental math students has raised a concern among degree administrators, first-year program advisors, and faculty (Executive Director for Student Academic Support, personal communication, June 29, 2015). These students represent a significant portion of the first-year student population that has a direct impact on the institution's sustainability.

Issues surrounding developmental education, student engagement, and low retention rates have piqued the interest of many scholars engaged in higher education research that has been conducted in 4-year institutions and community colleges across the country (Bettinger, Boatman, & Bridget, 2013; Center for Community College Student Engagement, 2015; Fiorini et al., 2014; Martin, Galentino, & Townsend, 2014; Sutter & Paulson, 2016; Vaughan, 2014). Deficiencies in math, English, and writing skills are the underlying causes of student underachievement in college (Barnes, 2012; Fike & Fike, 2012; Keup & Kilgo, 2013). Over 50% of college students enrolled in community colleges in the United States have been placed into developmental education courses (Barnes, 2012). Despite the high number of students being referred to developmental education, many institutions continue to delegate the decision of whether to actively engage with remedial education to the students themselves. This practice may not be in the best interest of students. Fain (2012) reported that

> much of the academic support offered by community colleges goes unused and that the success of the completion agenda may hinge on whether community

> colleges set more mandatory requirements for students, and drop their reliance on making academic support offerings optional. (p. 1)

Administrators, first-year advisors, and developmental faculty at the local institution also shared these concerns.

According to Bahr (2013), two-thirds of all first-time community college students require some kind of math remediation, and three-fourths of those students do not complete a college-level math course successfully. Many of the students who do not complete math remedial courses also leave college without finishing any kind of credential (Bahr, 2012; Hagedorn & Kuznetsova, 2016). The success rate of students who either postpone enrollment into developmental math or freely drop their remedial math courses has been poor at PTU, which aligns with the concerns of colleges and universities nationwide. Improving the success of developmental math students continues to be a priority at PTU, and studying the different factors that may have an effect on their success is a step in the right direction (Executive Director for Student Academic Support, personal communication, June 29, 2015). The purpose of this study was to determine which factors are predictive of the success of developmental math students.

Definition of Terms

The following definitions have been provided to facilitate the appropriate understanding of certain words and phrases used within the construct of the study:

College readiness: College readiness is the state of prerequisite knowledge possessed by students when they arrive at college for the first time. This state of

knowledge determines their readiness to undertake the rigor of college-level courses (Silva & White, 2013).

Developmental education: Developmental education is a field of practice and research within higher education with a theoretical foundation in developmental psychology and learning theory that promotes the cognitive and affective growth of all postsecondary learners (National Association of Developmental Education, 2015).

Early grade reporting period: Early grade reporting period is a period in the semester, usually 3 weeks into the semester, in which faculty members render an initial report of student progress in their respective disciplines (PTU, 2015).

First-year program: First-year program is composed of a number of services designed to help students academically succeed in their new environment. Some of the services provided include assistance in academic and career planning, techniques on how to improve study habits, guidance on how to best capitalize on developmental education, and tutoring (Bers & Younger, 2014).

First-year students: First-year students are a category of students who have entered the university environment for the first time without previous postsecondary experience regardless of age (Cole & Korkmaz, 2013).

Intervention: Intervention is the academic remediation of math skills that students may need to succeed (Barnes, 2012).

Math On-line Evaluation (MOE): The MOE is an interactive diagnostic test used by PTU to determine students' prerequisite knowledge in math and for prescriptive placement into the corresponding developmental math course (PTU, 2015).

Persistence: Persistence is successfully meeting the compulsory grade requirements of a developmental math course that fulfills the prerequisite for enrollment into subsequent college-level coursework. It also refers to the conscious decision of a student to stay in school until graduation (Barnes, 2012).

Success: Success is completion of a developmental math course with a grade of A, B, or C (Wolfe, 2012).

Science, technology, engineering, and mathematics (*STEM)*: The STEM acronym is used in education to refer to the teaching and learning in the fields of science, technology, engineering, and mathematics and it typically includes educational activities across all grade levels from preschool to postdoctorate in both formal and informal settings (Gonzalez & Kuenzi, 2012).

Underprepared students: Underprepared students are students who lack the prerequisite knowledge in foundational skills at the time they enroll into college (Li et al., 2013).

Significance of the Study

Institutions that establish an appropriate placement process, a quality assessment system, and an effective advising program are frequently more successful (Fuller & Deshler, 2013; Saxon & Morante, 2014). Providing the students with the necessary resources shows the commitment level of the institution, and it is this type of commitment that establishes the bases for policy enforcement (Saxon & Morante, 2014). Researchers have emphasized the need for policy mandating assessment of prior knowledge to identify the student's level of developmental mathematics referral (Cho &

Karp, 2013), while other scholars have shown that mandatory placement and engagement via guided interventions have positively contributed to student success (Fike & Fike, 2012; Saxon & Morante, 2014). Collectively, stronger institutional measures, coupled with the appropriate intervention strategies, may be in the best interest of students.

Although current institutional policy at PTU requires new incoming students to demonstrate proficiency in math by either passing an assessment exam or transferring credit from an accredited institution, it does not mandate immediate enrollment in remedial math courses when the minimum level of proficiency is not met. According to the Office of Institutional Research (2015b), between 2008 and 2013, 58% of the students enrolled in developmental math courses either voluntarily dropped or failed to persist, while another 11% opted to defer their enrollment into developmental courses until after their first year in college. This has taken a negative toll on the progress of these students by placing them in jeopardy of not completing all degree requirements within a prescribed amount of time. University officials are concerned about the lack of academic performance of math deficient first-year students, especially when there are resources available to help them succeed. Administrators want to know which factors are predictive of the success of developmental math students in order to make the necessary improvements (Executive Director for Student Academic Support, personal communication, June 29, 2015).

This study added to the research knowledge in more than one way. I examined the predictive value of some factors as they relate to student success. The information attained could aid administrators in employing more effective strategies that could be

adopted to improve remedial interventions. These changes could lead to the implementation of new institutional policy designed to improve the retention rate of new first-year students.

Research Question and Hypotheses

Although research has been done in the areas of attrition and retention, there is no one-size-fits-all formula that ensures the academic success of remedial students. As a result, many institutions have focused on identifying the factors that promote or detract from success and persistence among developmental students. Many institutions mandate the initial assessment of prerequisite knowledge as a way of facilitating placement; but, they fall short in prescribing enrollment into developmental courses when a deficiency is identified. Mandated assessment followed by voluntary enrollment by the student y undermines the reason for assessing (Fike & Fike, 2012).

Researchers have found a positive relationship between student success and mandatory placement of remedial math students (Saxon & Morante, 2014). Fike and Fike (2012) argued that due to the high number of college dropouts, institutions are justified in being more prescriptive in their developmental recommendations and to encourage students to complete their programs quickly. These challenges are ongoing, and PTU is working toward finding the best way to help its math deficient students. In this study, I investigated the role of several characteristics of developmental math students and whether these variables were predictive of the students' ability to succeed in their developmental math course at PTU. For the purposes of this study, success was defined as the students' ability to pass their respective developmental math courses with a

grade of C or higher. This study was guided by the following research question, null, and alternative hypothesis:

RQ: Which of the following factors are predictive of student success?

- Enrollment and completion of the Univ 101 college success course. Each student's academic record was used to determine whether the student enrolled and completed the Univ 101 course during their first semester.
- The MOE course placement results. The Academic Advancement Center maintains a database containing the results of each student's MOE and the resulting math placement recommendation.
- The frequency of use of the A^2 center. Each intervention plan recommended by first-year advisors requires a student to actively dedicate at least 4 hours to the A^2 center per week. The center's database provided a record of each student's attendance during their first semester.
- The source of tuition payment. Each student's record was accessed by the Institutional Research department to determine the source of the tuition funds used by each student.
- The student's age. The institutional research department compiled the students' ages from institutional records.
- The student's gender. The institutional research department compiled the students' gender from institutional records.
- The student's race/ethnicity. The institutional research department compiled a list the students' race/ethnicity from institutional records.

$H_{0:}$ None of the following factors are predictive of student success:

- Enrollment and completion of Univ 101 college success course
- The MOE course placement results
- The frequency of use of the A^2 center
- The source of tuition payment
- The student's age
- The student's gender
- The student's race/ethnicity

$H_{a:}$ One or more of the following factors is predictive of student success.

- Enrollment and completion of Univ 101 college success course
- The MOE course placement results
- The frequency of use of the A^2 center
- The source of tuition payment
- The student's age
- The student's gender
- The student's race/ethnicity

When developmental education students opt not to get involved with available resources, and do so without regard to the potential benefits from their involvement, then the resources are considered to have gone unused. Astin (1999) found that the more involved the student, the higher the likelihood of student persistence through college. The factors addressed in the research question were analyzed to determine which were predictive of developmental students' ability to succeed.

Review of the Literature

This literature review includes research conducted by two nationally recognized institutions dedicated to the assessment of student engagement: the National Center for Postsecondary Research (NCPR), which sponsors the National Survey of Student Engagement (NSSE) and the Center for Community College Student Engagement (CCCSE), which sponsors the Community College Survey of Student Engagement (CCSSE). The NSSE focuses on students attending 4-year institutions, while the CCSSE focuses on students attending community colleges. The NCPR and the CCCSE share similarities in their initiatives, and it is due to these similarities that they work in partnership (CCCSE, 2016). The data extracted from their survey research are used by many campuses across the United States to explore the connection between institutional expectations and actual student achievement. An element of their initiative is to study the influence of different variables to predict the academic success among students attending these institutions. First-year students who attend 4-year institutions, as well as those who enter community colleges, share characteristics related to academic performance (Kena et al., 2015). Based on these commonalities, I have decided to use some of the NCPR's and CCCSE's research findings to lend support to my own project study.

This literature review also includes data relevant to college readiness, race/ethnicity, the use of college support services, developmental education intervention programs, and other factors that could predict a student's ability to succeed into subsequent college-level coursework. Data related to commonly embraced standards for assessing students' prerequisite knowledge in math and institutional approaches to the

remediation of knowledge deficiencies will also be presented. The Walden University Library, Google Scholar, and the local university websites were used to access ProQuest Central, IEEE Explorer, and the Education Resources Information Center (ERIC) databases. Search terms used to find related support material included the following: *math developmental education, factors influencing academic success, remedial math, student persistence, mandatory assessment, college readiness, first-year experience, student engagement, STEM,* and *student involvement.*

Theoretical Foundation

The theoretical framework for this study was based on Astin's (1999) theory of student involvement and Tinto's (1988) theory of student retention Astin theorized that "the amount of student learning and personal development associated with any educational program is directly proportionate to the quality and quantity of student involvement in that program" (p. 519). Astin further hypothesized that the successful outcome of any educational policy or practice is contingent on its ability to increase student involvement. Many institutions have aligned their educational programs by basing their efforts on Astin's theory.

If students proactively get involved in their education and manage to persist toward completion of a program, then their success should have a direct impact on retention. This is where Tinto's theory of retention comes into play. Tinto (1988) argued that there are several factors responsible for student attrition. The factor most applicable to this study is a student's inability to socially and academically integrate into the fabric of the university system during the first semester. Tinto postulated that student retention

in college is contingent on the academic transition via an effective first-year program. Tinto also argued that institutional support towards this first-year program is a component of student development. Institutional commitment plays a role in a student's development. This same commitment is necessary for policy enforcement (Saxon & Morante, 2014).

Tinto (1982) asserted that the higher the students' desire to persist, the higher the retention rate. Desiring to persist requires motivation, and some of this motivation is found in the students themselves. In a qualitative study designed to investigate the challenges and motivations that developmental students experience, VanOra (2012) concluded that most students expressed an intrinsic desire to learn and to develop intellectually. Moreover, developmental students are motivated by the opportunity to make their friends and family proud of their accomplishments (VanOra, 2012). Petty (2014) indicated that friends and family can provide students with the stimulus needed to motivate themselves. This sort of intrinsic motivation can lead toward engagement.

However, some students generate the wrong perception about the value of developmental education, which affects their motivation to persist. This makes it necessary for advisors to find alternate ways to motivate them to engage. Scholars examined student perceptions relevant to developmental math and revealed that a key component necessary to increase the effectiveness of a placement process is making the student responsible for his or her level of academic preparation (Goeller, 2013; Koch, Slate, & Moore, 2012). Goeller (2013) concluded that when institutional factors are congruent with the students' needs, and students commit themselves to improve,

retention rises. This is where Astin's theory of involvement is relevant.

Astin (1999) used the word *involvement* as a descriptive noun that implies an action. The action is solicited on the part of the student and the institution. Astin developed five basic postulates that relate to involvement on the parts of the student and the institution, but it was the last two postulates that were considered key to this study. They impose a direct challenge to the student and the responsibility on the part of the institution to impose that challenge. The fourth postulate can be paraphrased as the following: the more a student puts into the learning process, the more he or she gets out if it (Astin, 1999). The behavioral actions of a student are not enough to ensure developmental success. The institution shares the responsibility in this venture by ensuring that its policy directly supports its practice. Barnes (2012) concluded that higher education practitioners should institute first-year programs designed to promote involvement and academic integration among students. This is done through established policy and the proactive assistance of personnel assigned to a first-year program.

College Readiness, Race/Ethnicity, and the use of College Support Services

The admissions criteria employed by an institution can involve an in-depth process that focuses on a variety of precollege characteristics (Fiorini et al., 2014). It is the comprehensiveness of the criteria that determines the quality of student being allowed to enroll into college. The more unselective and noncompetitive the process is, the lower the potential quality of the student being admitted (Fiorini et al., 2014). Conversely, the more selective and competitive the selection process, the higher the rates of student retention and graduation (Kena, Musu-Gillette, & Robinson, 2015). Wolfe (2012)

asserted that an institution that employs an open admissions policy often enrolls students with weak academic skills. Although the application of open admission policies is a common practice among many 4-year institutions and community colleges, community colleges undertake the responsibility of educating the majority of undergraduate students in the United States. According to the American Association of Community Colleges (2014), there are 1,132 community colleges serving over 13 million students nationwide. Sixty percent of those students have been classified as underprepared for college-level courses and commonly enroll in at least one developmental course upon entering college (Silva & White, 2013). These numbers have increased over time, and they appear to be growing every year.

Although research on racial and ethnic disparities supports a general narrowing of the achievement gap between less-advantaged minority groups (African Americans, Hispanic Americans, and Native Americans) and more advantaged groups (European Americans and Asian Americans), Zorlu (2013) asserted that the less-advantaged minority groups tend to choose community colleges rather than universities. Zorlu attributed this choice to their socioeconomic status and their lack of preparedness. Roscoe (2015) also argued that a significant percentage of underprepared students entering colleges and universities are African Americans and Hispanic Americans who, in many cases, lack the necessary skills to be successful. They begin their academic careers with financial pressures, causing them to experience difficulty in getting acclimated to the campus environment, which is followed by a progressive manifestation of behavior indicative of their low self-esteem (Roscoe, 2015). Contrary to the results of

these studies, Fiorini et al. (2014) found that a variation in performance did exist among minority students and that minority groups benefitted from the same activities, but in different ways. For example, European Americans, African Americans, and Hispanic Americans were found not to perform differently academically, when controlling for academic preparation (Fiorini et al., 2014). The disparity in the findings of these three studies motivated me to further examine race/ethnicity as a predictive factor for student success at PTU.

The level of student involvement with college support services have been linked to student success and persistence. Tovar (2015) examined how student interactions with institutional agents such as instructors and academic counselors influenced their ability to succeed, in terms of grade attainment. Tovar also examined how these student interactions affected their intention to persist to degree completion. Tovar found that the higher the frequency of meetings with faculty or instructional staff, the higher the GPA attained by the student. Tovar also found that the greater the students' involvement with college support services, the more positive the influence on students' GPA. These findings are in alignment with Astin's (1999) theory of student involvement in that the greater the effort toward personal development; the greater the benefit resulting from that effort.

In the case of PTU, the A^2 center is an example of the many support services available to developmental math students. Whether its use is predictive of the success of developmental math students is yet to be determined. Roscoe (2015) stated that the underpreparedness of students entering college is expected to increase, which will have a

significant effect on retention. These concerns have placed a greater demand on institutional leaders to find ways to mitigate the challenges associated with student remediation.

Developmental Education Intervention Programs

Developmental education is designed to bridge the knowledge gap of students who demonstrate deficiencies in basic reading, writing, and or math skills. Many colleges and universities structure these special programs to address the needs of high-risk students (Martinez & Bain, 2013). Although some progress has been made with respect to this phenomenon, it is not enough to compensate for the increasing number of students who continue to enroll in precollege-level courses (Martinez & Bain, 2013). Kosiewicz et al. (2013) suggested that the way to improve the efficiency and the effectiveness of developmental education is to reform the way that students are assessed and placed into remedial courses. Barnes (2012) concluded that mandating assessment and participation in developmental courses can improve student success not only in developmental courses but in subsequent coursework as well.

The number of students persisting through developmental courses is poor. According to Silva and White (2013), half of the students who voluntarily enter developmental education courses quit within the first few weeks of enrolling. This is an ongoing phenomenon that continues to draw the attention of scholars. In an effort to improve student success and persistence in developmental education, Roscoe (2015) identified the reasons for student underpreparedness while Tovar (2015) examined the role of faculty and counselors as it relates to student success. More can be studied in the

area of student involvement in developmental education. Fike and Fike (2012) argued that although a large percentage of students in the United States enter higher education possessing deficiencies in math and English skills, many institutions afford their students the freedom to determine when to address their deficiencies or seek help. This practice has brought about negative consequences to many students. K. McClenney and Dare (2013) asserted that students are not inclined to participate in optional activities, which lent evidence to the case for mandatory enrollment on behalf of the student.

First-year college students enter the realm of higher education with varied and complex backgrounds, experiences, beliefs, and expectations (Cole & Korkmaz, 2013). Each student is unique and requires continuous guidance to help him or her get acclimated to the new environment. First-year programs, often known as *gateway* programs, have been found to be successful in helping students overcome many barriers to success and to improve retention (Bers & Younger, 2014; Cho & Karp, 2013). They provide the students services including assistance in academic and career planning, techniques on how to improve study habits, guidance on how to best capitalize on developmental education, and tutoring (Barnes, 2012). PTU's office of first-year programs currently sponsors a one-credit course, University 101 (Univ 101), that focuses on providing students with all the services previously mentioned. Although not compulsory, it is recommended that all first-year students enroll and complete the course. Some students voluntarily enroll and complete Univ 101 and others do not, which provided a reason to study its predictive relationship to success at PTU.

Effective advising strategies play a role in the academic life of a student,

especially when the student is not prepared for college (Roscoe, 2015). First-year advisors, and academic advisors in general, share this role. Their service and dedication can help the underprepared student become socially integrated, intellectually engaged, and academically successful (Roscoe, 2015; Tinto, 1988). Advisors must approach their roles with an understanding of the whole student concept. There "may be multiple issues and influencing factors" that may hinder the success and persistence of a student (Roscoe, 2015, p. 57).

First-year advisors can be effective in motivating new students; but, their effectiveness might be enhanced if they could rely on institutional policy to support their decision to recommend active student involvement with available learning interventions (Executive Director for Student Academic support, personal communication, June 29, 2015). PTU's A^2 center was created as an intervention strategy to help developmental students achieve success during their remediation, which allows them to persist. Face-to-face tutoring, and blended iterations of face-to-face tutoring mixed with online instruction, has been developed to assist students in their quest to overcome barriers to success. Developmental math students are encouraged to invest at least 4 hours per week at the A^2 center to augment their remedial education. Although some students prefer to spend the recommended 4 hours of face-to-face instruction with a tutor, others blend the two methods to accommodate their academic schedules. Their level of involvement is crucial to their success (Astin, 1999); therefore, frequency of use of the center is a factor that was examined in this study to determine its predictive relationship to success.

Although scholars have shown a rise in student engagement over the past decade,

the CCCSE (2015) suggested that more can be done to improve student involvement. Li et al. (2013) concluded that institutions of higher learning must exercise a tighter alignment between the way they assess student knowledge and the behavioral interventions designed to promote involvement.

Other Factors Influencing Success and Persistence

Addressing the needs of developmental students has proven to be one of the most challenging problems in higher education (Pruett & Absher, 2015). Zientek et al. (2013) concluded that for an institution to see its mission come to fruition, its administrators should strive to acquire evidence related to student success, including those factors associated with student involvement. Fiorini et al. (2014), using NSSE data from 2006 to 2012 on over 16,000 first-year and senior students to examine the factors that predict academic success, found a relationship between first-year males and their likelihood for retention. For this reason, I included gender as one of the factors to be examined in my study. The level of student involvement was also found to have a relationship to student success. Specifically, such actions as participating in cocurricular activities and using computers in academic work were found to have a positive relationship (Fiorini et al., 2014). These findings supported my decision to study the frequency of use of the A^2 center at PTU.

Pruett and Absher (2015) used pre-existing data extracted from the CCSSE results from 2011 to 2013 for over 700 institutions, including more than 400,000 students, 60% of whom were enrolled in developmental education, to examine the factors that influenced student retention in community colleges. Pruett and Absher revealed that the

most significant factors related to retention were the students' GPAs and the extent of their academic engagement. Pruett and Absher also found that most students who persisted were those who asked questions in class, contributed to class discussions, made presentations, and worked with other students in and out of the classroom. Moreover, Wang et al. (2017) found that students who completed their math requirements during their first semester have a higher rate of degree completion. These findings directly support Astin's (1999) theory of involvement and my decision to analyze the use of the A^2 center as a potential predictive factor.

Stewart, Lim, and Kim (2015) conducted an investigation of the factors related to persistence in first-time developmental students at a 4-year public research institution. Persistence was defined as the students' conscious decision to stay in school past their first year. Stewart et al. revealed a statistically significant relationship between persistence and race/ethnicity. Asian/Pacific Islander students were most likely to persist in school, followed by African American/NonHispanic, White/NonHispanic, Hispanic, and American Indian/Alaska Native students, respectively (Stewart et al., 2015). The researchers noted the importance for underprepared students to address their deficiencies during their first year of college via available interventions, tutoring programs, academic advising, and counseling. Another statistically significant relationship was found between the financial aid status of the students and their ability to persist. Students with lower cumulative student loan debt reported less stress, therefore were more likely to persist. The source of the funds received by the student was a key factor in this study and an equally important variable to be examined at PTU.

Stewart et al. (2015) also concluded that traditional age students (17 to 21) who were prepared for college-level coursework were more likely to persist beyond the first year as compared to those students who were academically underprepared. The age factor will also be examined at PTU to determine its relationship to success.

Gansemer-Topf, Zhang, Beatty, and Paja (2014) employed a mixed-methods approach to examine factors that could potentially influence attrition at a small, liberal arts college. The researchers' goal was to investigate the potential relationships between the pre-entry characteristics of 3,600 students enrolled between 2000 and 2008 and their reasons for leaving. The quantitative analysis revealed that students with lower GPAs were less likely to persist in school, although students who left the college in their first 2 years did so in good academic standing (Gansemer-Topf et al., 2014). From the qualitative analysis three overarching themes emerged: student struggles with college transition, their inability to adjust to the academic rigor, and their inability to socially integrate with other students (Gansemer-Topf et al., 2014). Gansemer-Topf et al. (2014) concluded that the sense of isolation that resulted from the students' inability to socially integrate may have led to the students' withdrawal or transfer to other institutions.

Factors that influence the academic success and persistence of developmental students can have positive or negative effects. The factors that hinder progress are considered a barrier and are appropriately addressed by administrators who envision their students' success. David et al. (2013) developed a survey to determine the barriers that were hindering progress among developmental students, then examined the relationship between these barriers and actual student success in college. Among the barriers

identified, enrollment into one or more developmental courses was viewed as a challenge by students. The results revealed a number of barriers that were found to be significant in predicting student success and persistence through college. For example, the students' level of academic preparedness for college was found to have a significant relationship with GPA (David et al., 2013).

The barriers that were found to have stronger negative relationships with measures of success were the student's inability to adjust to the college environment, financial constraints, transportation challenges, and negative experiences with college services. A relationship between student developmental placement into at least one remedial education course and student GPA was found to be indicative of the level of difficulty students were experiencing in keeping up with college-level coursework (David et al., 2013). As this is also an area of concern at PTU, the results obtained by David et al. (2013) motivated me to examine the value of the MOE placement results in predicting the success of developmental math students.

Developmental education continues to be a concern for many post-secondary schools (Hagedorn & Kuznetsova, 2016; Silva & White, 2013). How and when students receive the help they need is under scrutiny because administrators want to see their students succeed. Among the academic deficiencies demonstrated by students entering college are the fundamental skills in math (Cafarella, 2014; Harwell et al., 2013). Although many institutions test for the appropriate level of prerequisite knowledge, they fall short in prescribing when to address deficiencies (Fike & Fike, 2012). As a result, underprepared students experience difficulty persisting through their chosen degrees,

which can often be attributed to their initial lack of adequate math skills (Hieb et al., 2015; Tolley et al., 2012).

This problem is compounded by the institution when it provides the student the option of deferring remediation to a later date (Fike & Fike, 2012). When the decision to defer remediation is made by students, they are often not aware of the potential consequences their decisions may bear (Hughes et al., 2013). Institutions that allow their students to forgo their developmental education and simultaneously provide them the freedom to determine when to address their deficiencies mat yield counterproductive results (Saxon & Slate, 2013). These practices are considered ineffective and generally not in the best interest of students (Barnes, 2012). Evidence shows that student academic engagement should be encouraged and emphasized by the institution (Pruett & Absher, 2015).

Institutions can be more effective in the way they help their developmental students by focusing on identifying the factors that have the greatest influence on retention (Pruett & Absher, 2015), persistence (Stewart et al., 2015), and attrition (Ganemer-Topf et al., 2014). Identifying and examining these factors can provide effective ways to improve learning strategies, remedial interventions, and advising services designed to help developmental students succeed (Pruett & Absher, 2015; Waiwaiole, Bohlig, & Massey, 2016). However, students need to engage with their academic environment (David et al., 2013). Pruett and Absher (2015) found that there was a relationship between the extent of student academic engagement and retention. Students who persisted through college had actively participated in class, made class

presentations, and proactively exchanged with other students in and out of the classroom (Pruett & Absher, 2015). These findings were also confirmed by the relationship between key factors such as active student participation with tutoring sessions, higher GPAs, and pass rates (CCSSE, 2012).

Implications

Investigating how specific factors relate to the success of first-year developmental math students may lead to further institutional research in other disciplines such as English that may also be hindering the success of students. The information from this study may facilitate a way for administrators to consider new intervention strategies to further help students overcome barriers to success. By minimizing these barriers, students may find it easier to get acclimated to their environment, which may motivate students to stay the course and persist through their remedial education.

The results of this project study may also motivate institutional leaders to implement changes to current policy by taking a more prescriptive role in ensuring students capitalize on the benefits of developmental education at the time when it is needed the most. Addressing students' needs early may increase their chances of completing their degrees, which may in turn have a direct effect on the sustainability of the institution.

Summary

The task of accurately assessing the factors that influence student success is an ongoing exploration for every institution of higher learning. Minimizing the negative effects of some of the factors while promoting the application of best practices can go a

long way toward improving the academic performance of developmental math students. One way of aligning the institutional expectations with student achievement is by motivating students to effectively use existing resources (Tovar, 2015). These may take the form of gateway courses, active involvement with interventions designed to help students succeed, tutors, counseling, and/or the use of centers dedicated to the remediation of students' academic deficiencies. Despite the best intentions of the leadership, the decision to effectively use these resources cannot be left solely in the hands of the students (Saxon & Morante, 2014). It requires institutional commitment by way of policy enforcement (Fike & Fike, 2012) and the students' commitment to get involved (Astin, 1999).

Sustaining the vitality of a developmental program is a priority for every administrator and evidence-based policies can be a viable way of promoting student involvement with available resources (Fike & Fike, 2012). According to B. McClenney (2013), colleges are beginning to make a cultural shift toward reducing the options for entering students. One way is to test and implement new policies that pilot, evaluate, and scale-up interventions to serve large student populations (B. McClenney, 2013).

Motivated by the research presented in this literature review and the support that it renders, I decided to conduct a retrospective prediction investigation to examine seven key variables that may be influencing developmental math students' ability to succeed at PTU. The theoretical framework for this project study centers on Astin's (1999) theory of involvement whereby student learning and personal development is directly proportionate to the students' level of involvement and Tinto's (1988) theory of retention

which postulates that social and academic integration are critical for students during their first year. The purpose of this study was to determine which factors were predictive of the success of developmental math students. The following section will delineate the methodology I used to collect and analyze the data.

Section 2: The Methodology

Increases in the attrition rate of first-year college students can have an adverse effect on an institution's ability to sustain growth. This has motivated institutions to become proactive about providing their students with the necessary resources that can help them succeed. Although many students enter higher education ill-prepared for college-level math, some strides have been made to improve their prerequisite knowledge during their first academic year (Bettinger et al., 2013). Scholars are directing their attention towards identifying the factors that influence student outcomes, such as retention (Pruett & Absher, 2015), persistence (Stewart et al., 2015), and attrition (Gansemer-Topf et al., 2014). I investigated several factors that were potentially predictive of the success of developmental math students at a local university.

Research Design and Approach

There are various quantitative designs that can be appropriately used to study an educational research phenomenon. Among these research designs are descriptive survey research, experimental research, and causal-comparative research (Lodico, Spaulding, & Voegtle, 2010). The descriptive survey research requires the use of a reliable and valid instrument (often called a survey) as the basis for data collection, while the experimental research requires the observation of one group and the treatment of another as the basis for data collection; neither of these approaches were applicable to my study. These research designs were not appropriate for my study because they rely on data resulting from events that are yet to occur. The data for my study were archival. These types of data are representative of events that occurred in the past and outcomes that have already

taken place. The effect, having taken place, prevents the manipulation of variables or differential treatment of groups. My study was quantitative in nature; I employed a retrospective prediction design with one group of students. The use of a causal-comparative design was not appropriate because I chose not to include a comparison group (Lodico et al., 2010).

The statistical analysis consisted of a binary logistic regression. The criterion (dependent) variable was dichotomous, succeeded or did not succeed. For the purposes of this study, success was defined as the students' ability to pass their respective developmental math course with a grade of C or higher. This study was guided by the following research question:

RQ: Which of the following factors are predictive of student success?

- Enrollment and completion of the Univ 101 college success course
- The MOE course placement results
- The frequency of use of the Academic Advancement Center
- The source of tuition payment
- The student's age
- The student's gender
- The student's race/ethnicity

The purpose of the study was to determine which of these seven predictor (independent) variables are predictive of the criterion variable. The null and alternate hypotheses for this study were

$H_{0:}$ None of the following factors are predictive of student success:

- Enrollment and completion of Univ 101 college success course.
- The MOE course placement results
- The frequency of use of the A^2 center
- The source of tuition payment
- The student's age
- The student's gender
- The student's race/ethnicity

H_a: One or more of the following factors are predictive of student success:

- Enrollment and completion of Univ 101 college success course
- The MOE course placement results
- The frequency of use of the A^2 center
- The source of tuition payment
- The student's age
- The student's gender
- The student's race/ethnicity

Setting and Sample

The setting for this study was a Southeastern U.S. 4-year university, PTU. I focused on adult learners categorized as first-year students who were placed in non-college-level remedial math courses. Student placement into developmental math courses was determined during the admission process as a result of the test scores attained on an institutionally-sponsored math prerequisite knowledge examination, the MOE.

The sampling strategy included all first-year students who entered the university during two consecutive fall semesters during the 2-year academic period, 2013–2014 and 2014–2015, who took the MOE, placed in remedial math, and enrolled and completed their developmental math courses during the first semester they were enrolled at PTU. According to the logistic model presented by Vittinghof and McCulloh (2007), more than 20 outcome events per predictor variable (EPV) should be used to appropriately predict the outcomes of this study. This study contained seven predictor variables, which multiplied times 20 EPVs produces a minimum sample size of 140 participants per academic year. The Office of Institutional Research at PTU revealed that each academic year from 2007-2012 yielded more than 200 participants from fall to fall. Collectively, 557 students encompassed the cohort of participants in this investigation. This number of EPVs was sufficient to produce results generalizable only to other students at the local university (Lodico et al., 2010).

Instrumentation and Materials

Archival data relevant to the enrollment and completion of Univ 101 college success course, the institution's MOE course placement results, the frequency of use of the A^2 center, the source of financial aid, age, gender, and students' race/ethnicity were the predictor variables used to predict the criterion variable of success in completing the developmental math course.

The MOE was developed in the spring of 2006 by math professors at PTU after testing and rejecting the use of nationally-normed placement tests that were found to lack the ability to accurately assess the math prerequisite knowledge required of students

taking college-level math courses at PTU (Associate Dean of Operations, personal communication, July 23, 2015). The newly developed MOE was tested in the fall of 2006 with more than 1,000 students to establish its reliability and validity, for which it met the minimum requirements of PTU and was implemented for institutional use in the fall of 2007 (Associate Dean of Operations, personal communication, July 23, 2015). Since then, the MOE has been the official placement test used by PTU to evaluate math prerequisite knowledge.

Data Collection and Analysis

Walden University's Institutional Review Board (IRB) and PTU's IRB requires all research be approved through an established process. Each institution's review process was followed to gain the appropriate consent to conduct my study. Each process included mandatory human research protection training and certification and the submission of an application, which were reviewed and approved by the respective IRB. The applications included a data use agreement and a letter of cooperation that delineated the format of the requested data.

Once approval (Walden IRB # 09-08-16-0409151) was obtained from both institutions, the data collected for this study were extracted from two individual archives maintained by offices at the A^2 center and PTU's office of institutional research. The following delineates the source of data, the predictor variables that were examined in this study, and the nature of the scale for each variable.

Data Available from the Academic Advancement Center

The MOE course placement results and the frequency of use of the A^2 center were

provided by the administrators at the A^2 center. The MOE course placement results are categorical in nature with one of the three categories assigned as a function of the number of correct questions answered in each section tested. There are four sections in the test: beginning algebra, intermediate algebra, college algebra, and trigonometry. Each section has a total of 30 questions that are algorithmically selected by the computer beginning with intermediate algebra. Progress into a higher level math section is dependent on the examinee's ability to answer eight correct answers in any section. Failure to answer eight questions correctly causes the computer to choose questions from a lower math level, which establishes the final level of remediation required for the examinee. The course placement results are: 1 = introductory/intermediate algebra, 2 = intermediate algebra, and 3 = precalculus essentials.

Information pertinent to the frequency of use of the A^2 center was used as a predictor variable. Each time any student visits the A^2 facilities, he or she must swipe his or her student ID to gain access and swipe again to end the session. The visit is recorded in a database. The frequency of use of the A^2 center is interval in nature and was measured by the average number of hours the developmental math student made use of the facilities throughout the last 10 weeks of the term (one term = 15 weeks). The A^2 center is not open for service until the end of the 5th week of classes during the fall semester, which is the start of the early grade period at PTU. It is during the early grade reporting period that first-year advisors make their recommendations for use of the A^2 center. The A2 services are available to any student; therefore, students may be referred by an advisor, an instructor, a friend, or be self-referred.

Data Available from the Office of Institutional Research

The office of institutional research compiled and provided information relevant to developmental math students who enrolled and completed the Univ 101 college success course in their first semester, the source of financial aid used, the students' age, the students' gender, the students' race/ethnicity, and whether these students succeeded in their respective developmental math courses. This information was extracted from the institution's student data management system and compiled for this study.

Enrollment and completion of the Univ 101 college success course is categorical in nature and was measured by the grade obtained in the course. A grade of D or better will qualify as a passing grade for the course: 1 = passed, 2 = did not pass, and 3 = did not enroll (DNE). Also extracted from each of the developmental math students' records was the source of financial aid used which is categorical in nature and was measured by categorizing the source of the funds: 1 = loans, 2 = grants, 3 = scholarships, and 4 = other.

The students' age was extracted from the students' records. The students' age is continuous in nature, and it was measured by documenting the actual age of the participant in years. The students' gender was extracted from the students' records: 1 = female and 2 = male. Finally, the students' race/ethnicity was extracted from the students' records. The students' race/ethnicity is categorical in nature and was based on their recorded origin: 1= White American, 2 = African American, 3 = Hispanic, 4 = Other.

Data Analysis

A binary logistic regression analysis was conducted to investigate the relationship of each of the seven predictor variables with one criterion variable. The criterion variable of success was dichotomous, succeeded or did not succeed. The purpose of the study was to determine if the seven predictor variables were predictive of the criterion variable.

The Statistical Package for the Social Sciences (SPSS) software was used to perform the analysis of the data. My ability to carry out a binomial logistic regression through SPSS was contingent on the validity of the data and its ability to conform to assumptions (Stoltzfus, 2011). Prior to conducting the analysis, I checked the criterion variable and each of the seven predictor variables to ensure the results obtained were valid and usable (Nussbaum, 2015). I considered the following seven underlying assumptions to check for conformity:

1. The criterion variable should be measured on a dichotomous scale. The criterion variable was categorical in nature, and it contained two outcomes: succeeded and did not succeed. The use of a dichotomous variable is appropriate for a binary logistic regression analysis (Nussbaum, 2015).
2. One or more predictor variables should be continuous or categorical in nature. Of the seven predictor variables analyzed in this study, two were continuous in nature (age and frequency of use of the A^2 center). The remaining five predictor variables (enrollment and completion results of Univ 101 course, MOE placement results, source of tuition, gender, and race/ethnicity) were categorical in nature, and each had multiple levels that prompted the use of

dummy variables (Nussbaum, 2015).

3. A basic assumption for conducting logistic regression is that there cannot be a relationship between the categories of any variable (Stoltzfus, 2011). I had independence of observations and the category of the dichotomous criterion variable. All nominal predictor variables were mutually exclusive and exhaustive.
4. There should be enough cases to support the reliability of estimates generated by a logistic regression. According to Stoltzfus (2011), there is no universally accepted standard for the minimum number of outcomes per predictor variable that should be obtained in a binary logistic regression. Nonetheless, I chose to follow the recommendations of Vittinghof and McCuloh (2007) who stipulated that a minimum of 20 EPVs should be enough to appropriately predict the outcome of a study. This study exceeded 20 EPVs, which satisfied the assumption.
5. There needs to be a linear relationship between the continuous predictor variables and the logit transformation of the criterion variable (Stolfus, 2011). I used the Box-Tidwell (1962) approach, which added an interaction term between the two continuous predictor variables (age and the frequency of use of the A^2 center) and their natural logs to the regression equation. The test for age resulted in a linear relationship with the logit transformation of the criterion variable, which met the assumption. However, the average number of hours indicating the frequency of use of the A^2 center by each student did

not show a linear relationship due to missing data. This result violated the assumption. The rationale for the missing data was that some students chose not to use the A^2 center during their first semester of math remediation; therefore, no hours of usage were logged. Under such circumstances, the violation can be corrected by imputation based on logical rules (Nussbaum, 2015). This imputation strategy does not rely on any assumption because the rationale for the missing data is known. I was able to correct the violation by imputing zeroes on all students who did not make use of the A^2 center. I took the same approach with the missing data relevant to students who chose not to enroll into Univ 101, which was one of five categorical predictor variables analyzed in this study. Because the rationale for the missing data was known, I identified this choice as Did Not Enroll, which added another level to the predictor.

6. Data must not show multicollinearity. This test assumes the absence of multicollinearity or redundancy among predictor variables. "A logistic regression model with highly correlated independent variables will usually result in large standard errors" (Stoltzfus, 2011, p. 1101). This violation is commonly resolved by eliminating redundant variables. Because my data did not show multicollinearity, no variables had to be eliminated.
7. There were no significant outliers in the results of the logistic regression; therefore, the assumption was met.

Once all tests were performed, violations corrected, and all assumptions satisfied,

I proceeded with the analysis of the data. The results were considered valid and supportive of a binomial logistic regression.

Assumptions, Limitations, Scope and Delimitations

Assumptions

One of the assumptions relevant to this study was that, because the data were extracted from official student records, the archival data provided by each of the departments at PTU were reliable and valid. Another assumption was based on the honesty exercised by each student taking the MOE. The dynamics of this online test assume that each student exercises personal integrity in the answers provided during the knowledge assessment. I also assumed that all students put forth their best effort in answering each question.

Limitations

This study was based on a single institution setting; therefore, the findings were not generalizable to other institutions. Furthermore, this study did not include veterans who entered the college environment for the first time without postsecondary experience and who were classified and processed as transfer students. The results of this study were limited to the two consecutive fall semesters during a 2-year academic period from which the data were extracted; therefore, generalizations to other years would depend on the similarities of the participants and predictive variables in those years.

Scope

The scope of this study was limited to the academic success of first-year developmental math students, and I did not assess any performance factors related to

other disciplines such as English, which may also contribute to the institution's overall attrition rate among developmental education students.

Delimitations

I chose this course for my study because I am interested in improving the success rates of developmental math students at my institution. However, I do understand that substandard performance in developmental math courses is not the only phenomenon affecting remedial students. Students taking English and science disciplines are also experiencing similar challenges, and these challenges can contribute to an institution's overall attrition rate.

Another delimitation is the fact that I did not include a comparison group in the study. The purpose of this study was to conduct a retrospective investigation of variables predictive of the success of one group of developmental math students, not to compare the data relevant to two groups, as in the case of a causal comparative study (Lodico et al., 2010). Lastly, the seven predictor variables measured in this study do not represent all of the variables that could be related to the criterion variable of success. They were chosen based on their importance reported in previous research as discussed in the literature review.

Protection of Participant's Rights

Approval to conduct this study was sought from Walden University's and PTU's IRBs prior to collecting any data. Once approval was obtained, the data collected as part of the everyday operations of the institution, were requested. The data from the two archives were matched and de-identified by PTU's Office of Institutional Research and

the office of the A^2 center prior to my receipt to protect the identities and the rights of the students in the sample. A signed consent form from each of the participants was not necessary because participants' names and ID numbers were removed from the data before they were provided to me as the researcher. A signed letter of cooperation between myself and the two offices charged with the custody of data delineated these protections.

Data Analysis Results

A binomial logistic regression was performed using SPSS software to ascertain the effects of a grade in Univ 101 course, source of tuition payment, age, gender, race/ethnicity, Math Online Evaluation (MOE) course placement results, and frequency of use of the A^2 center on the likelihood that participants would succeed in their respectively assigned developmental math course. Linearity of the continuous variables with respect to the logit of the dichotomous criterion variable was assessed using the Box-Tidwell (1962) procedure. The following are the results obtained from the analysis. The sample size (n = 557) consisted of participants who entered the university during two consecutive fall semesters during the 2-year academic period, 2013–2014 and 2014–2015 who took the MOE, placed in remedial math, and enrolled and completed their developmental math course during the first semester at PTU. Table 1 shows the descriptive statistics relevant to the sample.

Table 1

Descriptive Statistics for Predictor and Criterion Variables

Variable	*n*(%)	Mean	Median	SD	Skew
Freq of Use A^2 Center	149 (27)	0.86	0.00	2.16	3.01
Age	557 (100)	18.60	18.00	2.46	5.74
Completed College Success					
Passed	307 (55)				
Did Not Pass	5 (0.9)				
Did Not Enroll	245 (44)				
MOE Placement					
Intro/Intermediate Algebra	100 (18)				
Intermediate Algebra	329 (59)				
Pre-calculus Essentials	128 (23)				
Source of Tuition					
Loans	388 (70)				
Grants	473 (85)				
Scholarships	399 (71)				
Other	59 (11)				
Gender					
Female	121 (22)				
Male	436 (78)				
Race/Ethnicity					
White	288 (52)				
African American	57 (10)				
Hispanic	25 (5)				
Other	187 (34)				
Remedial Math Course Results					
Succeeded	446 (80)				
Did Not Succeed	111 (20)				

The correct encoding for the dichotomous criterion variable was verified to be 0 for Did Not Succeed and 1 for Succeeded. The results produced by SPSS under Block 0: Beginning Block show that the correct encoding for the criterion variable was used by the model without the effect of any of the predictor variables. Based only on this constant, the classification table shown below demonstrates that if we knew nothing about our predictor variables and guessed that a student would succeed in their developmental math course as placed by the MOE we would be correct 80.1 % of the time. Among these participants, there were 446 students who succeeded in their developmental math courses based on their MOE placement recommendation and 111 students who did not succeed. These results are shown in Table 2 below.

Table 2

Classification Table Without the Effect of Variables

		Predicted		
		Remedial Math Course Results		Percentage Correct
Observed		Did Not Succeed	Succeeded	
Remedial Math Course Results	Did Not Succeed	0	111	0
	Succeeded	0	446	100
	Overall Percentage			80.1

The logistic regression model was statistically significant, $X^2(16) = 38.247$, $p < .005$. Model fit was verified by two individual tests, the omnibus tests of model coefficients and the Hosmer and Lemeshow test. The omnibus tests revealed that the model was statistically significant ($p < .001$) and therefore fit, while the Hosmer and Lemeshow goodness of fit test verified the model's fitness through a significance of

p = .441. Failure to find significance in this test denotes proper fit of the model (Nussbaum, 2015).

I conducted a binomial logistic regression analysis of seven predictor variables to one dichotomous criterion variable (succeeded and did not succeed) using SPSS. The statistical analysis estimated the probability of success of developmental math students. Dummy variables were generated prior to the analysis to account for multilevel categorical predictors. The multilevel categorical predictors in this study were enrollment and completion of Univ 101 (Passed, Did Not Pass, or Did Not Enroll), the MOE course placement results (introductory/intermediate algebra, intermediate algebra, and pre-calculus essentials), the source of tuition payment (loan, grant, scholarship, and other), gender (female and male), and race/ethnicity (White, African American, Hispanic, and Other). The remaining two of the seven predictor variables were measured on a continuous scale, which were identified as age and frequency of use of the A^2 center. If the probability of a case was greater than the cut value of .5, then the model classified the event as occurring, which is to say that the student succeeded in the developmental math course. Otherwise, the case was classified as Did Not Succeed.

The model explained 10.5% (Nagelkerke R^2) of variance. With the addition of all predictor variables, the model correctly classified 80.8% of the cases. Sensitivity was 99.6%, which denotes the percentage of students who were predicted to succeed by the model. Specificity was 5.4%, which indicates the percentage of students who did not succeed as predicted by the model. The results provided a positive predictive value of 80.87%. This value represents the percentage of correctly predicted students compared to

the total number of cases predicted as being successful. The negative predictive value was .75%. This value represents the percentage of correctly predicted students who did not succeed compared to the total number of cases predicted as not being successful. Table 3 shows the overall prediction percentages made by the model taking into account the effect of all variables.

Table 3

Classification Table with the Effect of All Variables

Observed		Predicted		
		Remedial Math Course Results		Percentage Correct
		Did Not Succeed	Succeeded	
Remedial Math Course Results	Did Not Succeed	6	105	5.4
	Succeeded	2	444	99.6
	Overall Percentage			80.8

Inferential Analysis by Research Question and Hypotheses

One research question guided this study to determine which of seven variables were predictive of success in developmental math. The null hypothesis (H_0) stating that none of factors were predictive of student success was rejected. Conversely, the alternate hypothesis (H_a) was supported. Of the 16 predictor variables analyzed in this model (dummy variables included), three were statistically significant: Univ 101 college success course ($p = .019$), introductory/intermediate algebra ($p < .001$) and intermediate algebra ($p = .007$). Table 4 displays all the model predictions.

Table 4

Model Predictions of Success in Developmental Math

							95% CI EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Freq Use A2 Center	.14	.07	3.74	1	.053	1.16	1.00	1.34
Age	.02	.05	.11	1	.741	1.02	.93	1.11
Gender (male)	.28	.30	.89	1	.346	1.33	.74	2.39
Source of Tuition								
Loans	-.15	.29	.29	1	.593	.86	.49	1.50
Grants	-.38	.40	.90	1	.343	.68	.31	1.50
Scholarships	.10	.28	.13	1	.715	1.11	.64	1.93
Other	.25	.46	.29	1	.592	1.28	.52	3.17
Race/Ethnicity								
White	.06	.26	.05	1	.831	1.06	.64	1.75
African American	-.15	.43	.11	1	.736	.87	.37	2.01
Hispanic	.68	.50	1.86	1	.173	1.96	.74	5.18
Univ101 College Success								
Passed	.57	.24	5.52	1	.019	1.77	1.10	2.84
Did Not Enroll	1.09	.95	1.32	1	.250	2.98	.46	19.16
MOE Placement								
Intro/Intermediate Algebra	1.61	.40	15.75	1	.000	4.98	2.25	10.99
Intermediate Algebra	.93	.34	7.28	1	.007	2.53	1.3	4.97

The dummy variables that were considered predictive of success in developmental math represent students who voluntarily enrolled and successfully passed Univ 101 college success course, as well as students who took the MOE and immediately engaged with the placement recommendation relevant to introductory/intermediate algebra or

intermediate algebra developmental math courses. The model suggested that students who enroll and successfully complete Univ 101 are 1.8 times more likely to succeed than students who choose not to enroll. Similarly, students who place and engage with introductory/intermediate algebra are 5 times more likely to succeed in their developmental course than students who choose to engage with precalculus essentials after placement. Additionally, students who place and engage with intermediate algebra are 2.5 times more likely to succeed in their developmental course than students who choose to take precalculus essentials after placement.

During further analysis of my results, I compared the odds ratio of success between students who placed in introductory/intermediate algebra and intermediate algebra developmental math courses and discovered that although both groups of students were successful in their respective remedial math courses, there was a difference in the likelihood of students' success (see Table 4). The Exp(B) value for introductory/intermediate algebra indicates that students in this developmental course are 5 times more likely to succeed than students in the most advanced course. In contrast, the Exp(B) value for intermediate algebra indicates that students in this developmental math course are 2.5 times more likely to succeed. The difference in odds ratios between these two developmental math courses indicates that students who enroll in the lower developmental math course (introductory/intermediate algebra) are 2.5 times more likely to be successful than those who enroll in intermediate algebra.

Based on these results, I have concluded that enrollment in and successful completion of Univ 101 college success course is a contributor to success in these

developmental math courses. I have also concluded that the lower the level of developmental math a student is placed in, and consequently engages with, the higher the probability of success.

The theoretical framework for this study was based on Astin's (1999) theory of student involvement and Tinto's (1988) theory of student retention. Astin theorized that "the amount of student learning and personal development associated with any educational program is directly proportionate to the quality and quantity of student involvement in that program" (p. 519). The results of this study directly supported Astin's theory. Students at the local institution, who proactively enrolled and passed Univ 101 college success course were 1.8 times more likely to succeed in their developmental math courses. Additionally, students who placed and completed introductory/ intermediate algebra or intermediate algebra during their first semester, increased their likelihood of success when compared to students who enrolled in a higher level of developmental math course such as precalculus essentials.

The results of my study also supported Tinto's (1988) theory of retention. Tinto argued that there are several factors responsible for student attrition; one of which is a student's inability to socially and academically integrate into the fabric of the university system during the first semester. By enrolling and passing Univ 101 college success course and successfully completing a lower-level recommended developmental math course (introductory/intermediate algebra or intermediate algebra), students earned the opportunity to progress into college-level math courses, which in turn allowed them to persist toward the completion of their chosen degree program (Stewart et al., 2015).

Ultimately, this successful progression can have a positive influence on retention and the institution's ability to sustain growth (Pruett & Absher, 2015). The following section will introduce the project genre for this study and review the literature in support of a policy recommendation.

Section 3: The Project

Rationale

I chose a policy recommendation to address the problem because evidence-based research is an acceptable approach to policy reform (American College Personnel Association, 2015). Being able to identify which factors are predictive of student success in developmental math courses can assist the local institution in realigning its processes to help developmental students succeed. The data analysis conducted in Section 2 suggests a strong relationship between two of the predictor variables, enrollment and successful completion of Univ 101 college success course and students who placed and enrolled in two lower-level developmental math courses (introductory/intermediate algebra or intermediate algebra) with the criterion variable of success in developmental math courses.

An evidence-based policy recommendation will provide institutional stakeholders with the opportunity to review the results of this study and decide whether to make enrollment in Univ 101 college success course and math remediation courses compulsory for all first-year students in need of assistance. Based on the results of my study, I concluded that first-year students who enrolled and successfully completed the Univ 101 college success course were 1.8 times more likely to succeed in their developmental math courses. Similarly, students who placed and engaged with introductory/intermediate algebra were 5 times more likely to succeed in their developmental course than students who chose to engage with precalculus essentials after placement. Additionally, students who placed and engaged with intermediate algebra were 2.5 times more likely to succeed

in their developmental course than students who chose to take precalculus essentials after placement. If adopted, the new policy could potentially benefit the students and the institution in several ways. First, it can promote student involvement with available resources, which is a benefit supported by the theoretical foundation of this study. Second, the resulting success can facilitate student upward mobility into college-level math courses. Consequently, students may stand a better chance of persisting in school (Stewart et al., 2015), which can have a positive influence on the institution's retention rate (Pruett & Absher, 2015). For these reasons, development of a policy recommendation became the most appropriate genre for the project following this study.

Review of the Literature

This section is a review of literature on the importance of institutional policies, key factors to consider when planning and writing effective policies, the role that external influences play on the development of policy, how optional remediation became policy in Florida, and the challenges brought about by the implementation of these policies. For this literature review, I examined peer-reviewed articles, journals, and scholarly books. Resources of the Walden University Library and the local university websites were used to access ProQuest Central, IEEE Explorer, and the ERIC databases to conduct searches on terms related to policy reform. Search terms included the following: *education policy*, *policy reform*, *policy implementation*, *developmental education*, *assessment and placement*, and *writing effective policy*.

The Importance of Policy

It is important for higher education institutions to develop and implement policy.

Although policies are general in nature, they can be used to regulate actions and or outcomes. Policies are the *what* and *why* things are done (Swain & Swain, 2016). The construct of a policy can be philosophical in nature, such as that of a vision or mission statement (Campbell, 1998). A policy can also be used to impose a general rule, such as requiring compulsory participation in remediation courses. Policies can provide guidance and consistency in day-to-day operations. They are commonly supplemented by procedures, which specify *how* things are done (Campbell, 1998).

Many stakeholders are uncomfortable writing policy because these statements are often too general and or ambiguous. According to Campbell (1998), ambiguity is necessary and often desirable because not all pertinent details relevant to a policy are quantifiable. Some researchers would further argue that "policies are rarely implemented as written nor necessarily as intended" (Rigby, Woulfin, & Marz, 2016, p. 295). The amount of ambiguity incorporated into policy is contingent on the subject matter and the degree of subjectivity needed to uphold fairness and professionalism (Campbell, 1998). For example, policy may require that all first-year students be assessed for their prerequisite knowledge in math upon admittance into an institution, but may not specify how the knowledge is assessed, nor dictate the applicable placement scores. Procedures are developed to incorporate the details necessary to carry out general policy. Policies and procedures are the product of clear, conscious decisions made by stakeholders to convey how an organization intends to operate (Peabody, 2013). They are directed to an applicable audience to minimize or eliminate confusion and facilitate completion of an objective (Campbell, 1998).

Planning and writing a policy must be done systematically and with attention to detail. Policies must be written with the purpose of detailing *what* should be done as opposed to *who* should be doing *what*, which is a characteristic related to procedures (Peabody, 2013). When writing a policy, care must be taken to ensure its content conveys the right message.

A policy has the overarching goal of describing and conveying a management decision (Peabody, 2013). In an education setting, management includes those vested with the authority to make the decisions at an institutional level or even a department level. Management at an institutional level occupies such positions as members of the board of trustees, the president, or the chancellor, if applicable, while management at a department level may include department chairs or department supervisors. Although policies written at these levels tend to be general in nature, they are written with the purpose of informing faculty, staff, and the student body of decisions that regulate actions.

Peabody (2013) made recommendations on how to systematically plan and write an effective policy recommendation that is understood by the reader. Planning ahead gives the writer time to lay out the components of this document in a coherent manner. Some of these recommendations include the following:

1. Write the title in six words or less. This approach cuts down on filler words. Every word must convey the message. The end product is usually a short, creative, no-nonsense title that is easy to grasp by the reader.
2. Describe the boundaries of the recommended policy. In essence, this is the

scope of the policy. Who is the policy applicable to?

3. Identify the issue and list the main points in a concise manner. Limit sentences to 17 words or less. Long sentences tend to discourage the reader.
4. Use active verbs as opposed to passive verbs. Make ideas clear and readable. Passive verbs inflate writing. Be accurate.
5. Recommendations are based on the most recent and accurate information. Have a compelling argument.
6. Policy recommendations are a form of argument. Form reasons, justify beliefs, and draw conclusions with the intent of influencing others.

I applied these guidelines to the policy recommendation I intend to present to stakeholders at the local institution. My task is to pose a convincing argument for my audience of the appropriateness of my recommendation. I will delineate the results of my study, which will be used in the discussion section. This section will include the background for the problem, a summary of my research study, the factors I considered in arriving at the alternatives, the analysis of the options presented, and all empirical evidence that led to my recommendation.

Although developmental education policies are commonly motivated by the needs of the institution, their priority and justification can also be influenced by external interest groups or public decision makers. In this next section, I explain the role external influences play on developmental education policies.

External Influences on Developmental Education Policy

Improving developmental education has been a widespread topic in higher

education settings. Developmental education instructors, curriculum developers, and academic advisors have taken an interest in improving the mechanics of remediation. Their overarching goal has been to improve the success rate of students in need of remediation (Cafarella, 2016). There are also other external entities that have taken an interest in the topic. For example, the Bill and Melinda Gates Foundation has pledged $110 million to research and develop pioneering models that would help students succeed in developmental education (Cafarella, 2016). The Gates Foundation is also credited with helping start Complete College America (CCA), a nonprofit advocacy group that is working with lawmakers to reduce or eliminate developmental courses and facilitate vertical access into college-level required courses (Mangan, 2013). The CCA (2012a) argued that the remedial education efforts made by many higher education institutions were not as effective as many were thought to be.

This approach was at the top of a priority list for the head of Complete College America, Jones, who worked "to convince legislators throughout the country to eliminate remedial courses completely" (Boylan & Trawick, 2015, p. 27). The CCA's campaign influenced at least 30 states to join what is now known as the Complete College America Alliance of States (Boylan & Trawick, 2015). Consequently, many state governments are now using legislation as their tool to impose changes to developmental education policy in an effort to reduce student attrition and cost (ACPA, 2015; Boylan & Trawick, 2015; Cafarella, 2016; Gewertz, 2015; Turk, Nellum, & Soares, 2015). These legislative interventions are growing in intensity and are responsible for changing the academic and financial infrastructure of institutions in more than half the states in the United States

(Turk et al., 2015). Often motivated by budgetary constraints, some of these legislative decisions mandate that institutions realign their policies pertinent to developmental education and adopt new strategies that shorten a student's timeline between remediation and graduation (ACPA, 2015). The political push toward acceleration and compression, coupled with the burden of funding these new initiatives, consequently became a priority for college administrators.

According to Cafarella (2016), the rising cost of developmental education is at the root of many administrators' motivation to seek more funding, being that state funding is a key source of revenue for public institutions. The higher the student success and retention rates recorded, the more performance-based funding can be attained from the state (Hagedorn & Kuznetsova, 2016). This is one of the reasons why many legislators and college administrators are inclined to "view developmental math as a barrier rather than a gateway to college-courses" (Cafarella, 2016, p. 61).

The world in which educators operate is different from that of government policymakers. Each world has its own set of rules and systems of knowledge that serve their individual best interest (Turk et al., 2015). Although they are both important to their constituents, each world fails to understand the role and value of the other. A legislator's allegiance is to the general population of voters and not solely to college administrators, faculty, and counselors who deal directly with the needs of underprepared students.

Legislative decisions concerning developmental education are made with a limited government budget and a lack of relevant facts concerning the problems currently faced by institutional leaders. Faculty members complain about having been excluded

from conversations that take place somewhere on Capitol Hill when a bill is introduced and passed (Turk et al., 2015). One faculty member stated, "Sometimes it feels like we are being led around by the nose by people who haven't been down in the trenches doing what we are doing in developmental education math and English" (Turk et al., 2015, p. 7). These types of dynamics contribute to the opposition commonly generated in institutions around the country. When state legislators bypass faculty input, educators are left with limited options. This encourages faculty to depend on the accuracy of their institution's assessment and placement program (Two-Year College Association Research Committee, 2015).

Assessment and Placement Policies in Education

There is no national consensus on how a student's prerequisite knowledge should be assessed or how the student is placed in corresponding developmental coursework (Melguizo et al., 2014). Some researchers attribute this phenomenon to the disparity that exists between the efforts being made to ensure access to higher education and an institution's allegiance to academic standards for college-level work (Melguizo et al., 2014). This problem becomes greater when an institution makes use of an open access policy. This is another reason why assessment and placement policies are relied upon to determine the level of preparedness for college-level coursework (Melguizo et al., 2014).

Although legislative policy steers the ship in a given direction, the majority of states grant their colleges and universities some level of autonomy (Melguizo et al., 2014). Some legislatures issue a general policy, but give their respective schools the authority to generate procedures that ensure the overall objective of the policy is met. An

example is found in the states of Kentucky and Oklahoma. Although legislatures have decreed a general policy that contains the overall scope of the placement system, they have also delegated upon their respective institutions the authority to choose an alternate assessment method and its corresponding placement scores (Melguizo et al., 2014).

Standardized assessment and placement policies, along with their corresponding procedures, are frequently different among community colleges and universities mainly because of the way students are deemed college ready. Some researchers have argued that students are not being placed fairly (Ngo & Melguizo, 2015; TYCA Research Committee, 2015). Testing students while still in high school has been considered a viable method of reform for several states including California and Michigan (Melguizo et al., 2014).

Working within the legislated guidelines of the Texas Success Initiative, the state of Texas now mandates that all students entering a public postsecondary institution be assessed for prerequisite knowledge in reading, math, and writing skills (Hagedorn & Kuznetsova, 2016). As of the fall of 2013, legislative policy also mandates the use of one statewide assessment instrument with established cut scores that place students into one of three echelons: adult basic education, developmental education, and college ready. Students placed in the lowest echelon (adult basic education) are considered to have pre-high-school abilities. These students (adult basic education) are not eligible for the same types of financial aid as those placed in a developmental level (Hagedorn & Kuznetsova, 2016).

Florida State University's (FSU) Center for Postsecondary Success discovered

that approximately 78% of all Florida community college students who tested during the 2005-06 academic year placed in developmental education courses (Ross, 2014). Although this type of research-based evidence could have motivated legislators to enact policy that would mitigate these deficiencies, the Florida legislators opted to challenge the need for remediation. State law was introduced and passed in 2013 that mandated all 28 state colleges to restructure their developmental education placement processes and instruction policies. The new policy allows students who started their Florida education in ninth grade and veterans entering any of the 28 state colleges to be exempt from placement examinations and to enter directly into college-level courses despite their deficiencies (Hagedorn & Kuznetsova, 2016). This law received much criticism, and researchers continued to study the problem hoping to provide state legislators enough evidence to motivate reform (Park et al., 2016a).

Researchers have found that California accounts for the country's largest number of developmental students. Approximately 80% of the students in postsecondary schools are placing at a developmental level (Hagedorn & Kuznetsova, 2016). According to Hayward, Willet, and Harrington (2014), large numbers of community college students are being placed into lengthy traditional remedial sequences, some beginning at three levels below college-level courses. As a result, only 7% of developmental math students in California enroll in college-level courses within 3 years of starting their undergraduate coursework (Hagedorn & Kuznetsova, 2016).

Legislators in the state of Tennessee were proactive in dedicating funds to launch the Developmental Studies Redesign Initiative in 2009. This initiative focused on

promoting active learning strategies for its students using technology-infused curricula to improve developmental math and English (Hagedorn & Kuznetsova, 2016). This program, coupled with the Complete College Tennessee Act of 2010, ensured that students completed an early math course in high school and established the compulsory requisite enrollment of students in developmental courses with their enrollment in college-level courses for all first-year students. The Tennessee Board of Regents reported in 2015 that early remediation in high school has paid dividends in the amount of $6.6 million in savings and that their corequisite requirement in college has increased completion of gateway math by a factor of 4 (Freeman & Chambers, 2016).

The state of Washington has taken a different approach. Legislators implemented the Integrated Basic Education and Skills Training (I-BEST) program that combines workplace skills with literacy. The I-BEST program gives students the opportunity to complete a degree or certificate and bypass the requirements for developmental education (State Board of Community and Technical Colleges, 2015).

The legislative decisions and policies implemented by the different states previously mentioned are only a few examples of how government legislation can shape the interworking of assessment and placement programs in higher education. Some of these reforms have paid dividends and others continue to struggle, but all require the allocation of funds, which differ in availability based on the economic stability of each state. Regardless of the amount of funds allocated, every legislative decision and resulting policy has its own set of consequences that can validate or invalidate the entire effort. The next section will present some consequences that derived from a legislative

decision in Florida and some of the end results that are now being experienced.

Optional Developmental Education as a Result of Policy Reform

Traditionally, college students who are deficient in math and or English skills are assigned developmental courses with the goal of preparing them for college-level coursework. The state of Florida took a drastic departure from the status quo in 2013, when the governor signed Senate Bill 1720 into law, which essentially directed self-placement of students regardless of their deficiency (Park et al., 2016a). This law exempts Florida high school students who started their education in 2007 or later and all active duty members of the armed forces from taking placement tests, and allows them to opt out of remedial courses (Park et al., 2016a).

This law has generated much criticism (Park et al., 2016a) among school administrators, faculty, and academic advisors who had been directing these students to improve their deficiencies prior to enrolling into college-level courses. Complete College America (2012b) found that students who were given academic options commonly ignored their advisor's recommendations or opted to enroll in other nonrelated courses. In a more recent study, Park et al., (2016b) also asserted that "when important educational support systems such as developmental education are severely adapted and made optional, students may be less likely to enroll in the most appropriate course for their level of ability and future goals" (p. 225). This assertion has also been evident at the local institution.

The new legislation in Florida has had a wide sweeping impact and the concern for developmental students has grown to the point of attracting external interest

(O'Connor, 2014). For example, the Bill and Melinda Gates Foundation has funded and commissioned FSU with studying the impact of the law since its passage in 2013 (O'Connor, 2014). As a result, a series of studies were conducted by the Center for Postsecondary Success at FSU. The first study explored two colleges in the Florida College System to gain a better understanding of the decisions that students made following the passage of SB 1720 and to examine the factors that influenced these decisions (Park et al., 2016b). A survey was developed to investigate several student characteristics such as race, gender, and income. The researchers surveyed all new incoming students, especially those who were advised into developmental courses and either chose to enroll, bypassed and enrolled into college-level courses, or chose not to take any core subject area coursework (Park et al., 2016b).

After obtaining informed consent and acknowledging their voluntary participation, the two institutions emailed the online survey to 8,779 first-time students in the fall 2014 semester. Students were offered a $200 Amazon gift card to entice their participation. After 2 weeks, a total of 668 responses from both colleges were received. The majority of respondents were Latino (32%), followed by White (31%), Black (25%), Asian (6%), and Other (6%). The number of female respondents (64%) outweighed the male gender group. The modal household income for students living at home or financially independent was between $21,000 and $50,999. About 27% of the households reported an income between $11,000-20,999, 18% made less than $11,000 annually, and 22% of households reported making $51,000 or more. Students' ages ranged between 16 and 53 years of age, with 92% being 25 years or younger. The great

majority of students fell into the traditional age bracket of 18 to 19 years of age, which accounted for 71% of the participants (Park et al., 2016b).

Descriptive statistics were used to summarize the data, then chi-square tests were conducted to determine the statistical significance of associations between the student subgroups and enrollment choice patterns. Within the total number of participants, 21% were classified as needing developmental education in reading, 24% in writing, and 42% in mathematics. From the total subgroup of students classified as needing remedial math, 42% enrolled in developmental courses, 23% enrolled in college-level courses and 36% opted not to take any mathematics in their first semester (Park et al., 2016b).

Females accounted for approximately 70% of the students recommended for developmental math. The findings relevant to income and course enrollment, enrollment patterns of males versus females, and enrollment rates by race/ethnicity were not found to be statistically significant. However, the results did explain the rationale for the enrollment decisions made by these students.

The first of these findings asserted that "students don't (always) do optional" (Park et al., 2016b, p. 232). Many students elect not to take developmental courses when it is optional, even when advised to do so; instead, they enroll in a course above the level recommended to them (Park et al., 2016b). However, it was also discovered that some students were inclined to take developmental courses even when they were made optional. This finding was particularly relevant to students in developmental mathematics. The students' rationale for this decision was based on the fact that remedial math was both appropriate and necessary for their academic success (Park et al., 2016b).

Finally, for those students who did enroll, career goals and time to degree completion were the most important factors relevant to their decision to enroll.

Evidence-based research is a good way to influence policy reform in higher education. However, influencing legislators to implement policy that aligns with the specific needs of the education institution is a challenge in itself. The next section will delineate some of the challenges related to policy reform and what institutional leaders, faculty, and advisors can do to advocate for developmental education.

Challenges Associated with Policy Reform

There has been a notable push for acceleration and compression practices in developmental education in the past decade (Cafarella, 2016). Part of the acceleration strategy includes making remediation courses a co-requisite with credit-bearing courses (Mangan, 2015). The driving force behind this surge is centered on the increasing number of students who have not completed their degrees due to their lack of preparedness for college-level coursework. External entities such as the Bill and Melinda Gates Foundation and Complete College America took interest in this phenomenon and lobbied for a new direction that influenced state lawmakers to impose change through legislation. Policy reform mandated by legislation can pose serious challenges to the leadership of an institution (Turk, Nellum, & Soares, 2015), especially when many of the legislative decisions that preceded the mandate exempted the input of developmental education instructors (Cafarella, 2016). This lack of purposeful communication between public officials and institutional leaders can infringe on the possibility of a unified view relevant to what is best for developmental education (ACPA, 2015). College leaders and

developmental educators have the practical knowledge and research-based evidence that can be used to best serve the developmental education student. However, legislators cannot agree on the best way to integrate this information with useful legislation (ACPA, 2015).

Although these dynamics continue to produce frustration among educators (Turk, Nellum, & Soares, 2015), there are options that can help counteract this challenge and promote a collaborative effort toward policy reform. First, developmental educators and department chairs can do their part to communicate their concerns to their chief academic officers. Second, these concerns can then be forwarded to institutional leaders who are in the best position to speak to college trustees within their own institutions. Lastly, members of the board of trustees can use their influence with civic organizations that have the capability of hosting civic forums to address educational issues such as curriculum enhancements and funding for developmental education programs (ACPA, 2015). During these forums, institutional decision makers can ask their political leaders about their stances on issues relevant to developmental education. This type of advocacy can be effectively used to familiarize government officials with the efforts being made by local institutions in helping their constituents improve their chances for educational success.

Faculty and academic advisors also play an important role in motivating students to succeed. Faculty can advise students on how to map out an academic plan that would establish a clear path to graduation (Capt, Oliver, & Engel, 2014). Conversely, it is a challenge for faculty to map out a realistic plan for students when they are mandated to

accept a policy that promotes voluntary remediation (Pain, 2016). Park et al., (2016a) found that a considerable number of campuses that were affected by Florida's new developmental education policy resisted the legislation, which posed an increased challenge for institutional leaders. Faculty found themselves caught between the political pressures of having to document student success and the reality of underperforming students (Pain, 2016).

Academic advisors can also contribute to the growth of developmental students. Research has shown that students tend to rely on their advisor's input before making decisions relevant to their academic progress (Cafarella, 2016), which places the academic advisor in a position to influence many of the decisions made by developmental students, especially when remediation is voluntary. Without such guidance, developmental students are commonly prone to ignore the value of remediation (Pain, 2016).

Advisors can also advocate for their student's needs, by motivating them to take advantage of student success courses. Kimbark, Peters, and Richardson (2016) concluded that there was a statistically significant relationship between student participation in student success courses and persistence, retention, and academic achievement. When advisors encourage students to actively engage with available institutional resources, they are essentially contributing to their success, while promoting good policy and practice (ACPA, 2015).

Project Description

Based on the findings of my study and related literature, I developed a policy

recommendation to be presented to a group of decision makers at the local institution. The policy in question is first-year students' ability to opt-out of taking the college success course and math remediation courses during the first semester at PTU regardless of their math deficiency. Members invited to this presentation will include the Vice-Chancellor of Academic Support, the Executive Director of Student Academic Support, the Director of the Academic Advancement Center, and the Dean of the College of Arts and Sciences.

The Vice-Chancellor of PTU will select the location, date, and time of the forum that is most convenient to all invited members. A written summary of the recommendation will be provided by me to all members one week prior to the start of the meeting to provide time for all members to prepare questions. The meeting will take place at least one month prior to the end of the semester, to provide enough time for feedback and or potential follow-up meetings. A PowerPoint presentation will be used to guide the discussion.

Project Evaluation Plan

I intend to carry out an outcome-based formative and summative evaluation for my study. This type of project evaluation is appropriate when the organization is attempting to determine if the implemented changes are addressing the needs of the institution (Lodico, Spaulding, & Voegtle, 2010). The formative portion of my evaluation will require PTU's office of institutional research to provide me data relevant to the total number of students who enrolled and succeeded in Univ 101 college success course and who placed and enrolled in introductory/intermediate algebra, intermediate

algebra, or precalculus essentials as recommended by the MOE. The requested data will be due to me no later than the end of the fifth week of the fall 2018 semester. These data will establish a reference point from which to compare the data that will be requested for the summative evaluation report.

With the approval of the members previously identified as decision makers, it is also my intention to present my proposed policy recommendation to the campus community (faculty and staff) to assess their opinion with respect to the practicality of the project. After the presentation, I will be disseminating a short evaluation form to assess their opinion toward the proposed policy recommendation. Once filled out, the evaluation form can be return to me by campus mail. A sample of the short evaluation form is included in Appendix B of this study.

As part of the summative report, the office of institutional research will provide me the total number of developmental math students who enrolled and successfully completed Univ 101 college success course and the results of their assigned remedial math courses by the end of the subsequent spring 2019 semester. A comparison of these two sets of numbers will establish the success rate for this group of developmental math students being assessed at the local institution, which will serve as the indicator for measuring the effectiveness of the recommended new compulsory policy. The collected results of the short evaluation form will also be added to the summative report. Neither the formative data nor the summative data collected by the Office of Institutional Research will have participant names or ID numbers when forwarded to me to protect the identity of all students. An outcome-based summative evaluation report will be prepared

by me no later than the end of the spring 2019 semester and subsequently made available to the same stakeholders to whom the policy recommendation was originally presented.

Project Implications

This study investigated which of seven factors were predictive of student success in developmental math courses at PTU. Out of the seven predictor variables, a logistic regression analysis found two factors to be significantly predictive of student success in developmental math. Decision makers at PTU can use this evidence-based research to consider the adoption of a policy recommendation that would make it compulsory for students to increase their involvement with available resources that would help them succeed.

Minimizing barriers and improving the success of developmental math students will continue to be a priority for administrators at PTU. Although the results of this investigation are only applicable to the sample of students needing math remediation studied at PTU, similar investigations can be initiated to identify other factors that may relate to developmental students in other disciplines such as English.

The information extracted from this study also has the potential to foster social change related to the quality of the curriculum currently in use by other disciplines. This type of positive social change could be viewed as a best practice, which can prompt other departments at PTU to adopt and implement changes accordingly. The following section will summarize the reflections and conclusions for this study.

Section 4: Reflections and Conclusions

Project Strengths and Limitations

In this section, I discuss my project's strengths and limitations, and I share possible future research directions. The strength of my project is in its potential to identify factors that can enhance the academic success of students enrolled in developmental math courses during their first semester. Although there is research in the field relevant to the lack of student preparedness for college-level coursework (Okimoto & Heck, 2015), there is not enough research dedicated to examining which factors may have a positive effect on success after remediation. Conversely, finding the reasons why students fail their remedial math courses is just as important; the lack of this information was a limitation in my study.

Astin (1999) postulated that the more students put into the learning process, the more they would get out of it. Astin's argument was based on the students' ability to get involved with their own academic development. Although the level of involvement of students can be affected by their level of motivation (Krumrei-Mancuso, Newton, Kim, & Wilcox, 2013), leaving the choice solely to students has proven to be a barrier to success (Fain, 2012). Alternatively, institutionally-mandated interventions may be in the best interest of developmental students (Fike & Fike, 2012).

In the project for this study, I make an argument for a more prescriptive intervention on behalf of the institution. A change in policy would require compulsory participation in developmental math courses for all first-year students found to be deficient upon admission. If the policy recommendation is adopted, developmental math

students who enroll and successfully complete the institution's Univ 101 College Success course, as well as engage and complete introductory/intermediate algebra or Intermediate algebra remediation courses, stand to improve their odds of success in developmental math, which was another strength of this study.

Recommendations for Alternative Approaches

In the theoretical foundation and the review of literature, scholars described the importance of student involvement and the role it plays in the success of students in need of math remediation. The factors that were identified to be predictive of success during my investigation would not have surfaced had the participants not made a decision to voluntarily enroll into Univ 101 College Success course and into their prescribed remedial math courses. An alternative approach that would promote student involvement would be for the institution to offer the college success course and the recommended remediation courses at a fraction of the cost. By reducing the cost, the institution would reduce the financial constraints, which are viewed by the remedial math student as a barrier to success (David et al., 2013).

Given that student use of the institution's A^2 center was not predictive of success of developmental math students in this study, an alternative approach may be to study the intervening factors on a deeper level. The teaching methodology of the developmental math courses can be studied for correlation to the tutoring methodology offered at the A^2 center. If both methodologies are supportive of each other, then students could reap the benefits of both resources during the first semester, which could contribute to the success of remedial math students.

Scholarship, Project Development and Evaluation, and Leadership and Change

Scholarship

Conducting meaningful research is contingent on following pre-established rules of engagement. Every step of the process has a purpose, and every process is planned ahead of time. Everything from defining the problem to proposing the best approach to study a phenomenon is calculated and strategically approached.

On a personal level, I have learned new disciplines that have equipped me to become a better researcher. Such disciplines include keeping my biases in check, the importance of protecting the rights and privacy of all participants, and maintaining my objectivity throughout the research process. I feel I understand the fundamental requirements relevant to research in academia, which will guide me in future investigations.

Project Development and Evaluation

My doctoral capstone project allowed me to develop many skills that I did not have. It taught me how to value retrospective data—how to acquire them, organize them, and prepare them for analysis. During this process, I learned some of the intricacies of SPSS and how to manipulate its functions. My study has also taught me the value of descriptive statistics and how to accurately infer based on the results obtained. Finally, this investigation has taught me the importance of applied research and how it can be used to evaluate the effectiveness of institutional programs.

Leadership and Change

As a beginner researcher, I learned early that following a sequential set of

instructions could help me avoid many pitfalls along the way. Being able to submit to established rules and proven guidelines made it possible for me press through and succeed. Nonetheless, my desire to succeed and my personal drive was not enough. Having a knowledgeable and effective committee chair with the ability to influence me to follow made a world of difference.

The most valuable lesson I learned in this process was influencing others to follow with the intent of changing the status quo. Gaining enough buy-in from those empowered to implement change is essential to the process of change. However, change does not come easy to many. Influencing stakeholders to see the need for change while relying on research results is no easy feat. This negotiation of sorts accentuates the importance of being thorough in the research process. The more compelling the evidence, the greater the odds of affecting change.

Reflection on Importance of the Work

This doctoral project study has given me an opportunity to contribute a small measure of research toward the field of student success in developmental education. Although the results of my study were only applicable to the local institution, I am hopeful that my work piques the interest of other researchers in the discipline.

As a practitioner, I discovered that I was missing the essential skills that would help me reach the level of a successful scholar-practitioner. I soon learned that although I had the desire to solve pressing problems at my institution, I needed to approach the problem with a different attitude. I had to learn how to think in a scholarly way and to convey the facts without allowing them to be skewed by my personal bias. I have

enriched my vocabulary in the process, which has allowed me to effectively communicate my research discoveries to those empowered to make changes.

As project developer, this research study has allowed me to think in new directions. I have learned that in research, there is strength in numbers. Collaborating with other researchers and collectively pooling our strengths can open the door to new possibilities. In doing so, I not only allow myself to learn new techniques from other researchers, but I place myself in a position to see a problem from their perspective. I have learned to engage in open dialogue with other professionals in the field, as well as create new opportunities for me to share my ideas.

Implications, Applications, and Directions for Future Research

Implications and Applications

Nationally, over 40% of first-year students begin their higher education inadequately prepared for college-level coursework (Harwell et al., 2013). The percentage of students in need of math remediation at the local institution coincides with the national trend. The challenges experienced by students in this cohort are greater than those encountered by college-ready students. Although the culprit of these challenges is not a single cause, researchers continue to study the phenomenon hoping to find ways to minimize its effects.

Although some researchers have focused on studying the reasons why remedial math students fail, others have studied the factors that help these students succeed. In this study, I examined seven factors for their likelihood of predicting the success of students enrolled in developmental math courses. I found that students who enrolled and

successfully completed the college success course (Univ 101) were 1.8 times more likely to succeed than students who chose not to enroll. Similarly, students who placed and engaged with introductory/intermediate algebra were 5 times more likely to succeed in their developmental course than students who chose to engage with precalculus essentials after placement. Additionally, students who placed and engaged with intermediate algebra were 2.5 times more likely to succeed in their developmental course than students who chose to take precalculus essentials after placement. Immediate enrollment into Univ 101 and developmental math courses is currently optional at the local institution and generally left to the student to decide when to address the deficiency. The results of my study prompted me to develop a policy recommendation to change existing policy and make it compulsory for students to enroll into Univ 101 and the prescribed remedial math course upon identification of their deficiency. Taking a more prescriptive role in the remediation of students is a way for the institution to exercise a tighter alignment with behavioral interventions designed to promote involvement (Li et al., 2013).

The potential for social change at the local institution resides in the hands of its stakeholders. Although it is true that a greater number of first-year students would fill the seats of remedial math courses at the beginning of each academic year, the benefits of such change would outweigh the increase in cost for remediation. Ultimately, this change has the potential of positively affecting the institution's ability to sustain growth.

The effect of this social change can also reach beyond the boundaries of the institution. Other colleges in the local area can view this change in policy as a best practice and choose to benchmark and advocate for change of their own policies based on

the empirical results obtained at PTU.

Directions for Future Research

This study has the potential of capturing the interest of other researchers within PTU. If the policy recommendation resulting from this study is adopted and if it produces the expected results, other internal departments may be motivated to investigate which negative factors may be influencing students to drop out of developmental education courses before receiving the full benefit of remediation. Identifying these negative factors may present the administration with the opportunity to minimize or eliminate these obstacles, which can further strengthen the students' ability to succeed.

Conclusion

Helping students see the importance of their own contributions toward their education likely was the motivation that drove Astin's (1999) to write the fourth postulate. Astin stated that the more students put into the learning process, the more they get out of it. Students should want to help themselves, especially when the necessary resources are made available at no additional cost.

I focused on finding which elements were predictive of student success in developmental math, a discipline proven to be an essential part of many science and technology programs. My personal motivation to study this topic was based on my desire to see the students in my program succeed. It was later that I saw the broader picture as I considered all developmental math students arriving at the local institution. I saw an opportunity to make a difference.

As I reflect back on the process of this doctoral project study, I realize one

irrefutable fact—that change does not come easy. Humans are creatures of habit, and habits are often hard to change. The power to change the status quo for the good of many (the students) commonly resides in the hands of the few (the administration). I trust that my small contribution via this research project elevates the thinking of those empowered to implement change. If nothing else changes, at least I can say that my way of thinking and reacting to the needs of students have changed. I am compelled to examine their frustrations and their needs more attentively. I use their lack of knowledge as my motivation to contribute to their success. As a result, I am now driven to improve the status quo.

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Appendix A: The Project

Helping Students Help Themselves

by

Isaac Martinez

White Paper Submitted in Partial Fulfilment

of the Requirements for the Degree of

Doctor in Education

Walden University

August 2017

Abstract

Addressing the needs of developmental math students has been one of the most challenging problems in higher education. Administrators at a private university were concerned about poor academic performance of math-deficient students and sought to identify factors that influenced students' successful progression from developmental to college-level coursework. The purpose of this retrospective prediction study was to determine which of 7 variables (enrollment in a college success course, math placement results, frequency of use of the developmental resource center, source of tuition payment, student's age, gender, and race/ethnicity) would be predictive of success in developmental math as defined by a final course grade of C or higher. Astin's theory of student involvement and Tinto's theory of student retention formed the theoretical framework for this investigation of 557 first-year students who entered the university during Fall 2013 and Fall 2014. Binary logistic regression analysis was performed. Successful completion of the university's college success course as well as enrollment in introductory/intermediate algebra or intermediate algebra were significant predictors of success in remedial math courses. In addition, the lower the level of developmental math a student was placed in and engaged with, the higher the probability of success in the course. These findings were used to create a policy recommendation for a prescriptive means of ensuring students' early enrollment in developmental math courses and engagement with university resources, which may help students overcome barriers to success in developmental math and lead to positive social change for both the students and university through higher retention and graduation rates.

Table of Contents

Introduction

This white paper will delineate a problem statement relevant to the developmental math education of first-year students at the local university. As the researcher, I will review the current educational landscape and give examples of policies that other institutions in the United States have implemented to highlight the effects brought about by policy reform. I will present the results of a research study conducted at the university and an evidence-based recommendation for institutional stakeholders to implement new policy. Relevant retrospective data and the support literature used in the investigation will also be included.

Problem Statement

It is common for scientific and technical fields of study such as engineering and career technical degrees to employ even higher levels of math that require certain fundamental skills to be strong from the very beginning (Miller, 2017). When new students who possess math deficiencies enter these types of fields, they are immediately faced with a barrier that can have a profound effect on their academic progress (Okimoto & Heck, 2015). Not possessing the necessary math skills at this point only exacerbates the problem. The university is a highly scientific and technical institution and remedial education continues to be the primary choice for helping students categorized as underprepared for college-level coursework progress toward successful degree completion.

Although the initial assessment of prerequisite knowledge has been institutionally mandated at the university since 2007, giving students the option of when to address their

deficiencies has also proven to be a barrier to their success. According to data collected by the Office of Institutional Research (2015), between 2008 and 2013, 58% of the students enrolled in developmental math courses either voluntarily dropped or failed to persist, while another 11% opted to defer their enrollment into developmental courses until after their first year in college. The success rate of students who either postpone enrollment into developmental math or freely drop their remedial math courses has been poor at the university. This has taken a negative toll on the progress of these students by placing them in jeopardy of not completing all degree requirements within a prescribed amount of time.

On one hand, improving the success of developmental math students continues to be a priority among the university's administrators, faculty, and advisors. While on the other, there is no prescriptive method of addressing the immediate remediation of math deficient students. In order to close this gap, the institution must take a different approach. Researchers have found a positive relationship between student success and mandatory placement of remedial math students (Saxon & Morante, 2014). Fike and Fike (2012) argued that due to the high number of college drop-outs, institutions are justified in being more prescriptive in their developmental recommendations and to encourage students to complete their programs quickly. They also asserted that mandatory assessment followed by voluntary enrollment by the student completely undermines the reason for assessing in the first place. Fain (2012) reported that

> much of the academic support offered by community colleges goes unused and that the success of the completion agenda may hinge on whether community

> colleges set more mandatory requirements for students, and drop their reliance on making academic support offerings optional. (p. 1)

Administrators, first-year advisors, and developmental faculty at the local institution also share these concerns.

Research has shown that the level of student involvement with college support services has been linked to student success and persistence (Sutter & Paulson, 2016; Tovar, 2015). Taking a more prescriptive role in the remediation of students is a way for the institution to exercise a tighter alignment with behavioral interventions designed to promote involvement (Li et al., 2013).

Samples Taken from the Education Landscape

There is no national consensus on how a student's prerequisite knowledge should be assessed or how the student is placed in corresponding developmental coursework (Melguizo et al., 2014). Some researchers attribute this phenomenon to the disparity that exists between the efforts being made to ensure access to higher education and an institution's allegiance to academic standards for college-level work (Kosiewicz et al., 2016; Ngo & Melguizo, 2015). This problem becomes exponentially greater when an institution makes use of an open access policy. This is another reason why assessment and placement policies are so entrenched and relied upon to determine the level of preparedness for college-level coursework (Melguizo et al., 2014).

Traditionally, college students who are deficient in math and or English skills are assigned developmental courses with the goal of preparing them for college-level coursework. Researchers at Florida State University's Center for Postsecondary Success

discovered that approximately 78% of all Florida community college students who tested during the 2005-06 academic year placed in developmental education courses (Ross, 2014). Although this type of research-based evidence could have motivated legislators to enact policy that would have aggressively mitigated these deficiencies, the reaction was quite the contrary. Florida legislators took a drastic departure from the status quo in 2013 by opting to challenge the need for remediation instead. This happened when the governor of the state of Florida signed Senate Bill 1720 into law (Park et al., 2016a). The new law mandated all 28 state colleges to restructure their developmental education placement processes and instruction policies. The implemented policy now allows students who started their Florida education in ninth grade and veterans entering any of the 28 state colleges to be exempt from placement examinations and to enter directly into college-level courses despite their deficiencies (Hagedorn & Kuznetsova, 2016).

The Center for Postsecondary Success (2015) reported that administrators across the state have now realized that students in this cohort who decided not to take developmental education shortly after being advised to do so were more likely to later fail developmental or college-level courses. Researchers continue to study the problem in depth hoping to provide state legislators enough evidence to motivate reform (Park et al., 2016b).

Criticism toward this new law also came from faculty and academic advisors, who had been directing these students to improve their deficiencies prior to enrolling into college-level courses. Complete College America (2012) found that students who are given academic options commonly ignore their advisor's recommendations or opt to

enroll in other nonrelated courses. In a more recent study, Park et al., (2016b) also asserted that "when important educational support systems such as developmental education are severely adapted and made optional, students may be less likely to enroll in the most appropriate course for their level of ability and future goals" (p. 225). Nonetheless, not all policy makers see remediation as an obstacle to progression.

Legislators in the state of Tennessee were proactive in dedicating funds to launch the Developmental Studies Redesign Initiative in 2009. This initiative focused on promoting active-learning strategies for its students using technology-infused curricula to improve developmental math and English (Hagedorn & Kuznetsova, 2016). This program coupled with the Complete College Tennessee Act of 2010, ensured that students completed an early special math course in high school, and established the compulsory co-requisite enrollment of students in developmental courses with their enrollment in college-level courses for all first-year students. The Tennessee Board of Regents reported in 2015 that early remediation in high school has paid big dividends in the amount of $6.6 million in savings and that their co-requisite requirement in college has increased completion of gateway math by a factor of 4 (Freeman & Chambers, 2016).

The Study at the Local University

While some researchers have focused on studying the reasons why remedial math students fail; others have studied the factors that help these students succeed. My study focused on adult learners categorized as first-year students who placed in noncollege level remedial math courses. Student placement into developmental math courses was determined during the admission process as a result of test scores attained from an

institutionally sponsored math prerequisite knowledge examination called the MOE. In my study, I examined seven factors for their likelihood of predicting the success of students enrolled in developmental math courses. I found that students who enrolled and successfully completed Univ 101 college success course as well as students who engaged with introductory/intermediate algebra or intermediate algebra as placed by the Math Online Evaluation (MOE), increased their likelihood of success.

The sampling strategy included all first-year students who entered the university during two consecutive fall semesters during the 2-year academic period, 2013–2014 and 2014–2015 who took the MOE, placed in remedial math, and enrolled and completed their developmental math courses during the first semester they were enrolled at the university. Collectively, data for a cohort of 557 students were compiled from archival data and provided to me by the Office of Institutional Research.

Walden University's Institutional Review Board (IRB) and PTU's IRB requires all research be approved through an established process. Each institution's review process was followed to gain the appropriate consent to conduct my study. Each process included mandatory human research protection training and certification and the submission of an application, which were reviewed and approved by the respective IRB. The applications included a data use agreement and a letter of cooperation that delineated the format of the requested data. Once approval was obtained from both institutions, the data collected for this study were extracted from two individual archives maintained by offices at the A^2 center and PTU's office of institutional research

The statistical analysis for my study consisted of a binary logistic regression. The

criterion (dependent) variable was dichotomous, succeeded or did not succeed. For the purposes of this study, success was defined as the students' ability to pass their respective developmental math course with a grade of C or higher. This study was guided by the following research question:

RQ: Which of the following factors are predictive of student success?

- Enrollment and completion of the Univ 101 college success course
- The MOE course placement results
- The frequency of use of the Academic Advancement Center
- The source of tuition payment
- The student's age
- The student's gender
- The student's race/ethnicity

The null hypothesis (H_0) stating that none of factors were predictive of student success was rejected. Conversely, the alternate hypothesis (H_a) was supported. Of the 16 predictor variables analyzed in this model (dummy variables included), three were statistically significant: Univ 101 college success course ($p = .019$), introductory/intermediate algebra ($p < .001$) and intermediate algebra ($p = .007$). Table 1 shows all the model predictions.

The dummy variables that were considered predictive of success in developmental math represent students who voluntarily enrolled and successfully passed Univ 101 college success course, as well as students who took the MOE and engaged with the placement recommendation relevant to introductory/intermediate algebra or intermediate

algebra developmental math courses. The model suggested that students who enroll and successfully complete Univ 101 are 1.8 times more likely to succeed than students who choose not to enroll. Similarly, students who place and engage with introductory/intermediate algebra are 5 times more likely to succeed in their developmental course than students who choose to engage with precalculus essentials after placement. Additionally, students who place and engage with intermediate algebra are 2.5 times more likely to succeed in their developmental course than students who choose to take precalculus essentials after placement.

During further analysis of my results, I compared the odds ratio of success between students who placed in introductory/intermediate algebra and intermediate algebra developmental math courses and discovered that although both groups of students were successful in their respective remedial math courses, there was a difference in the likelihood of students' success (see Table 1). The Exp(B) value for introductory/intermediate algebra indicates that students in this developmental course are 5 times more likely to succeed than students in the most advanced course. In contrast, the Exp(B) value for intermediate algebra indicates that students in this developmental math course are 2.5 times more likely to succeed. The difference in odds ratios between these two developmental math courses indicates that students who enroll in the lower developmental math course (introductory/intermediate algebra) are 2.5 times more likely to be successful than those who enroll in intermediate algebra.

Table 1

Model Predictions of Success in Developmental Math

							95% CI EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Freq Use A2 Center	.14	.07	3.74	1	.053	1.16	1.00	1.34
Age	.02	.05	.11	1	.741	1.02	.93	1.11
Gender (male)	.28	.30	.89	1	.346	1.33	.74	2.39
Source of Tuition								
Loans	-.15	.29	.29	1	.593	.86	.49	1.50
Grants	-.38	.40	.90	1	.343	.68	.31	1.50
Scholarships	.10	.28	.13	1	.715	1.11	.64	1.93
Other	.25	.46	.29	1	.592	1.28	.52	3.17
Race/Ethnicity								
White	.06	.26	.05	1	.831	1.06	.64	1.75
African American	-.15	.43	.11	1	.736	.87	.37	2.01
Hispanic	.68	.50	1.86	1	.173	1.96	.74	5.18
Univ101 College Success								
Passed	.57	.24	5.52	1	.019	1.77	1.10	2.84
Did Not Enroll	1.09	.95	1.32	1	.250	2.98	.46	19.16
MOE Placement								
Intro/Intermediate Algebra	1.61	.40	15.75	1	.000	4.98	2.25	10.99
Intermediate Algebra	.93	.34	7.28	1	.007	2.53	1.3	4.97

Based on these results, I have concluded that enrollment in and successful completion of Univ 101 college success course is a contributor to success in developmental math courses. I have also concluded that the lower the level of developmental math a student is placed in, and consequently engages with, the higher the probability of success.

The theoretical framework for this study was based on Astin's (1999) theory of student involvement and Tinto's (1988) theory of student retention. Astin theorized that "the amount of student learning and personal development associated with any educational program is directly proportionate to the quality and quantity of student involvement in that program" (p. 519). The results of this study directly supported Astin's theory. Students at the local institution, who proactively enrolled and passed Univ 101 college success course were 1.8 times more likely to succeed in their developmental math course. While students who placed and completed introductory/ intermediate algebra or intermediate algebra during their first semester, increased their likelihood of success when compared to students who enrolled in a higher level of developmental math course such as precalculus essentials.

The results of my study also supported Tinto's (1988) theory of retention. Tinto argued that there are several factors responsible for student attrition; one of which is a student's inability to socially and academically integrate into the fabric of the university system during the first semester. By enrolling and passing Univ 101 college success course and successfully completing a lower-level recommended developmental math course (introductory/intermediate algebra or intermediate algebra), students earned the

opportunity to progress into college-level math courses, which in turn allowed them to persist toward the completion of their chosen degree program (Stewart et al., 2015). Ultimately, this positive progression can have a positive influence on retention and the institution's ability to sustain growth (Pruett & Absher, 2015).

The Recommendation

Institutions can be more effective in the way they help their developmental students by focusing on identifying the factors that have the greatest influence on retention (Pruett & Absher, 2015), persistence (Stewart et al., 2015), and attrition (Ganemer-Topf et al., 2014). Identifying and examining these factors can provide more effective ways of improving learning strategies, remedial interventions, and advising services designed to help developmental students succeed (Pruett & Absher, 2015; Waiwaiole, Bohlig, & Massey, 2016). However, students need to engage with their academic environment if they want to improve their chances of being successful (David et al., 2013). Wang et al., (2017) found that students who complete their corresponding math requirements during their first semester have a higher rate of degree completion. Pruett and Absher (2015) also found that there is a relationship between the extent of student academic engagement and retention. Their evidence indicated that students who persisted through college actively participated in class, made class presentations, and proactively exchanged with other students in and out of the classroom (Pruett & Absher, 2015). These findings were also confirmed by the relationship between key factors such as active student participation with tutoring sessions, higher GPAs, and pass rates (CCCSE, 2012).

The results of the study I conducted at the local university added valuable research knowledge relevant to the phenomenon at hand. It examined the predictive value of seven factors and their relationship to student success. The results revealed two key factors were highly predictive of success in developmental math courses. Consequently, I have concluded that enrollment and successful completion into Univ 101 college success course is a contributor to success in developmental math courses. I have also concluded that the lower the level of developmental math a student is placed in, and engages with, the higher the probability of success. Research has shown that early intervention courses can help students succeed in their personal development (Copus & McKinney, 2016).

Administrators can use this research knowledge as the basis for policy reform, which is specifically designed to promote student involvement with remedial interventions. Because private institutions do not fall under the constraints and mandate of SB 1720, the local university has the opportunity to implement a compulsory policy that would require first-year students to enroll into Univ 101 college success course during their first semester. Moreover, students identified as math deficient by the local university's MOE, must also enroll in the prescribed remedial math course during the first semester. The implementation of this new policy could lead to new levels of success among developmental math students at the university.

If adopted, the new policy could potentially benefit the students and the institution in several ways. First, it can promote student involvement with available resources; a benefit supported by the theoretical foundation of this study. Second, the resulting

success can facilitate student upward mobility into college-level math courses. Consequently, students will stand a better chance of persisting in school (Stewart et al., 2015), which can ultimately have a positive influence on the institution's retention rate (Pruett & Absher, 2015).

Conclusion

The task of accurately assessing the factors that influence student success is an ongoing exploration for every institution of higher learning. Minimizing the negative effects of some of the factors while promoting the application of best practices can go a long way toward improving the academic performance of developmental math students (Harwell et al., 2013). One way of aligning the institutional expectations with student achievement is by motivating students to effectively use existing resources (Tovar, 2015).

Despite the best intentions of the leadership, the decision to effectively use these resources cannot be left solely in the hands of the students (Saxon & Morante, 2014). It requires institutional commitment by way of policy enforcement (Fike & Fike, 2012) and the students' commitment to get involved (Astin, 1999).

Sustaining the vitality of a developmental program is a priority for every administrator, and evidence-based policies can be a viable way of promoting student involvement with available resources (Fike & Fike, 2012). According to McClenney (2013), colleges are beginning to make a cultural shift toward reducing the options for entering students. One way is to test and implement new policies that pilot, evaluate, and scale-up interventions to serve large student populations (McClenney, 2013).

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Appendix B: Success of Developmental Math Students Survey

Success of Developmental Math Students Survey

Purpose of survey: To evaluate the practicality of a policy recommendation addressing the success of developmental math students at PTU.

I am a faculty member ◯ I am a student advisor ◯ I am both ◯

Please mark the level of agreement with the following statements:

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. I advise students to address their math deficiencies immediately.					
2. PTU has ample resources to help developmental math students succeed.					
3. Timely remediation helps students prepare for college-level math courses.					
4. Students should have the freedom to decide when to address their math deficiencies.					
5. Students benefit from enrollment into Univ 101 College Success course.					
6. Enrollment into Univ 101 College Success course should be compulsory for all first-year students.					
7. Developmental math students can benefit from a compulsory policy requiring them to enroll in Univ 101 College Success course and math remediation courses as prescribed by the Math Online Evaluation during the first semester at PTU.					