THE IMPACT OF MATH PLACEMENT ON COMMUNITY COLLEGE STUDENT OUTCOMES

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ABSTRACT

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For most students entering a community college, placement tests have become a high-stakes venture as it is often a placement test score alone that determines whether a student is considered college-ready (Scott-Clayton, 2012). The purpose of this study was to assess the math placement, persistence, and retention of first-time community college students from fall 2016 through fall 2019 at one community college located in the Northeast. Students in these cohorts were assigned to introductory math courses based on two different sets of placement guidelines. The first set of guidelines relied more heavily on a single test score, while newly developed guidelines incorporated high school achievement markers, such as performance in HS math courses, often instead of placement testing, for a more holistic evaluation. The new guideline criteria resulted in more students placed into college-level math with a statistically significant increase in the number of college-level credits students enrolled in their first semester ($M = 11.107$, $SD = 4.572$); $t(8921) = -10.305$, $p = 0.00$. Placement into college-level math improved across all ethnic student groups.

The independent variables of age, gender, ethnicity, financial aid/SES, enrollment status and high school GPA, were included in the logistic regression analyses to evaluate dichotomous outcomes on persistence and retention. The study relied on archived data

collected by the study institution, including high school transcript data and math course placements. The results were mixed and the effect sizes were small. The regression models predicted statistically significant effects on student persistence and retention between students evaluated under the two different placement criteria. Enrollment status, HSGPA, age, ethnicity and financial aid were found to have significant effects on predicting student outcomes. The new math placement guideline criteria showed promising results regarding improved access to gateway math courses and opportunities for improved student outcomes. This study supports the literature on holistic measures for assessment and placement, and recognizes placement policies as a mechanism for validating student outcomes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Much is written about the academic preparedness of entering community college students, specifically the need for remediation and the controversial assessment and placement policies that determine remedial placement (Bailey, Jaggars, & Jenkins, 2015; Melguizo, & Ngo, 2015; Jaggars, & Stacey, 2014; Scott-Clayton, & Rodriguez, 2012; Brint, & Karabel, 1989). With 92% of two-year institutions using the results of placement test scores to determine enrollment decisions (Parsad & Lewis, 2003), placement testing has become a high-stakes endeavor. For the majority of community college students, the consequence of assessment is placement into developmental education. Developmental education also referred to as remediation or pre-college level coursework, denotes a set of policies and practices aimed at helping academically underprepared students reach college-readiness standards. Often these policies require courses that must be completed prior to coursework that contributes toward degree requirements. Almost half of entering college students receive placements into developmental education, with many of these students ultimately choosing not to enroll (Bailey, Jeong, & Cho, 2010; Radford & Horn, 2012; Scott-Clayton, Crosta, & Belfield, 2014; Snyder, de Brey, & Dillow, 2016).

The goal of developmental education is to give students the knowledge, skills, and habits that will help them be successful in college-level courses (Bailey, Bashford, Boatman, Squires, & Weiss, 2016). As open-access institutions, community colleges are duty-bound to offer acceptance regardless of academic preparedness. Most community colleges use placement tests administered after students are accepted to college. These assessments are given in place of standardized tests (e.g., SAT/ACT) to determine the

academic preparedness of entering students (College Board, 2020). The discussion around test-optional policies for college admission (Syverson & Franks, 2018) can be applied to community college assessment and placement policies. Placement test policies that emphasize a single placement test score, rather than the totality of the academic record, limit access to college-level courses and disproportionately affect underrepresented groups (Scott-Clayton et al., 2014; Melguizo & Ngo, 2015). These policies have transformed community colleges from gateways (open access/open admission) to gatekeepers (admitted but restricted to developmental education). Using multiple measures of student academic performance, including high school grade point average (GPA), the highest course in discipline completed, course grades, and state assessment grades, provides a more comprehensive evaluation of college-readiness minimizing reliance on a single test and cutoff score to access college-level courses.

The path to college-level coursework is particularly challenging in mathematics, where students are more likely to require remediation than in reading and writing. Bailey, Jeong, and Cho (2010) report, that 59% of community college students are referred to developmental courses in mathematics. The impact on students placed into developmental math courses portends unfortunate outcomes. After analyzing approximately 150,000 students from community colleges across the country, only 30 percent of students referred to developmental math completed their sequence within three years, and only 16 percent completed a first college-level math course (Bailey et al., 2015). Outcomes were even worse for students assigned to lower-level developmental math courses (Bailey et al., 2015). In addition, higher proportions of Black and Hispanic students, first-generation students, and those from low-income backgrounds are placed

into remedial education than their peers (Chen, 2016; Radford & Horn, 2012). Placement into developmental math courses must be done with sagacity and thoroughness.

For most students entering the community college, placement tests have become a high-stakes venture as it is often the test score alone that determines whether a student is considered college-ready. The challenges inherent in using a single placement test score to separate college-ready from developmental students were explored by Judith Scott-Clayton (2012). She found that at the cutoff margin, over 30 percent of developmental students would have earned a B or better had they been allowed to enroll directly in college-level math, and termed these students "severely underplaced". Placement tests have become a source of concern as they possibly exclude students rather than improve access (Kirst, 2001; Ruiz, 2007). Studies by the National Center for Public Policy and Higher Education (Brown & Niemi, 2007), and the Achieving the Dream Foundation/Jobs for the Future (AtD, 2020) delineated the magnitude of this problem emphasizing that colleges focus more on the initial assessment process used to evaluate entering students to implement more accurate placements. A primary concern is that the majority of students placed into developmental courses do not go on to complete college-level courses nor earn a college degree (Bailey et al. 2015). Ngo and Melguizo (2016) suggest that changing assessment and placement policy is increasingly being seen as a lever to improve outcomes. The authors' reason that if more accurate placement measures are used, and used more accurately, then students will be more likely to complete the courses in which they are placed and persist toward their academic goals (Ngo & Melguizo, 2016). Improving assessment and placement policies and procedures

deserves attention, and community college leaders must consider alternatives to remedy the situation (Brown & Niemi, 2007).

Within 2-year community colleges where remediation is prevalent, virtually all campuses use brief, standardized tests administered to new students just before registration to determine who needs remediation (Fields & Parsad, 2012). Often, assignment to developmental courses is determined solely based on a cutoff score. The cutoff scores are usually set by faculty within the given department at the individual college campuses in conjunction with recommendations by the testing agency. Often, little consideration is given to students' high school record. Those students who are academically prepared, based on high school transcript information, yet are assigned to remediation gain little or no educational benefit, but incur additional tuition and time costs and may be discouraged from or delayed in their degree plans (Scott-Clayton et al., 2014). Bailey et al. (2010) suggest that students who chose to defy placement results by going directly into college-level courses fared far better than their counterparts who conformed to their placement results and enrolled in developmental courses.

The research shows that a significant number of students placed into developmental courses never complete their degree programs and only a small number of students who enroll in developmental courses ever complete their developmental coursework much less enroll in subsequent college-level courses (Scott-Clayton et al., 2014; Scott-Clayton, & Rodriguez, 2012). Jaggars and Stacey (2014) found that over 68% of community college students are placed into at least one developmental course, with only 28% of community college students who take a developmental course ever go on to earn a degree within eight years. Placement into developmental math courses often

precludes students from enrollment into their desired degree, moving the goal of degree completion further from sight and almost guarantees a student will never earn a college degree. The completion of a college degree impacts student earning potential and social mobility and can reduce equity gaps among student groups.

With an array of research on the negative aspects of developmental education there has been significant emerging data on alternative placement options that many colleges across the nation are already implementing (Bowen, 2018; Ngo & Kwon, 2015; Marwick, 2002). The purpose of this study is to compare the math placement of first-time community college students who entered between fall 2016 through fall 2019. The secondary purpose is to determine the effect the math placement criteria had upon enrollment in college-level credits, completion of the first semester of course work, subsequent enrollment into the second semester, and if there were differences in outcomes between student groups. In fall 2019, new math placement guideline criteria that used a comprehensive review of high school transcript data was implemented. This study will analyze the effect the expanded criteria had on the aforementioned measures.

Background

In 2004, Lumina Foundation, one of the largest private funders of postsecondary reform, launched Achieving the Dream: Community Colleges Count (AtD). This initiative was explicitly designed to improve institutional outcomes, including helping academically underprepared students succeed in college-level work, increasing semester-to-semester persistence, and improving rates of degree completion (AtD, 2020). The community college in this study had been engaged in the AtD initiative beginning in

2015. AtD (2020) considers community colleges an indispensable asset in the nation's efforts to ensure and preserve access to higher education and success for all students, particularly historically underrepresented student populations. However, AtD (2020) understands that achievement gaps among student groups are a reflection of structural inequities that are often the result of historical and systemic social injustices. These inequities typically manifest themselves as the unintended or indirect consequences of unexamined institutional policies (AtD, 2020), policies that disproportionately place underrepresented students in developmental courses. With approximately two-thirds of incoming community college students failing to meet the standards for college-readiness as determined by their institution's placement tests and other standardized tests (Bailey, 2009), this represents a national crisis, with social justice implications.

In 2006, Secretary of Education Margaret Spellings released the findings of a year-long study on the US education system, which ushered in a new era of accountability in higher education for publicly funded institutions. The Spellings Report (2006) urged the creation of a robust culture of accountability and transparency throughout higher education. Improving access and affordability while enhancing quality and innovation based on the implementation of increased accountability measures were emphasized (Jones, 2012). A shift from enrollment data to performance and completion data reverberated throughout academe as the recommendations provided by the Spellings Report (2006) reinforced the need among institutions of higher education to improve the retention and graduation rates of their students or risk losing valuable financial support from federal and state governments.

The pressure on institutions of higher education to improve retention and graduation rates has not only continued but intensified. In 2009, the Obama administration called for 10 million additional college graduates by 2020, and in the same year, Lumina Foundation announced its goal that by 2025, 60 percent of the US population would have a high-quality postsecondary credential or degree (Bailey et al., 2015). With this national attention on the completion agenda, community colleges have been compelled to examine their data with renewed urgency aimed at improving outcomes for all students. To improve retention and graduation rates, community colleges have begun disaggregating their data to identify where students drop out.

Purpose of the Study

The purpose of this study was to compare the math placement of first-time community college students who entered in fall 2016 through fall 2018, under old math placement guideline criteria, with students who entered in fall 2019, under new math placement guideline criteria. The secondary purpose was to determine the effect the different math placement criteria had upon enrollment in college-level credits, completion of the first semester of course work, and subsequent enrollment into the second semester. The driving factor behind the changes in math placement guidelines was to improve the accuracy of math placement, to evaluate students' academic records more effectively, and to eliminate unnecessary courses reducing student costs and time to degree completion.

Those students placed into developmental classes incur full-tuition costs for courses that do not count toward degree completion, adding expenses that those placed

directly into college-level courses do not incur. The additional expenses impact student debt and default rates, and attrition associated with developmental course enrollment is significant (McKinney & Novak, 2013). An inverse relationship exists between degree completion and developmental course enrollment. The likelihood that a student will complete a college degree decreases as the number of developmental courses a student must enroll in increases (Chen, 2016). The completion of a college degree impacts student earning potential and social mobility. Further, those students who could benefit the most from educational opportunities are often diverted away from entry into college-level programs of study, never quite catching up to their peers in terms of the number of college-level credits they earn (Scott-Clayton & Rodriguez, 2012; Clotfelter, Ladd, Muschkin,& Vigdor, 2013). Establishing an appropriate placement policy is critical to reducing structural inequities and the reinforcement of equity gaps, which impact underrepresented students who enroll at community colleges in higher numbers.

Equity gaps, those academic differences between students of different ethnic backgrounds, are difficult to overcome and limit the economic opportunities for those groups most affected. According to Stoup (2015), the biggest driver of inequity in outcomes (college completion) occurs during the assessment of college-readiness. High school graduates by ethnicity continue to show massive gaps; 82.7% of Asian students and 78.4% of White students graduate high school on time while only 57.6% of Hispanics and 57% of Black students graduate on time (Ansell, 2011). Data from 2009 found that White and Asian students were twice as likely to take academically rigorous core high school courses while fewer than 10% of Black and Hispanic students participated in rigorous courses (Ansell, 2011; NCES, 2009). With respect to gender

gaps, only 68% of male students graduated high school on time in 2008 compared to 75% of female students, and only about 50% of male students from minority backgrounds graduated on time (Ansell, 2011). Within low-income groups, equity gaps are still evident. According to Carnevale and Strohl (2013), 23% of low-income Whites graduate with a Bachelor's degree compared to only 12% of low-income Blacks and 13% of Hispanics. These equity gaps are reinforced upon entrance to college, often perpetuated by placement policies and practices based on a single test score, limiting opportunities for students to enroll in college-level courses. Achievement gaps were identified in the Spellings Report (2006) as disproportionately affecting low-income and minority students, including the misalignment of academic expectations between high schools and colleges. According to Stoup (2015), more than 50% of equity gaps occur during the college assessment and matriculation process. For decades, placement policies may have unwittingly sealed the fate of countless students.

The disparate college preparedness between advantaged and disadvantaged students is a major determinant of inequities in educational attainment (Bowen, Kurzweil, & Tobin, 2005). Some of the reasons for the gap in academic preparation between children from a privileged socioeconomic status (SES), and children from a low SES, include differences in family resources, neighborhoods, and schools (Bowen et al., 2005). Bowen et al. (2005) also suggest that schooling can either mitigate or exacerbate non-school influences on children; that it is the accumulation of (often small) advantages and disadvantages throughout their education that leads to massive preparation differences by the time of college application. Further, while the disadvantages and advantages are cumulative and reinforcing, a later disadvantage can cause harm without the presence of

an early disadvantage, and conversely, later forms of support can mitigate earlier disadvantage (Bowen et al., 2005). Community colleges enroll significant numbers of academically and economically disadvantaged students. These students must be positively reinforced, early and often, notably during the assessment and placement process. The message that test scores or their associated labels (e.g., developmental, remedial, pre-college) sends to students, may influence their beliefs about belonging in college, their ability to succeed, and may discourage students from enrolling or persisting (Ngo & Melguizo, 2016).

Community colleges have attempted to assess entering student skills in basic competency areas, including mathematics for decades. The use of a single placement test score has been seen as the most cost-effective and standardized way to assess students with different academic preparation. The original intent of placement testing was to screen out students who were judged as deficient in order to maintain standards and the perceived quality of college-level courses. Many faculty and administrators believe that without the assessment of students through placement testing, academic standards and quality would be at risk.

The placement of students in developmental courses is not a perfect science. There is no consensus on what it means to be "college-ready" nor are there clear and unmistakable cutoff scores below which a student will fail and above which a student will succeed (Clotfelter, Ladd, Muschkin, & Vigdor, 2013; Hodara, Jaggars, & Karp, 2012; Jaggars & Hodara, 2011). The math SAT cut scores used to place students into college-level math ranges from 450 to 510 at 2-year institutions (Fields and Persad, 2012). At the

institution for the researcher's current study, a math SAT score of 510 (old SAT)/540 (new SAT) indicates college-readiness.

There are a multitude of studies on how placement policies influence and affect developmental student outcomes, including how placement test results affect enrollment decisions (Ngo, & Melguizo, 2016; Martorell, Mc Farlin, & Xue, 2015; Rodriguez, 2014), and, the effectiveness of using multiple measures to make placement decisions (Ngo & Kwon, 2015). Using evidence-based data is essential when colleges examine their placement and assessment policies. Selecting placement instruments, setting cutoffs, incorporating multiple measures, and defining college-readiness is a complicated exercise. Examining the effectiveness of new math placement guidelines and providing data on the success of new policies is essential.

Theoretical Framework

Laura Rendón's (1994) validation theory and Bean and Metzner's (1985) model of nontraditional student attrition, will be used to frame the examination of the effect of math placement on entering community college students. Rendón (1994) introduced validation theory with particular applicability to low-income, first-generation students enrolled in higher education. She proposed a new way to envision how these students might find success in college, especially those who found it challenging to get involved, had been invalidated in the past, or had doubts about their ability to succeed. She suggested two types of validation: academic and interpersonal. Academic validation occurs when students trust their innate capacity to learn and gain confidence in being a college student. Interpersonal validation occurs when action is taken to foster students'

personal and social adjustment (Rendón & Munoz, 2011). Validation has provided a theoretical framework to guide research that attempts to understand the college experience for low-income, first-generation students, including developmental education students and community college students.

Academic validation for community college students begins at the point of first contact with the college. As open-admission institutions, whose mission is to provide opportunity and access, community colleges are enrolling students who are more diverse and present with more deficiencies than at any other time in history. Increasingly, what is thought of as the traditional community college student is being redefined by changing student demographics, increased social disengagement and diverse academic needs (Tinto, 1987, 1993). The diversity of goals, life experiences, academic preparedness, English language proficiency, and family responsibilities magnify the challenges of community college student retention. Validation becomes a vital part of the initial contact the student has with the institution and reflects a process rather than an end goal. According to Rendón (1994), the more students are validated, the richer the academic and interpersonal experience, and it is most powerful when validation is offered during the early stages of the student's academic experiences, preferably during the first few weeks of classes. Evidence is clear that validation promotes student success, but it is particularly critical for nontraditional students who may doubt their ability to succeed (Patton, Renn, Guido, & Quaye, 2016).

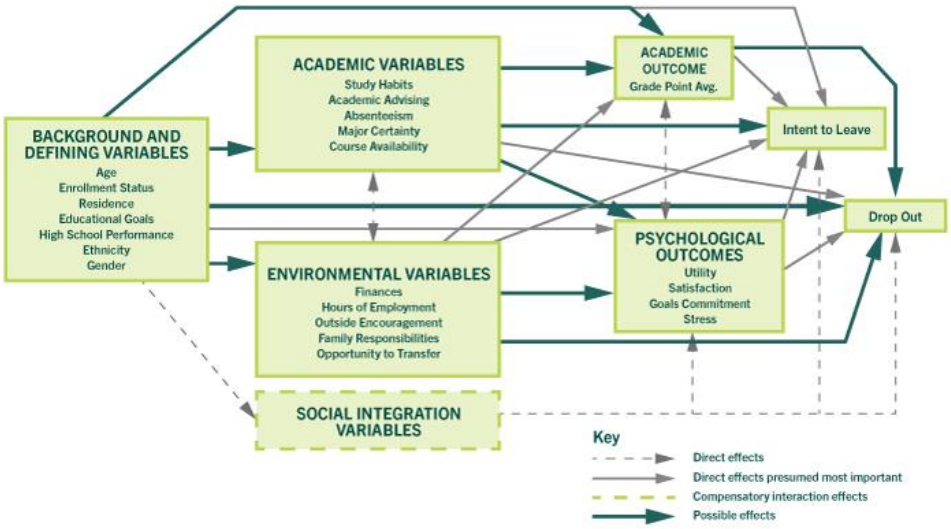
Bean and Metzner's (1985) student departure theory was developed as a model of nontraditional undergraduate student attrition. It expanded on other models of student departure (Pascarella & Terenzini, 1980; Tinto, 1975) which primarily focused on factors

relevant during late adolescence. Nontraditional students are an increasing constituency among undergraduate student populations, particularly in community colleges, and therefore a review of Bean and Metzner′s (1985) model was also applied to this researchers' study to provide an additional theoretical perspective on community college enrollment.

Bean and Metzner (1985) defined nontraditional students broadly, based on three characteristics: age (over 24 years old), residing off-campus (commuter students), and attending less than full-time. According to Bean and Metzner (1985), if a student meets any one of these three criteria, they are considered nontraditional. Most community college students, regardless of age or enrollment status, are commuters due to the lack of on-campus or off-campus housing. Bean and Metzner's (1985) model identifies four sets of variables and two interaction effects as predictors of nontraditional student dropout. The first set, background and defining variables, are factors examined in the current study. These variables are thought to influence dropout primarily through their effect on other variables in the model. Completion of first semester course(s) and associated grades are dependent variables in the current study.

Figure 1

Nontraditional Undergraduate Student Attrition Model (Aljohani, 2016)



Students who are told their performance on the placement exam is deficient, resulting in developmental course placement, may decide not to enroll or may be more likely to subsequently dropout. Bean and Metzner (1985) predicted that negative psychological outcomes would have a stronger influence on the decision to dropout than would positive academic outcomes. If a student's initial contact with the college is viewed as negative, for example, they are told they must take developmental courses which delays goal/degree completion, students will likely have a negative psychological outcome. For nontraditional students, this reinforces their uncertainty about belonging on a college campus. Laura Rendón (1994) examined the experiences of college students and found that nontraditional students often doubted their academic ability and needed validation to encourage their involvement in campus life. She found that students who are validated develop confidence in their ability to learn, feel self-worth, and a sense of belonging in the academic community (Patton et al., 2016).

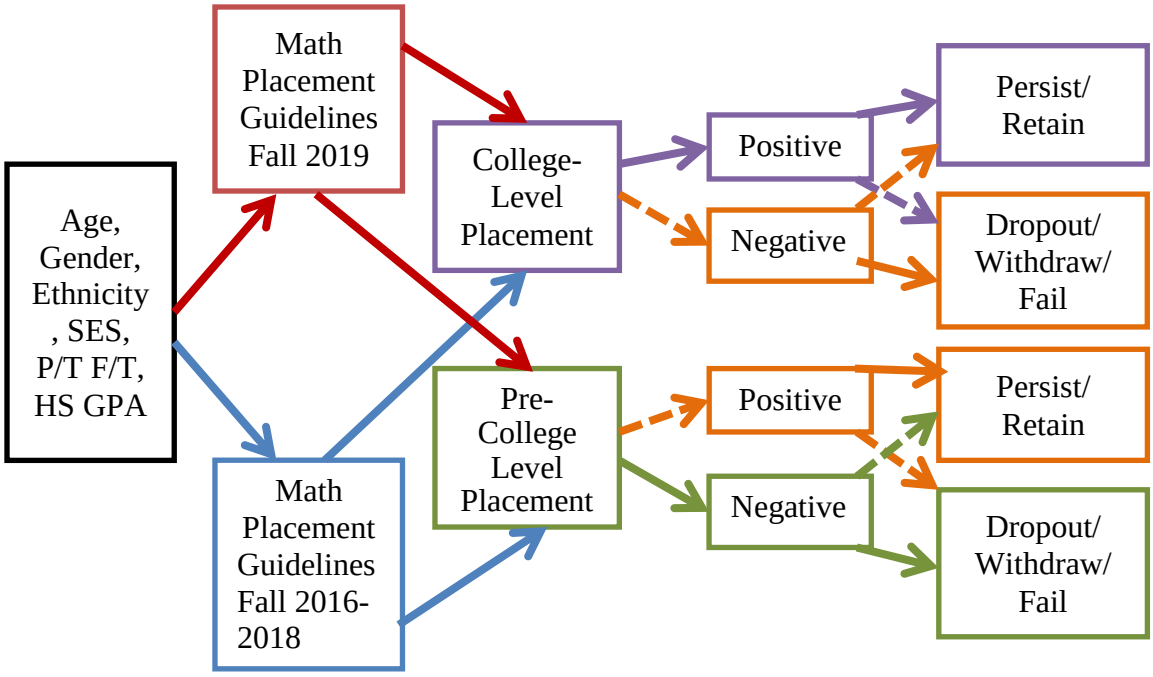
Using Rendón's (1994) validation theory, and Bean and Metzner's (1985) model of nontraditional student attrition, the current study examined the effect of math placement on entering community college students and the impact on completion and subsequent enrollment. Bean and Metzner's background and defining variables, along with the definition of nontraditional students, are foundational in the current study. From these variables, Rendón's validation theory provided the framework for examining how the assessment and placement guidelines of a community college provided validation by conveying positive or negative associations, the consequence of which may lead to dropout or withdrawal. For nontraditional students, these early validation points may be significant to persistence and retention. As Rendón (1994) suggests, validation is most effective in the early stages of the academic experience.

Conceptual Framework

The defining variables from Bean and Metzner's (1985) model of nontraditional student attrition are the characteristics associated with entering community college students (age, gender, ethnicity, SES, enrollment status, and HSGPA). All entering students are assessed for math placement based on guidelines established by the institution (fall 2016, 2017, and 2018 = old guidelines; fall 2019 = new guidelines). The result of assessment determines course placement (pre-college or college-level) and this placement decision is the initial and consequential validation point. As Rendón (1994) affirms, validation enriches the nontraditional students' academic and interpersonal experience. Students undergo either a positive or negative psychological effect (college-level placement = positive effect; pre-college level placement = negative effect), which impacts projected outcomes (persist/retain; dropout/withdraw).

Figure 2

Conceptual Framework



Significance of the Study

With the national emphasis on degree completion illustrated by the work of Lumina Foundation and the Achieving the Dream initiative (Lumina, 2011), addressing any deficiencies within the onboarding process - the process of helping students move from application through enrollment into their second semester - becomes an essential focus. The evaluation of first-time students and their placement into developmental courses impact students' early college experiences. It impacts the length of time to degree completion, may affect eligibility for financial aid and scholarship funding, and often has an undesirable effect on students' initial contact with an advisor. For community college students, the transition from high school, or from the work environment, to a new environment where many feel they are outsiders, is intimidating and often overwhelming. Placement testing intensifies the challenges already encountered by entering students. It amplifies the level of trepidation particularly when students are tested in mathematics, a subject in which many feel apprehensive. Reducing the number of students who need math placement testing and reducing the length of the math placement test when it is required should improve students' overall intake experience.

Concerns about assessment, placement, and developmental education are so strong that measures have been imposed, rather than undertaken, in some states (CCCSE, 2016). These measures include limiting or eliminating developmental education and modifying or restricting the use of placement tests. According to the Center for Community College Student Engagement (CCCSE) National Report (2016), colleges must be willing to try new approaches, but those approaches must be grounded in

research about what leads to better results. There are differences between current practice and emerging strategies that show promise, but there is no simple, single solution. Therefore, there is much work to be done as the field creates and refines new models of assessment, placement, and delivery of developmental education (CCCSE, 2016). The CCCSE National Report (2016) encourages colleges to assess their data; discuss data with faculty, students, and others; update processes based on new information, and continue to evaluate success over time. In this way, every college, and collectively the nation, can move toward the bold completion goals that will best serve students (CCCSE, 2016).

Enrollment of first-time students is on the decline among most colleges, including the study institution. According to the national data, undergraduate postsecondary enrollment increased by 28% between 2000 and 2016, yet the projected enrollment through 2027 is expected to increase by 2% (NCES, 2018). This can be attributed, in part, to a decline in the number of high school graduates across school districts. In the decade between 2008 and 2019, there was an anticipated 12.3% decrease in the number of high school students graduating, due primarily to the actual declines observed by grade level within the secondary schools in the state, and county, in which the study institution resides (Office of Higher Education, 2009). With the numbers trending down, colleges must find every means necessary to increase enrollment. Improving retention rates takes on an added urgency. Many community colleges have placed the retention and persistence of first-year students as a top strategic priority in their evolving enrollment management plans (Hawley & Harris, 2005). Every effort should be made to improve the accuracy of the assessment and placement of first-time students. Limiting the time spent

in developmental education will minimize exit points and reduce the likelihood that outside events or influences will pull students away from college (Edgecombe, 2011). The changes made to the assessment and placement testing guidelines by the study institution was part of a comprehensive effort to increase enrollment and improve retention rates.

This researcher's current study will add to the extensive research that exists on developmental education and the use of multiple measures (i.e., high school grades, GPA, course grades, state exam scores, standardized tests) for college placement (Bailey et al., 2015; Bailey, Jaggars, & Scott-Clayton, 2013; Scott-Clayton, 2012; College Board, 2017). The study institution implemented changes to the assessment and placement guideline criteria aimed at improving performance outcomes for entering community college students. Improved placement enhances students' experience and may impact persistence toward goal completion, which has consequential effects. Goal completion can herald improved employment opportunities, financial security, social mobility, and a sense of personal achievement/mental health. For a thriving and vibrant community, where a rapidly evolving and complex economy demands an increase in skilled employees, improving student vocation, certificate, and degree completion is critical. A well-educated citizenry is the foundation of social equity, cohesion and successful participation in the global economy (Lumina, 2011). The current study aims to inform institutional policy and performance outcomes. Through ongoing data analysis and the systematic monitoring of progress, institutions can begin to achieve performance goals.

Connection with Social Justice

The community college in this study provides educational opportunities for all people, especially those lacking economic, physical, or social advantages. As in the Vincentian tradition, seeking out the causes of poverty and social injustice while encouraging solutions that are adaptable, effective, and concrete, the mission of St. John's University aligns with the purpose of the current study. By evaluating identified limitations to the math placement of community college students, limitations that deter students from college completion, and consequently from achieving academic success, the purpose of this study was to provide support for the removal of barriers for first-time students, including those most in need of validation and support.

Research Questions

This study investigated the impact of math placement guidelines and the effect on community college student enrollment, persistence, and retention at one community college located in the Northeast.

1) To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in the number of college-level credits taken in their first semester?

2) To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in the completion of the first semester of coursework?

3) To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in enrollment into the second semester of coursework?

Design and Methods

This ex post facto research study looked at two different groups of first-time community college students to determine if there were differences in outcomes based on different assessment and placement guidelines. The result of this analysis informs institutional policy and practice while adding to the existing research on developmental education and placement testing measures.

Research Design and Data Analysis

A parametric independent samples t-test (Fraenkel, Wallen, & Hyun, 2019) was used to answer the first research question. In answering the last two research questions, a logistic regression analysis was used to assess the relationships among the independent variables to determine any associations and provide a model that describes the factors associated with the observed outcomes (Fraenkel et al., 2019; Knapp, 2018).

Hypotheses

There are three possible outcomes which were anticipated by the researcher: 1) student placement, college credits and persistence/retention outcomes improved, 2) student placement, college credits and persistence/retention outcomes remain unchanged, and 3) student placement, college credits and persistence/retention outcomes decreased/declined. While there may be many unique combinations of possible

outcomes, the three main trajectories anticipated are: positive, no-change, or negative. That is, the new placement guidelines increased the number of students placed into college-level math, increased the number of college-level credits in which a student enrolled, and improved student persistence and retention. The first two outcomes (positive and no-change) would be a validation of the new placement guidelines; the positive outcome for obvious reasons, and the no-change outcome would also validate the new guidelines, particularly as the number of students placed into college-level math increased. A negative outcome is not anticipated; however, would serve as a critical analysis of the modifications in assessment and placement guidelines, and possible intervening effects not evaluated in the current study.

Sample Population

The target population of the current study consisted of all first-time students within the largest campus (LCCC) of a suburban multi-campus community college located in the northeastern United States. The total population of the campus is approximately 13,000 students.

Instruments

This research relied on archived data already collected by the study institution. As such no instruments are used for the study.

Research Procedures

Permission was requested from the study institution to utilize archived data by agreeing to secure the privacy of individual students, their personally identifiable

information, and with the understanding that the data be presented in the aggregate. No individual student files, transcripts, or other student materials were removed from the institution. The student records were categorized by the independent variables identified in this study and obtained through the institutions database. The researcher kept the data files secured and entered the accumulated data of the sample population into the researchers' personal SPSS data file. The data was screened for normalcy, outliers and missing values.

Definition of Terms

Specific terms which are crucial to understanding the current study are defined in this section. The definitions are commonly used within the body of relevant literature and within the higher education arena.

College Board ACCUPLACER® -a series of tests that evaluate students' skills in reading, writing, and mathematics to assist colleges' assessment of student readiness and make placement decisions (College Board, 2020).

College-level math courses – mathematics courses in which students earn college credits that are applicable toward degree requirements.

Completion rate – the proportion of students who satisfy degree or certificate requirements in programs of study offered at institutions of higher education to earn the requisite credential.

Computerized Placement Test (CPT) – a standardized testing instrument designed to assess students' academic ability in English, reading, and mathematics.

Cut score or cutoff score – the score established by an institution of higher education as meeting the minimum proficiency level to perform successfully in college-level courses at that institution. Scores below are identified as needing remediation, scores at or above are deemed college-ready.

Developmental Education – a series of courses designed to help academically underprepared students reach college-readiness standards. The courses do not carry college credit and therefore, do not apply toward a degree or certificate. Completion is required before students can enroll in required college-level courses.

Equity gaps - the disparity in academic performance between groups of students. These gaps can occur in grades, standardized-test scores, course selection, dropout rates, and college-completion rates (Ansell, 2011).

First-generation – the first member of an immediate/extended family to attend an institution of higher education.

High-stakes test – a test which determines the decisions being made about an individual.

Intake Advising – the process of assisting new students acclimate to the college environment, primarily by selecting courses for the first semester based upon placement assessments.

Math placement test – a standardized test given to newly admitted students to determine the students' level of math proficiency. The test screens for basic college-level proficiency and for two lower-levels of developmental proficiency.

Nontraditional students – students who enter institutions of higher education with any one of a variety of demographic factors which include: age (over 24 years old), ethnicity (historically underrepresented groups), first-generation college student, academically underprepared, economically disadvantaged, enrolling part-time, working full-time, living off-campus (commuting) (Rendón, 1994; Bean & Metzner, 1985).

Onboarding – the process of helping first-time community college student's move from application through enrollment into the second semester.

Persistence – first-time students who remain enrolled, and earn passing grades, in their first semester of coursework.

Remedial/Pre-college level courses – courses for academically underprepared students which do not count toward degree or certificate requirements but are required before enrollment in college-level courses.

Retention – first-time students who subsequently enroll into the second semester of coursework (i.e., fall to spring).

Conclusion

Studies have shown that using a single, high-stakes math test for placement into college-level courses is ineffective, especially for students who test at the margin of college-readiness (Bowen, 2018; Scott-Clayton & Rodriguez, 2012). Since community colleges are a pathway toward vocational, certificate, and degree programs for many nontraditional, low-income, first-generation, underrepresented students, it is critical to increase access to college-level courses through more accurate assessment and placement

policies. Improving placement test policies so that accuracy is improved and misplacement errors are minimized can benefit both the college and the students. Chapter two will delineate the theoretical framework for this study and examine those variables that influence placement testing and its impact on nontraditional community college students.

CHAPTER 2

Chapter one described the challenges inherent in the mission of the community college as both a gateway to access higher education and as a gatekeeper, enrolling academically underprepared students in need of remediation. The assessment and placement policies that determine remedial placement are the foundation of this study. Using Laura Rendón's (1994) Validation Theory and Bean and Metzner's (1985) Model of Nontraditional Undergraduate Student Attrition as the theoretical framework, the purpose of this quantitative study was to examine the effect of math placement on community college student enrollment and its impact on persistence and retention for students attending a public community college in the Northeast. In chapter two, a discussion of the two theoretical frameworks for nontraditional student populations are presented. Following the theoretical frameworks, a review of the literature on developmental education in the community college provides perspective on the success and challenges of remediation. In the next section, the literature on financial and time costs associated with remediation, math placement and misalignment of standards between high school and college, equity gaps and the importance of accurate placement for equitable outcomes, and the use of multiple measures for math placement are reviewed. Finally, the variables used in this study associated with nontraditional students are discussed.

Theoretical Frameworks

The theoretical framework is guided by Rendón's (1994) Validation Theory and Bean and Metzner's (1985) Model of Nontraditional Undergraduate Student Attrition.

Validation Theory

Validation theory hypothesizes how nontraditional students might find success in college (Rendón & Munoz, 2011). Nontraditional students, typically identified as low-income, first-generation, as well as adult students returning to college were included in this research. In developing the theory of validation, Laura Rendón (1994) was influenced by the work of researchers Belenky, Clinchy, Goldberger, and Tarule (1986), who studied women as learners, women who were considered undereducated and felt powerless and voiceless. What had transformed these women was affirmation provided by nurturing authorities. The need for affirmation was similarly noted by Rendón (2002), who understood that many nontraditional students come to college needing a sense of direction and guidance, but not in a patronizing way.

Rendón (2002) suggested that many students encounter subtle and overt forms of racism, sexism, and oppression on college campuses. While some students can overcome these potentially devastating invalidating experiences, she posited that those who feel most vulnerable will respond by dropping out of college. These students may benefit from external validation that serves to propel them toward gaining internal strength resulting in increased confidence (Rendón, 1994). Validation theory provides a framework for those working with students, the ability to convey a sense of agency, affirmation, self-worth, and liberation from past invalidation (Rendón & Munoz, 2011). Both external affirmation and internal acknowledgement of self-worth are important in shaping academic success of nontraditional students. Rendón (1994) theorized that for many low-income, first-generation students, external validation is initially needed to move students toward an acknowledgment of their own internal ability and potentiality.

When placement testing policies and practices reinforce negative beliefs about a student's academic ability, the message students hear is they do not belong. It reinforces negative beliefs about their ability to succeed academically and their qualifications to participate in the higher education arena. The impact of validation, as exerted by the placement of students into developmental or college-level math courses, and its effect on persistence and retention at the study institution was the focus of this research.

Rendón's (1994) theory of validation has six elements. Each element can be seen in the assessment and intake advising process at the community college in the current study. The first element places the responsibility for initiating contact with students on faculty, advisers, coaches, and counselors. Nontraditional students will likely find it difficult to navigate the world of college alone. It is critical that validating agents (faculty, advisors, etc.) actively reach out to students to offer assistance, encouragement, and support. The second element is the notion that when validation is present, students feel capable of learning and have a sense of self-worth. The third and fourth elements are validation as a prerequisite for student development, and that validation can occur in and out of the classroom; the fifth element is that validation is a developmental process which begins early and can continue over time. Finally, because nontraditional students can benefit from early validating experiences and positive interactions in college, validation is most critical when administered early in the college experience, especially during the first few weeks of class (Rendón & Munoz, 2011). Assessment and placement testing occurs in the early stages of the community college student enrollment process and is the initial validation (positive or negative) students receive from college representatives reinforcing students potential to learn and be successful.

There are two types of validation identified in Rendón's (1994) theory: academic and interpersonal. Academic validation occurs when college representatives (faculty, counselors, etc.) assist students in trusting their innate capacity to learn and to acquire confidence in being a college student. Interpersonal validation occurs when college representatives foster students' personal development and social adjustment. Validation theory is cited in many literature reviews, research findings, and in recommendations made by educators and policymakers attempting to understand at-risk, underrepresented populations, and to propose strategies to improve student retention and academic success (Dodson, Montgomery, & Brown, 2009; Nuñez, Murkami-Ramalho, & Cuero, 2010; Nora, Urick, & Quijada Cerecer, 2011). Two key findings proposed in the literature relate to the current study. First, low-income, first-generation students require both in- and out-of-classroom validating support strategies and communities comprised of faculty, counselors, advisers, family, peers, and professionals; and second, a validating team of faculty and counselors can provide students with care, encouragement, and support, as well as essential information needed to be successful in college. The current study assigns the math placement assessment guidelines as an independent variable, which determined the initial validation experience first-time students received upon admission to the institution. These experiences occurred outside the classroom by a team of faculty advisors and counselors, guiding new students as they navigate the enrollment process.

The transition from high school to college can be challenging for first-time students. When additional factors associated with nontraditional students are added, a different perspective or framework from which to understand the experience is required. The next section examines Bean and Metzner's (1985) nontraditional student departure

theory, which captures those demographic variables associated with the community college student population.

Nontraditional Undergraduate Student Attrition Model

Historically, models of student attrition or dropout emphasized the importance of students' social interactions with members of the campus community and focused primarily on factors relevant during late adolescence. (Spady, 1970; Tinto, 1975; Pascarella & Terenzini, 1980). In Bean and Metzner's (1985) model of nontraditional undergraduate student attrition, social integration variables have only minimal effects on retention, partly due to the way nontraditional students are defined, and partly because social variables from the outside environment are expected to have a greater influence than the college environment. With the increased enrollment of nontraditional students influencing retention, Bean and Metzner (1985) developed their model of student departure. They defined nontraditional students as having at least one of three criteria: non-residential/commuter, enrolled part-time, and being over 24 years of age. Bean and Metzner (1985) found that environmental factors exert more pressure on nontraditional students than social integration into the college community. Their model is based on four sets of variables: academic performance, intent to leave, background and defining variables and environmental variables (Aljohani, 2016). The community college in this study is comprised exclusively of commuter, non-residential students, therefore, the researcher incorporated concepts and definitions from Bean and Metzner's background and defining variables to advance the theoretical framework of the current study.

Bean and Metzner (1985) developed their conceptual model of the dropout process specifically to understand the nontraditional student experience. Even in their early research, they found the likelihood of nontraditional students finishing a degree program much less than for traditional students. Due to the heterogeneity of a nontraditional student profile, Bean and Metzner (1985) focused their definition on the differences between traditional and nontraditional students and identified living on-campus as a primary distinction between traditional and nontraditional students. The majority of community colleges, by definition located in the neighborhood community, do not offer on-campus residential living, consequently, all students commute to campus. In the current study, all students attending the community college are commuters and therefore, using Bean and Metzner's (1985) definition, are considered nontraditional.

For nontraditional students, Bean and Metzner (1985) found that attending college for academic reasons was paramount, with the primary focus on the academic offerings. They defined dropout as any student who enrolls at the institution one semester but does not enroll the next semester. They recognized that this broad operational definition does not take into consideration stopouts, those students who may return after a semester or more, or transfers, who continue their education at another institution (Bean & Metzner, 1985). To examine the persistence and retention of nontraditional students in the current study, Bean and Metzner's broad definition of dropout was applied.

The outcome (persist or dropout) of validation (pre-college/college-level math placement) is the dependent variable under consideration. Bean and Metzner (1985) predicted that negative psychological outcomes would have a more substantial influence on the decision to dropout than would positive academic outcomes. If a student's initial

contact with the college is viewed as negative (i.e., they are assigned to developmental courses that delay degree completion), students will likely have a negative psychological outcome. For nontraditional students in particular, this reinforces their uncertainty about belonging on a college campus. Placement into developmental courses comes at a cost, including retention and completion challenges, financial and time costs, and equity and economic consequences.

Nontraditional college students may be influenced by their initial experiences with assessment and placement, and therefore the review of related literature begins with a look at developmental education in the community college.

Review of Related Literature

The assessment and placement of first-time students is a critical juncture where validation may prove valuable to retention efforts. For new students entering the community college, much of the research has found that placement into developmental education is a deterrent to retention and graduation. Research suggests that the longer a student spends taking developmental courses, the more likely the student is to dropout altogether (Clotfelter et al., 2012; Martorell & McFarlin, 2011). Limiting the time spent in developmental education reduces the likelihood that outside events or influences will pull students away from college before they complete their developmental sequence (Edgecombe, 2011). The next section examines relevant studies on developmental education outcomes including financial implications, followed by math placement and the misalignment between high school and college-readiness expectations, equity gaps

and the impact of developmental education on marginalized students, and the use of multiple measures to reduce negative effects of remedial placement.

Developmental Education in Community Colleges

With over 40% of entering community college students enrolling in remedial courses (NCES, 2011), the growing use of developmental education reflects increasingly common practice in the transition from high school to community college. This practice of placement into developmental courses has been under assault in recent years due in part to state and federal accountability pressures, a national focus on college completion, and inequitable outcomes found among student groups. A review of the literature on developmental education found mixed results on its success, most notably adverse outcomes for students testing at the margins of college-readiness. The research has heightened the urgency to improve placement policies as concerns about assessment, placement, and developmental education have resulted in measures taken in some states to limit or eliminate developmental education and modify or restrict the use of placement tests (CCCSE, 2016). According to the Center for Community College Student Engagement National Report (CCCSE, 2016), colleges must be willing to try new approaches, but those approaches must be grounded in research about what leads to better results.

In a meta-analysis by Valentine, Konstantopoulos, and Goldrick-Rab (2017), they report on studies that used regression discontinuity to examine the effects of placement into developmental education. This systematic review examined the effects of developmental placement on four indicators of college attainment: (a) college-level

credits earned, (b) passing a college-level course in which remediation was needed, (c) earned grade in the college-level course if taken, and, (d) degree or certificate completion. The authors (Valentine et al., 2017) found 11 studies with over 100,000 students represented in the database that used regression discontinuity (RD) to examine the effects of placement into developmental education at two- and four-year institutions.

This meta-analysis represents the most rigorous review to date (Valentine et al., 2017). The results were troubling, more than 75% of the estimates in the meta-analytic database are negative, and the estimates for college credits earned, passing a college-level course, and degree attainment were all negative, statistically significant, and large enough to be meaningful (Valentine et al., 2017). Relative to their peers, students who were at the margin of college-readiness and were placed into developmental education earned fewer college credits, were less likely to eventually pass the college-level course in which remediation was needed, and were less likely to earn a degree or certificate.

Developmental education is one of the largest single interventions intended to improve outcomes for underprepared college students. Scott-Clayton, Crosta, and Belfield (2014) examined the screening process for remedial course placement using a predictive model of community college grades to identify the prevalence of remedial course misplacement. Their study explored whether high school transcript information was a more valuable screening device for placement into college courses and whether the choice of remedial screening device has disparate impacts by race and gender. The authors used data from tens of thousands of students in two community college systems; a large urban community college system with six affiliated campuses, and a state-wide community college system of over 50 community colleges.

The results show that one quarter to one-third of tested students are severely misplaced (could have earned a B or better in a college-level course), with severe under-placements two to six times more prevalent than severe over-placements. They found nearly one in four students who take a math placement test, place into remediation even though they could have earned a B or better in the college-level course (Scott-Clayton et al., 2014). Further, if high school information alone were used for screening instead of test scores, college-level math classes would have substantially higher proportions of female students (from 53.4% to 60.6%) and Hispanic students (from 22.3% to 30.8%). Compared with current test-score-only policies, the authors (Scott-Clayton et al., 2014) found that using high school information for remedial assignment not only reduces severe placement errors overall but also within each racial/ethnic and gender subgroup examined. The analysis by Scott-Clayton et al. (2014) suggests the need to improve the remedial screening process and highlights the impact the choice of screening policy has on the racial and gender composition of college courses.

Evidence of the negative effects of developmental placement and assessment policies, and the possibility of a discouragement effect, was recognized in a study by Martorell and McFarlin (2011). Using a regression discontinuity approach, they focused on students just above and below test score cutoffs for remediation in higher education. They examined over 250,000 students in Texas public two- and four-year colleges, and found that assignment to remediation decreased the probability of completing additional years of college and reduced credit accumulation. Martorell and McFarlin (2011) observed that assignment to remediation negatively impacts college persistence, and they suggest the presence of discouragement or stigma effects. These stigma effects are

consistent with evidence on the impact of test score performance labels at the high school level, which indicate that being labeled as a poor performer discourages students from enrolling in college (Papay, Willett, & Murnane, 2011). The perceived stigma associated with being placed into developmental courses may negatively impact student enrollment and retention.

While many developmental education studies look for negative impacts on persistence based on enrollment and course completion, Scott-Clayton and Rodriguez (2015) examined whether there are any effects on college enrollment between the time of the first placement test and initial course registration, which they label the discouragement hypothesis. They suggest that some students assigned to remediation may be negatively affected even if they never actually enroll in or complete remediation (Scott-Clayton & Rodriguez, 2015). While their findings suggest little support for the discouragement effect, they did find negative diversion effects in math. Specifically suggesting that one-quarter of students diverted out of college-level coursework in math could have earned passing grades had they been given the opportunity. They suggest that those students taking remedial coursework are delayed from their path, and never quite catch up to their peers in college-level credits earned (Scott-Clayton & Rodriquez, 2015). Rather than facilitating a student's successful entry into college-level programs of study, the current developmental education system diverts students away from such programs (Bailey et al., 2015).

Being diverted away from college-level courses or programs of study based on developmental math placement is associated with additional tuition and time costs and may discourage or delay students' degree plans. The completion of a college degree

impacts student earning potential and social mobility and can reduce equity gaps among student groups. The financial implications of developmental education may be consequential and have a considerable impact on nontraditional students.

Financial and Time Costs

The financial and time costs associated with developmental education cannot be over stated. With half of all undergraduates taking one or more developmental courses while enrolled, and over 1.2 million first-time students entering community colleges annually, the cost of remediation is estimated at nearly $4 billion per year (NCES, 2012; Scott-Clayton & Rodriguez, 2015). The Spellings Report (2006) identified that among those high school graduates who enroll in postsecondary education, a troubling number waste time and taxpayer dollars mastering English and math skills that they should have learned in high school. The public institution in this study resides in a state which provides scholarship funding to state residents based on generous income criteria, but only for students who complete 30 college-level credits each year (NYSHESC, 2020). Placement into developmental courses, especially for students at the margins of college-readiness, often makes access to available scholarship funding unrealistic or forces students to take credits over the summer at additional personal expense. Nontraditional students generally work to defray the cost of attendance or to pay living expenses. More than 63% of students report working to pay expenses or are employed while enrolled in college (NPSAS, 2016). The additional time and expense of developmental education creates a burden more keenly felt by nontraditional students.

When making decisions about attending and paying for college, access to accurate and timely information is not equivalent across all student groups (Long, 2004; Perna, 2006). The types of students most likely to enroll in community colleges often have the most difficulty acquiring the information and guidance they need to make informed decisions about the college process (Avery & Kane, 2004). Further, first-generation students often come from home environments that possess a limited understanding of higher education in general. This lack of "college knowledge" stands in stark contrast to the advantages enjoyed by students from more affluent socioeconomic backgrounds who have college-educated parents able to provide them with information related to attending and paying for college (McDonough, 1997). Higher-income and private high schools typically provide more considerable resources and support to help students make informed decisions about the college process when compared to lower-income and urban public schools (McKinney & Novak, 2013). These cultural and financial limitations are felt before students even arrive on campus and add to the heightened sense of insecurity and lack of belonging.

According to Pretlow and Wathington (2012), the national cost estimate of developmental education has remained relatively consistent over time. These estimates evaluate the cost to federal, state and local governments and higher education institutions, and do not account for the costs to individual students considered in terms of time, tuition, or forgone income (Pretlow & Wathington, 2012). Pretlow and Wathington (2012) found that many state policymakers believe that the proper venue for offering developmental courses is in less-expensive community colleges. The consequence of these state policies is the restriction of developmental students to community colleges,

which have fewer resources per student than do four-year institutions (Bailey & Morest, 2006). Further, students who begin postsecondary education at a community college are less likely to transfer and earn a Bachelor's degree when compared to similar students who begin at four-year institutions (Long & Kurlaendar, 2009). The authors (Pretlow & Wathington, 2012) argue that the result of a system in which fewer resources are disbursed to institutions with large numbers of students who have great financial and educational need, is not only inequitable, but contributes to further stratification of the higher education system.

The stratification of higher education has racial/ethnic implications as well as academic and economic consequences. While the academic and ethnic diversity of first-time community college students is both a strength and challenge, the equity gaps that exist among high school graduates and entering community college students must be recognized and addressed. Improving assessment and placement policies may prove to be an appropriate undertaking to reduce the gaps among entering community college students.

Equity Gaps

The diversity of enrollment enjoyed by community colleges necessitates their role as providers of remediation for academically underprepared students. The accessibility and affordability of community colleges make them a particularly attractive choice for historically underrepresented student groups, low-income students, and first-generation college students (Carnevale, Smith, & Strohl, 2010). Community colleges are seen as a gateway to a better future for many disenfranchised/marginalized student groups.

In a recent study by Melguizo and Ngo (2015), they examined why so many students who appear to be college-ready repeat courses like algebra when enrolling in a community college. They argue that the prevalent equity gaps inherent in college remediation must be confronted. To identify equity gaps, the authors evaluated the misalignment between high school math courses and standards, and the math readiness standards for students enrolling in community college. They examined over 85,000 community college students across nine cohorts of students between 2005 and 2014 within the state of California. They discovered that Black and Latino students consistently experienced the highest rates of math misalignment; 77% of Black students and 64% of Latino students experienced math course misalignment compared to 29% of White students and 26% of Asian students. Their findings also suggest there is strong evidence that math misalignment is more prevalent in colleges that serve larger Black and Hispanic student populations (Melguizo & Ngo, 2015).

In a study by Park, Woods, Hu, Bertrand Jones, and Tandberg (2018), the authors examined math placement in Florida's community college system under the new optional developmental education policy, which passed the state legislature in 2013. The optional developmental education policy allows students to enter directly into college-level courses regardless of academic preparation. Park et al. (2018) sampled over 20,000 students who were defined into four preparation groups: severely underprepared, moderately underprepared, slightly underprepared, and college-ready. Ethnicity, income status, and high school math courses were identified as variables. The results indicate that White and Black students were inversely and disproportionately represented across the preparation levels; White students comprised 42.5% of college-ready students

compared with only 16.5% of Black students identified as college-ready. Hispanic students comprised nearly equal proportions of the student population across all four bands of preparation (Park et al., 2018). Their findings suggest that Black and female students are less likely to voluntarily enroll in gateway math courses (do not see themselves as college-ready in mathematics) and Park et al. (2018) speculate whether academic advising might play a factor in how these historically underrepresented students are encouraged or discouraged from enrollment into college math courses.

According to Paulsen and St. John (2002), social class has a profound effect on higher education, influencing who has access to college, the colleges students choose to attend, and whether or not college is affordable, or even an option. Social class and socioeconomic status (SES) are often used interchangeably. Nevertheless, social class was more accurately defined by Yeskel (2008) as a group of people who share a similar economic and social position in society based on their income, wealth, property ownership, job status, education, skills, and cultural capital or power in the economic and political sphere. It also affects the transition to college, determining college-readiness, academic preparedness, and performance on standardized tests (Patton et al., 2016). Studies of social class and student involvement revealed differences in the level of involvement among students from different social classes. Those students from lower-income backgrounds were less involved in social activities due to working to fund their education and were less likely to attend graduate school (Martin, 2012; Walpole, 2003). Ostrove and Long (2007) found a strong relationship between social class and a students' sense of belonging, impacting their adjustment to college, the quality of the college experience, and their academic performance.

Social class cannot ignore the intersection of race and gender. Race and class are often simultaneously examined (Patton et al., 2016). In a study by Walpole (2008), the role of social class in the college experiences and outcomes for African Americans was examined. She looked at indicators for college success and found that low-income African American students were less likely to be involved, had fewer interactions with faculty, and had lower grades than their peers. Further, almost a decade later, those same students had lower incomes, lower rates of degree completion, and were less likely to have attended graduate school (Walpole, 2008). Social class has the potential to place boundaries on students' career aspirations and choices and the opportunities throughout life that shape those aspirations and choices (Patton et al., 2016). Matusov and Smith (2012) suggest that these choices are manufactured through structural inequality, which ensures that only certain groups of people have access to certain choices. Class inequality is reproduced to maintain stratification and inequitable differences between the lower and upper classes, and Aries and Seider (2007) suggest it is power and privilege that dictates the choices one has.

Developmental education has become a contentious issue in part because the completion and graduation rates for developmental students are low, and enrollment in developmental courses reinforces equity gaps. It is clear that the majority of students enrolled in developmental courses are at community colleges, and that the burden on community colleges for remediation has increased in recent years (Parsad & Lewis, 2003). Examining developmental education and the assessment and placement policies that determine who requires remediation is necessary to improve accuracy in deciding who can access college-level courses and to redress equity gaps present at enrollment.

Critical to the issue of equity is recognizing the misalignment between high school math courses and community college standards of college-readiness.

Math Placement and Misalignment

The lack of alignment between high school courses taken and the standards for college math placement testing operates either directly or indirectly as a mechanism to discard the knowledge and skills accumulated in high school, and functions to track students into developmental math in college (Melguizo & Ngo, 2015) disproportionately impacting marginalized/underrepresented student groups. To measure the alignment between community college entrance expectations and the tests taken by the majority of California high school students, Shelton and Brown (2010) investigated the consistency of high school and community college mathematics standards. They focused on the alignment between placement test content and the content of the states' high school math tests in General Mathematics, Algebra I, and Geometry taken by the vast majority of California high school students as the standard of math proficiency. Overall, the high school tests evaluated in the study did not demonstrate a considerable amount of content alignment with the math placement tests given in community colleges. The findings reveal that one-third of all objectives emphasized on math placement tests are not tested on the General Mathematics, Algebra I, and Geometry tests administered by high schools in the state. This result suggests that entering community college students were tested on material they were never taught while in high school. Where alignment did occur, the high school assessments measured the objectives at a level of cognitive complexity standards at least as high as that of the college placement tests, indicating that high school

tests have the potential to be utilized as benchmarks towards meeting college-readiness standards (Shelton & Brown, 2010).

In a study by Rodriguez (2014), a comparison of the math course placement rates between two cohorts of students in the Virginia Community College System were evaluated. One cohort used a new instrument designed to improve placement accuracy, matching student proficiency in competencies required by specific programs of study (STEM majors, Liberal Arts majors), as compared with the second cohort placed into college math using prior/old placement criteria. Rodriguez (2014) found a higher proportion of students placed into and enrolled in college-level math under the new guidelines, and these higher enrollments boosted completion rates (with a C or better). However, pass rates among those enrolled declined modestly, suggesting that colleges may need to offer more support to improve the performance of some students who place into college-level math. Rodriguez (2014) argues that colleges may have to tolerate lower pass rates, at least initially, in order to facilitate more students attempting college math courses, leading to higher college-level math completion rates.

Similarly, Hu, Park, Woods, Richard, Tandberg, and Bertrand Jones (2016), found that while college-level math course passing rates declined, the net percentage of incoming students taking and passing college-level math courses increased. A higher percentage of all incoming students are passing gateway college-level courses now that developmental education is optional in Florida's state system, suggesting that these students who would have previously been placed in developmental courses are taking and succeeding in college-level courses (Hu et al., 2016). Increasing the number of students

enrolling in college-level math through a change in placement policies and procedures may lead to improved student outcomes.

Community colleges must reevaluate their placement testing policies and practices to better assess student potential for college success. High school math course proficiency and the lack of alignment with community college readiness standards, is well documented. Using a comprehensive review of high school transcript data along with standardized test results when necessary may improve placement outcomes. The use of multiple measures (i.e., high school GPA, highest math course taken) to evaluate student potential in mathematics has support in the literature.

Multiple Measures

The research on multiple measures to determine course placement is plentiful and promising. Ngo and Kwon (2015) examined the extent to which using multiple measures for math course placement achieves the dual goals of access and success. Using data from the largest community college district in California, Los Angeles Community College District (LACCD), Ngo and Kwon (2015) evaluated math placement based on additional information provided by the student (educational background, college plans). This additional information, in conjunction with math placement test scores, can result in students being placed into higher level math courses, which the authors called a multiple measures boost. The impact of the multiple measures boost on access and success in developmental math was measured using community college transcript data from 2005 to 2008 to provide the descriptive analysis. Two specific measures used to evaluate

educational background were: prior math achievement (high school math courses) and high school GPA.

LACCD is comprised of nine community colleges serving over 200,000 students annually, with an estimated 80% of entering students placing into developmental math courses. The researchers used linear probability regression models to examine long-term outcomes and to compare performance of colleges within the district. The results suggest that community colleges can increase placement accuracy by using multiple measure information, specifically, prior math background and high school GPA, in conjunction with placement scores. They found that low scoring students who placed into higher-level math courses using the multiple measures boost, performed no differently from their higher scoring peers, and that high school GPA is highly predictive of college persistence and success. Their findings indicate that community colleges can improve math placement accuracy and increase access to higher-level courses by considering high school GPA and prior math courses taken, in their placement guidelines.

In another study of multiple measures, Bowen (2018) examined whether the Multiple Measures (MM) for Placement policy utilized within community colleges in the North Carolina state system impacted student success differently for those who received the MM waiver than for those who placed out of developmental courses via placement test alone. Only students with a high school GPA of 2.6 – 3.0 were included in the study since this was the population whom faculty believed were inappropriately placed into college-level courses based on the state's MM policy. Two groups of students at one urban community college in North Carolina were compared for success (as defined by

receiving a grade of A, B or C) in their first college-level English or mathematics courses.

The major findings were that there was no statistically significant difference in college-level course success for math and English, and no statistically significant differences in retention from fall to spring or fall to fall, between those students placed by the two different evaluation methods. This result affirmed the success of the states' Multiple Measures Placement policy and disputed the negative anecdotal comments by faculty. With no difference in outcomes found based upon placement criteria, the new MM method used by the community college system is effective at accurately placing students into college-level courses. Uncovering implicit biases among faculty and advisors may be an avenue to explore as colleges seek to reduce equity gaps through placement policies.

A study on math placement by Marwick (2002) compared the effectiveness of three alternative methods for initial placement in mathematics with the current method of placement by test scores alone, at one urban community college in the Midwest. Effectiveness was defined as academic success which was measured by course completion rates, course grades, and persistence to enroll in another math course the following semester. Using a controlled randomized experiment, students were randomly assigned to one of four placement methods (placement test score; high school preparation via student survey; a combination of both test scores and high school prep.; or student choice). The self-reported survey was chosen primarily because of Armstrong's (1999) finding that self-reported high school preparation more strongly correlates to college grades and course completion than a placement test score does.

There were no significant differences in academic success among students placed by the four methods. Students performed equally well regardless of the method used for initial math course placement. The study found that when conflicting placement recommendations by method occurred, students who placed into higher-level math, did not hurt their chances of academic success, instead, it increased their chances in some cases (Marwick, 2002). The research discovered a significant relationship between placement method and the distribution of enrollments. Single measure methods place students into lower-level classes more often than do multiple measure methods, particularly for developmental students (Marwick, 2002).

These studies confirm the importance of initial math course placement as a mechanism for creating or removing barriers to access college-level education. Further, the use of multiple measures, rather than a single test score, can more effectively place students into math courses resulting in improved outcomes. Optimizing math placement at the community college level may improve academic progress and reduce financial and time burdens, particularly for nontraditional and marginalized students.

Nontraditional Community College Student Demographics

Community college students have more characteristics that might compromise their ability to succeed in college compared to students enrolled in 4-year institutions (Bailey, Jenkins, & Leinbach, 2005). They generally have lower high school test scores and many need remediation, are more likely to delay enrollment, attend part-time, and are much more likely to come from lower-income households. All of these factors have been shown in studies to be related to lower retention and graduation rates (Voorhees & Zhou,

2000; Bailey, Alfonso, Scott, & Leinbach, 2004). Further, community colleges serve older students who face additional challenges, often working full-time and may have families to support, characteristics that have been found to be significant barriers to educational success (Gooden & Matus-Grossman, 2002).

In a study by Nakajima, Dembo, and Mossler (2012), factors likely to influence a community college student's decision to dropout were investigated. Specifically, the authors examined demographic, financial, academic, academic integration, and psychosocial variables and the relationship of these variables to student persistence. Results of the study revealed that age, work hours, and financial aid influenced student persistence, and of all the variables, cumulative GPA was the strongest predicting variable for student persistence (Nakajima et al., 2012). Students who had higher cumulative GPAs were twice as likely to stay in college. The authors argue that most of the research has been given to demographic risk factors, such as age, ethnicity, past academic performance, financial status, and registration behaviors; however, they suggest that environmental factors such as faculty-student interaction and student services are also associated with student persistence. Nakajima et al. (2012) found that faculty concern had a significant relationship with student persistence. Interactions between faculty, counselors and students occur early in the enrollment process and may serve to validate students' sense of belonging. Students may benefit from positive interactions with advisors (being placed into college-level courses/regarded as college-ready) influencing their decision to enroll and persist.

The current study used Bean and Metzner's (1985) definition of nontraditional students and background and defining variables, including socioeconomic status (SES)

related to the demographics in Rendón's research on nontraditional, low income, first generation, and adult students. These variables are age, gender, ethnicity, SES, enrollment status, and high school grade point average.

Age

Decades of research have shown age as a factor affecting student enrollment, retention, and degree completion. In an early theory by McClusky (1974), the key elements in the lives of adults were defined as the load (demands) they carry and the power (support, resources) they have to carry the load. A central feature of his Power-Load theory is the ability to meet any learning demands by maintaining an appropriate ratio between load and power. The ability of an adult student to earn a degree may be directly affected by their ability to maintain a balance between load and power. Nontraditional adult students, defined as over 24 years of age, face many external demands that may negatively impact their ability to earn a degree. To appreciate the challenges facing community colleges, Adelman (2005) suggested that the distinction between traditional and nontraditional-aged students is so noteworthy that mixing these age populations does a considerable disservice to understanding and judging the effectiveness of community colleges.

Macari, Maples, and D'Andrea (2005) found that nontraditional-aged students are often engaged in activities and responsibilities outside of college, which require a great deal of time and attention limiting campus involvement. Despite the challenges of nontraditional-aged students, the percentage of adult students remains a significant portion of the enrollment in remedial courses at community colleges; in 1999-2000 35%

of those age 24 -29, and in 2007-2008 22% of the same age group enrolled in remedial courses (NCES, 2013). Given that age is a factor impacting the persistence and retention rates of community college students, this demographic was included as a variable in this study along with gender and ethnicity.

Gender

Central to any discussion of factors influencing gender on campus is the academic contexts of classes and majors. While women became the majority of college students beginning in 1979 and have remained so (Patton et al., 2016; NCES, 2014), they also remain the minority in science, technology, engineering, and mathematics (STEM) fields (NCES, 2014). STEM fields are essential to the 21st century workforce and many companies are experiencing personnel shortages (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). Social-cognitive theories suggest that students come to college with predetermined ideas about appropriate majors and careers for men and women (Patton et al., 2016). Math placement and initial course enrollment can impact students' planned career goals. Evidence suggests that persistence of minoritized genders in STEM majors is lower than persistence of those in the majority (Gayles & Ampaw, 2014). Gender is also a factor in student experiences at the individual course level. Different genders may engage more actively in different academic settings. Wood (2014) found that Black men in community colleges were more hesitant to actively engage in classroom discussions; Latino men in community colleges were reluctant to seek academic help citing gender and male pride as contributing factors (Sáenz, Bukoski, Lu, & Rodriguez, 2013).

There has been debate about whether same-gender faculty mentors are necessary to buffer the effects of stereotyped academic majors (Blake-Beard, Bayne, Crosby, & Muller, 2011; Patton, 2009). The research has found that having a faculty mentor of either gender is more effective than no mentor at all, and is an endorsement of faculty role models in the success and persistence of students in nontraditional gender majors (Herzig, 2004; Smith, 2007). This aligns with Rendón's (1994) theory of validating agents - faculty, counselors, and advisors – as critical to the academic success of nontraditional students. In addition to differences found among age and gender of community college students' persistence and retention, research on ethnicity is also noteworthy.

Ethnicity

All students face challenges in college, and those challenges may be different for students from underrepresented/minority groups. Schlossberg (1989) considered the concepts of marginality and mattering and their impact on the college experience for members of minoritized groups. She found that when students feel marginalized, they worry if they matter to anyone, resulting in poor performance and ultimately leaving college. More recently, scholars and student affairs educators have become aware of the need to be more cognizant of the role of race and ethnicity in student development theory and practice (Patton et al., 2016). Ethnicity was examined in the current study as a consequential variable given that ethnic minorities enroll in higher numbers at community colleges (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006; NCES, 2008), and a greater percentage of Black (30.2%), Hispanic (29%) and Asian (22.5%) students report

taking remedial courses compared with White (19.9%) students attending public institutions (NCES, 2013).

Students from historically underrepresented backgrounds are overrepresented in community colleges but underrepresented with regard to graduation and completion rates (Engle & Lynch, 2009). Although the degree-attainment rates of minority and low-income students have improved over the past three decades, Engle and Lynch (2009) report that these rates have not kept pace with those of other students, and the gaps that separate Hispanic and African American students from White students are wider today than in 1975. Further, although over 80% of students enrolling in a community college indicate that they plan to earn a college degree, only 7% of low-income and minority students are estimated to do so within ten years. For underrepresented minorities, gaps exist on all measures of community college success as they are less likely than other students to earn a certificate, associate degree, or transfer to a 4-year institution (Engle & Lynch, 2009).

The Tennessee Board of Regents (TBR) redesigned their elementary and intermediate algebra developmental math courses at Austin Peay State and several community colleges to improve the graduation rates among students entering the state system. The TBR system enrolls a large proportion (67%) of underrepresented minority students (Engle & Lynch, 2009). This math initiative was implemented to address the high freshmen dropout rate and improve overall graduation rates. The impact of developmental math placement on student persistence and retention was recognized by the TBR as a potential exit point and factor for improving degree completion.

While access to higher education, specifically community colleges, has been successful in providing opportunities for ethnically diverse and underrepresented student groups, it has not resulted in improved graduation rates. AtD (2020) considers community colleges an indispensable asset in the nation's efforts to ensure and preserve access to higher education and success for all students, particularly historically underrepresented student populations. Improving the accuracy of math placement, more effectively evaluating students' academic records, and eliminating unnecessary courses reducing student costs and time to degree completion, could substantially improve outcomes for all student groups. Any discussion of ethnicity often brings up economic status. In addition to age, gender, and ethnicity, this study assessed the socioeconomic status of community college students using Pell-grant eligibility as a means to identify low-income students.

Socioeconomic Status (SES) and Social Class

According to Bowen, Kurzweil, and Tobin (2005), the disparate college preparedness between economically advantaged and disadvantaged students is a major determinant of inequities in educational attainment. Students from privileged families have resources, live in neighborhoods, and attend schools, which provide academic advantages that account for the gaps seen in students' academic preparation (Bowen et al., 2005). Socioeconomic status and social class are associated with the economic, social and cultural capital students' bring to the higher education arena. Low-income backgrounds are characterized by a lack of power, limited cultural capital, economic vulnerability, and a low level of education (Borrego, 2003). Socioeconomic status and social class have a profound effect on school choice, influencing who has access to

college, which colleges students attend, the affordability of college, and whether or not college is an option at all (Paulsen & St. John, 2002).

Many low-income students view college as financially prohibitive and often have less information about the college process, along with having limited resources to support a college education (Adair, 2005; Patton et al., 2016). As such, variations among SES and high school environments can account for the varying levels of knowledge students have about college and financial aid. The underutilization of financial aid has been identified as a formidable barrier to access, persistence, and degree attainment among community college students (ACSFA, 2008). Novak and McKinney (2011) found that among Pell-eligible students, those who filed a FAFSA had 122% higher odds of persisting from the fall to spring semester than their peers who did not file. In a subsequent study by McKinney and Novak (2013), they identified variables that effect persistence in community college students. These variables encompass the academic, social, cultural, and financial capital and equity issues that typically affect historically underrepresented students to a greater degree. Low-income status and associated circumstances were seen as environmental pull factors that exert pressure on persistence and lead to dropout. The overlap between gender, ethnicity, and SES is often difficult to separate when evaluating the impact on college persistence and retention.

In addition to commonly identified demographics of age, gender, ethnicity, and SES, nontraditional student enrollment status (part-time, full-time) may provide insight into persistence and retention issues.

Enrollment Status

Bean and Metzner (1985) identified enrollment status as a defining variable of nontraditional college student attrition. Students who attend college part-time in order to work full-time to finance their education or to support a family are less likely to remain enrolled or graduate. In a national report published by the US Department of Education (NCES, 2018), about one-third of community college students were working full-time while enrolled, and more community college students attended college part-time than traditional four-year students. Nontraditional community college students identify themselves more often as employees enrolled in college, or working to meet expenses, and in 2011, as many as 80% of community college students had attended college part-time (NCES, 2018). According to Hawley and Harris (2005), working 35 or more hours per week was associated with higher rates of dropout. Schimid and Abell (2003) identified several risk factors that played a role in negatively impacting persistence for community college students, including part-time enrollment, and working full-time. Part-time enrollment is associated with increased dropout (Horn, 1996) and poor outcomes, including completion rates (Darolia, 2014; Skomsvold, Radford & Berkner, 2011).

While it is important to recognize the increased risk of dropout among part-time students, the opposite appears to be true about part-time work (Jones, 2012). Evidence in a study by King (2002) found that enrolling full-time in college and working part-time, especially working on-campus, improved students connection to the campus and likelihood that the student would earn a college degree. First-time students who worked part-time while enrolled in community college were more than twice as likely to graduate in three years compared to those who did not work at all and those who worked full-time

(NCES, 2018). The effect of enrollment status on persistence and retention is well documented, as is the influence of high school grade point average (GPA) on student success, the final variable defined in the current study.

High School GPA

There is significant research on students' prior HS academic performance as the best predictor of success in college. According to Trusty and Niles (2004), it is logical that what students do in high school has a strong bearing on later academic experiences. Most studies focus on high school GPA as the predictor of college success with college GPA as the dependent variable. Pascarella and Terenzini (1991) stated that student grades are the single most revealing indicator of successful adjustment to the intellectual demands of college. While high school math GPAs have increased moderately in the last two decades, they remain well below English and social studies grade point averages over the same period (NCES, 2011). In an extensive analysis of high school transcripts, Adelman (1999; 2006) combined high school performance data elements to predict the completion of a college degree. He concluded that the academic rigor of a student's high school curriculum still counts more than anything else in the pre-college background for providing momentum toward degree completion.

The push for standardized testing both before and after admission is based on the belief that high school grading is not uniform, that grade inflation is evident, and that there are different grading standards within schools and between school districts (Sedlacek, 2004). Many studies have discovered a positive relationship between high school performance and first-year retention (Astin and Oseguera, 2005; Caison, 2005;

Glynn, Sauer & Miller, 2006). In a study by Williford (2009), a strong positive relationship was found between a students' performance in high school courses and their success in the first term of college. French, Homer, Popovici and Robins (2015) determined that the effects of high school GPA on the highest level of education attained and annual personal earnings were statistically significant and observed effect sizes that were relatively large and economically meaningful. Their results predicted that a 1-point increase in high school GPA doubles the probability of completing college (21% to 42%) for both men and women, and an equivalent increase in high school GPA raises annual earnings in adulthood by more than 11% for men and almost 14% for women. If high school GPA is predictive of college GPA, retention, degree completion and beyond, using high school transcript data when assessing the placement of entering community college students is imperative.

Conclusion

The evaluation of first-time students and their placement in developmental courses impacts students' early college experiences. It impacts the length of time to degree completion, may affect eligibility for financial aid and scholarship funding, and often has an undesirable effect on students' initial contact with an advisor. For nontraditional community college students, the transition from high school, or the work environment to a new environment where many feel they are outsiders, is intimidating and often overwhelming. Rendon's (1994) Validation Theory, the framework for the current study, posited that nontraditional students may benefit from external validation that moves them toward gaining internal strength and increased confidence, resulting in college success, expressed as persistence and retention. Bean and Metzner's (1985)

definition of nontraditional students, along with their background and defining elements, were the independent variables considered in the current study.

The assessment and placement testing, which occurs in the early stages of the community college student enrollment process, is often the initial contact students receive from college representatives, reinforcing students potential to learn and be successful. Improving the accuracy of math placement through the use of multiple measures, reducing the number of students who need math placement testing, and reducing the length of the math placement test when testing is required should improve students' overall intake experience and, ultimately, persistence and retention.

The current study evaluated the effectiveness of a new math placement policy that used multiple measures and more closely aligned with high school courses. It fits within the existing literature on the use of multiple measures for improved placement, the impact on persistence and retention, and the effect from nontraditional community college student background variables. Given that academically, ethnically, and economically diverse students continue to enroll in community colleges in record numbers, improving outcomes through policy analysis is a significant effort. The Center for Community College Student Engagement National Report (CCCSE, 2016) encourages colleges to assess their data, update processes based on new information, and continue to evaluate success over time. Removing barriers to college-level math courses, validating nontraditional students' sense of belonging, and improving retention are worthy goals.

CHAPTER 3

Higher education institutions across the nation are making, and being encouraged to make, every effort to improve the accuracy of the assessment and placement of first-time students. Since community colleges are a pathway toward vocational, certificate, and degree programs for many nontraditional, low-income, first-generation, underrepresented students, it is crucial to increase access to college-level courses through more accurate assessment and placement policies. Improving placement testing policies so that accuracy is improved and misplacement errors are minimized can benefit both the college and the students.

The purpose of this study was to compare the math placement of first-time community college students who entered in fall 2016 through fall 2018, under old math placement guideline criteria, with students who entered in fall 2019, under new math placement guideline criteria. The new math placement guideline criteria include an emphasis on multiple measures (e.g., high school math courses, math course and test grades, and highest math course taken) along with using a redesigned version of the placement test (College Board, 2017) for those not waived by high school record alone. The secondary purpose was to determine the effect the different math placement criteria has upon enrollment in college-level credits, completion of the first semester of course work, and subsequent enrollment into the second semester (fall to spring retention). Using an independent samples t-Test and a logistic regression analysis, this study evaluated the independent variables of age, gender, ethnicity, SES, enrollment status and high school GPA, and their effect on persistence (first semester course completion) and

retention (enrollment into second semester) at one community college located in the Northeast.

Methods and Procedures

This study addressed three research questions with both categorical and continuous independent variables. The first step in the analysis examined the background and defining characteristics of community college students in the study by generating a set of descriptive statistics. The descriptive statistics considered the differences and similarities between new students entering the study institution each fall term from 2016 through 2019. The first three enrollment terms (fall 2016, fall 2017, and fall 2018) were selected to compare students under the old guideline criteria, evaluating uniformity among these groups. These three years (2016, 2017, and 2018) were evaluated separately and collectively. A separate column in SPSS was added with the combined fall 2016 – fall 2018 data. Statistical analysis was performed for each year and for the combined years. Students who enroll in fall 2019, under the new placement guideline criteria, were the comparison group used to determine the effect the new guidelines had on the number of registered credits, and on persistence and retention. Comparisons between fall 2019 and each prior year (fall 2016, fall 2017, and fall 2018), along with the combined years (fall 2016 – fall 2018), were reported.

In order to answer the first research question and look at the differences between the two groups of students (evaluated using old guidelines and evaluated using new guidelines), an Independent Samples *t*-Test was used since the independent variable (IV) was categorical and had two levels or groups (old guidelines = fall 2016, 2017, 2018, and

new guidelines = fall 2019), and the dependent variable (DV) was continuous (number of credits). The *t*-Test is a parametric statistical test used to compare the mean scores of two different, independent groups to determine whether the difference between means is significant (Fraenkel, et. al., 2019). Parametric techniques make various assumptions about the nature of the population from which the sample is drawn, are generally more powerful than non-parametric techniques, and are most appropriate for interval data (Fraenkel, et. al., 2019). An alpha level of .05 was chosen for the analysis.

Conclusions from an independent samples *t*-Test can be trusted if the following assumptions are met:

1. Independent observations – if each case represents a different person or statistical unit.

2. Normality – the dependent variable must follow a normal distribution in the population. This is only needed for samples smaller than 25 cases, in the current study the sample size for each group (fall 2016, fall 2017, fall 2018, and fall 2019) was approximately 2,000.

3. Homogeneity of Variance – the standard deviation of the dependent variable must be equal in both populations. This is only necessary if the sample sizes are sharply unequal. In the current study the groups were approximately equal in size.

Levene's Test for Equal Variances determined if the assumption of homogeneity was met.

To address the second and third questions, logistic regression was used. Logistic regression predicts the probability that an observation falls into one of two categories of a dichotomous categorical dependent variable based on one or more independent variables that can be either continuous or categorical (Birringer-Haig, 2019). The relationships among the independent variables (i.e., age, gender, ethnicity, SES, enrollment status, and HSGPA) on the dependent variables of persistence (completion of the first semester), and retention (subsequent enrollment into the second semester) were assessed to provide a model that described the factors associated with the observed outcomes. Given that the outcome variables (1 = persisted; 0 = did not persist) (1 = retained, 0 = not retained) were dichotomous, logistic regression was an appropriate technique. Logistic regression allows a researcher to explain the effect of both categorical and continuous independent variables on a binary dependent variable (Fraenkel, et. al., 2019). Dey and Astin (1993) stated that logistic regression is one of the most appropriate analytic tools for studying outcomes such as retention. An additional benefit of logistic regression is that the independent variables do not have to be normally distributed, linearly related, or of equal variance within each group (Tabachnick & Fidell, 2007). This statistic indicates which variables predict a dichotomous outcome and accommodates multiple continuous and categorical predictor variables with one dichotomous outcome variable for each record (Knapp, 2018).

There are seven assumptions associated with choosing to analyze data using a logistic regression. These pretest checklist assumptions or criteria were satisfied before proceeding with the analysis. With all seven assumptions met, the logistic regression provides valid results.

1. The dependent variable was measured on a dichotomous scale (persist/not persist; or retain/not retain).

2. There were one or more independent variables which were either continuous or categorical.

3. There was independence of observations (fall 2016, fall 2017, fall 2018, and fall 2019) and the dependent variable had mutually exclusive and exhaustive categories (i.e., persist/not persist). For each independent variable, the participants only belonged to one group (gender, ethnicity, SES, and enrollment status), or had one identified age and HSGPA. The independent variables of age and HSGPA were continuous. The remaining independent variables were numerically coded (i.e., male = 0, female = 1). The dependent variables were binary coded (i.e., 0 = not persist; 1 = persist).

4. There was a linear relationship between any continuous independent variable and the logit transformation (log odds = the logarithm of the odds) of the dependent variable. Every probability could be easily converted to log odds, by finding the odds ratio and taking the logarithm.

5. There was a reasonable ratio of cases to variables included in the analysis. The minimum number (*n*) required in the sample size was determined.

6. Logistic regression relies on a goodness-of-fit test as a means of assessing the fit of the model to the data. A goodness-of-fit test includes values for the expected frequencies for each cell in the data matrix formed by combinations of discrete variables. None of the cells had expected frequencies that were too

small (< 5), therefore the analysis had high power (Tabachnick & Fidell, 2007).

7. Multicollinearity – which is defined as a very high correlation among the predictor variables, was determined. The absence of multicollinearity was confirmed, therefore, each continuous variable that was loaded into the logistic regression model was statistically unique (Knapp, 2018). If multicollinearity were present, then the predictor variable(s) with the high correlation would be eliminated.

Descriptive statistics is SPSS were used to evaluate the pretest checklist items. An alpha level of .05 was chosen for the analysis.

Research Questions and Hypotheses

This study investigated the impact of math placement guidelines and the effect on community college student enrollment, persistence and retention at one community college located in the Northeast.

1) To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in the number of college-level credits taken in their first semester?

2) To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in the completion of the first semester of coursework?

3) To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in enrollment into the second semester of coursework?

H_0: There is no significant difference in the number of college-level credits a student registered for in their first semester based upon the guideline criteria (old placement guidelines or new placement guidelines).

H_1: There is a significant difference in the number of college-level credits a student registered for in their first semester based upon the guideline criteria (old placement guidelines or new placement guidelines).

H_0: There is no significant difference in the completion of the first semester of coursework between the two groups (old placement guidelines or new placement guidelines).

H_2: There is a significant difference in the completion of the first semester of coursework between the two groups (old placement guidelines or new placement guidelines).

H_0: There is no significant difference in the enrollment of students into their second semester of coursework between the two groups (old placement guidelines or new placement guidelines).

H_3: There is a significant difference in the enrollment of students into their second semester of coursework between the two groups (old placement guidelines or new placement guidelines).

Research Design and Data Analysis

This was an inferential, non-experimental ex post facto, criterion research study. There were no active or manipulated variables. The research looked at two different groups of first-time community college students, those who enrolled under old math placement guideline criteria (fall 2016, fall 2017, and fall 2018) and those who enrolled under new math placement guideline criteria (fall 2019). Three different groups of students (fall 2016, fall 2017 and fall 2018) who entered under the old placement guideline criteria were examined independently to assess the consistency of the guideline criteria on student outcomes. The purpose of the current study was to compare math placement (developmental or college-level) of first-time community college students who entered in fall 2016, fall 2017 and fall 2018, assessed under old math placement guideline criteria, with students who entered in fall 2019 under new math placement guideline criteria. The secondary purpose was to determine the effect the different math placement criteria (old placement guidelines or new placement guidelines) had on student enrollment, persistence and retention.

The independent variables (IV) or predictor variables are the presumed cause in a nonexperimental study. The predictor variables were the math placement guidelines (IV) used for enrollment in fall 2016 through fall 2019. Other continuous and categorical predictor variables were: age and HSGPA (both continuous), and gender (male, female), ethnicity (White, Black, Hispanic, Asian, Unknown, and Other), SES (Pell/TAP-eligible, Pell/TAP ineligible/unknown, Excelsior Scholarship), and enrollment status (part-time, full-time).

The Outcome/Dependent Variable or Criterion Variable is the presumed effect in a nonexperimental study. The effect math placement guidelines (old guidelines or new guidelines) had on the number of college-level credits a student enrolled in their first semester (DV) as a result of placing into developmental or college-level math was one outcome measured in total between the two different groups. In addition, the first-semester completion rate (DV), the number of students who completed at least one course during their first semester, and the subsequent enrollment into the second semester (DV), registered for at least one class in the second semester, were assessed for outcomes between the two groups.

Reliability and Validity of the Research Design

Ex post facto designs are vulnerable to all internal and external threats because they lack random assignment and specific treatment control. Outside events at the time students took their high school state exams and at the time students enrolled in college cannot be controlled and may affect the outcome variables. Processes outside the administration of the test that occur within an individual student, simply as a function of maturation, may have affected the results. For example, if a student enrolls after a gap between high school graduation and taking the college math placement test it could result in different outcomes. Changes in the way the state math exams were administered, changes in the way each high school teaches, how the state math exams are graded, and in the way the college math placement test is administered, could impact the results. The new college math placement guidelines allow for professional judgement by evaluators and those individual differences among evaluators could affect the results.

The external threat of the interaction of selection and treatment make the results generalizable only to populations that share the same combination of factors as those first-time students who enrolled in the community college in the fall 2016 through fall 2019 semesters. The interaction of the setting and treatment including the unique characteristics of the largest campus of the community college in which the subjects were assessed, placed and enrolled, and the characteristics of the individual high schools which reside within that community, may restrict generalizability of the results. The interaction of history and treatment could affect the results. If a noteworthy event occurred when students took their state exams, or the college math placement test, it may affect performance. Different results may be obtained in the absence of the noteworthy event.

The Sample and Population

The community college in this study is a multi-campus institution located in the Northeast. It is part of a state system comprised of over 50 public colleges and universities. Community colleges within the state system enroll over 190,000 students. The community college in this study enrolls over 26,000 students college-wide. The largest campus of the community college (LCCC) represents more than half of the total college population with over 13,000 students. Each fall semester, LCCC engages approximately 2,000 new students in the advisement and registration process. The sample population in the current study was obtained using institutional archived data from LCCC, delimited from fall 2016 through fall 2019. LCCC is a co-ed, two-year, public community college, located within a suburban community in the Northeast.

The 2-year and 3-year graduation rate reported for community college students within the state system is 15.4% (2-year), and 28.6% (3-year). This is higher than the national average of 12.9% and 25.7%, respectively. The study institution had benchmarked data which indicated a college-wide three-year graduation rate of 16%. The 2013-2020 strategic plan from the study institution projected that the college would increase the three-year graduation rate of first-time, full-time students to 20%. The College intended to increase the rate of fall-to-spring persistence from the current rate of 72% to a higher rate of 75%. It is important to note that the persistence rates reflect all students, not just first-time, full-time freshmen.

Table 1

Gender of LCCC Population

Gender*	
Male	48.5%
Female	51.2%

*unknown accounts for <1%

Table 2

Ethnicity of LCCC Population

Ethnicity	
White	49.8%
Black	7.9%
Hispanic	18.9%
Asian	4.0%
Unknown	19.0%
Other*	0.4%

* American Indian/Alaska Native, Native Hawaiian/Pacific Islander, International students, two or more races.

Instruments

This research relied on archived data already collected by the study institution. As such no instruments were used for the study.

Procedures for Collecting Data

Upon receiving IRB permission from the Office of Institutional Research at the study institution, data from four sets of first-time students who enrolled in fall 2016, fall 2017, fall 2018 and fall 2019 were requested. The data had no personal identifying information and the student numbers were transformed before the Excel data file was received. The raw data included 10,163 student records of which 1,238 were excluded for lack of a reported math placement, leaving 8,923 records. The records with no reported math placement were from students not subjected to an evaluation using the

math placement guidelines or were missing for unknown reasons, and therefore not part of this study. No other data elements were deleted.

The raw data included gender, date of birth, high school GPA, first-term GPA, enrollment status, first-term remedial credits, first-term college-level credits, first-term total credits, second-term lower division credits, math course placement, ethnicity, financial aid received, and first-term course grades. These data elements were coded by the researcher before loading into SPSS. Date of birth was converted to age at the time of enrollment (i.e., September 1, 2016; September 1, 2017). The Excel data file was screened using pivot tables and screened again by year of enrollment for each data element. Missing data elements were re-requested through the Office of Institutional Research at the study institution. The Ethnicity category termed Other, included American Indian or Alaska Native, International Students, Native Hawaiian or Other Pacific Islander and Two or More Races. Financial aid received was recoded with federal and/or state grant-funded, need-based aid only, which included any one or more of the following programs: PELL, SEOG, TAP, APTS, or FWS.

No individual student documents, transcripts, or test scores were used or removed from the institution. The researcher is employed at the study institution, IRB permission was requested to access the aggregate data file.

Research Ethics

The data in the study was evaluated and presented in the aggregate with no individually identified student information therefore, informed consent was not required. No treatment or interventions were utilized in this ex-post facto research study, and no

student volunteers were necessary. The proper handling of confidential student data was exercised to maintain the confidentiality of the aggregate data.

Conclusion

This study evaluated the impact of placement and assessment guidelines on student outcomes. The driving factor behind the changes in math placement guidelines at the community college in the current study was to improve the accuracy of math placement, to more effectively evaluate students' academic records, and to eliminate unnecessary courses reducing student costs and time to degree completion. Further, improved persistence and retention rates were a strategic objective for the study institution. The findings from the analysis of the data are presented in the next chapter.

CHAPTER 4

The purpose of this study was to compare the math placement of first-time community college students who entered in fall 2016 through fall 2018, under old math placement guideline criteria, with students who entered in fall 2019, under new math placement guideline criteria. The secondary purpose was to determine the effect the different math placement criteria had upon enrollment in college-level credits, completion of the first semester of course work, and subsequent enrollment into the second semester (fall to spring retention).

As discussed in Chapter one, the community college mission has inherent challenges as both a gateway to access higher education and as a gatekeeper, enrolling academically underprepared students in need of remediation. Chapter two described Laura Rendón's (1994) Validation Theory and Bean and Metzner's (1985) Model of Nontraditional Undergraduate Student Attrition which provided the theoretical framework used to examine math placement as a validating influence on community college student enrollment, persistence and retention. Chapter three delineated the methods and procedures used for the analysis.

This ex post facto research study looked at two different groups of first-time community college students to determine if there were differences in outcomes based on different assessment and placement guidelines. A parametric independent samples *t*-Test was used to answer the first research question. In answering the last two research questions, a logistic regression analysis was used to assess the relationships among the independent variables to determine any associations and provide models that described

the factors associated with the observed outcomes (Fraenkel et al., 2019; Knapp, 2018). This chapter describes the findings from the analysis explored in the three research questions.

Results

First semester students who enrolled in fall 2016, fall 2017, fall 2018 and fall 2019, and who had been evaluated for math placement, were identified and selected for inclusion in the research. The community college in this study enrolls over 26,000 students college-wide, with more than half of the total college population (n = 13,000) enrolls at the largest campus (LCCC). Each fall semester, LCCC engages approximately 2,000 new students in the advisement and registration process, these students were the focus of the study. The raw data included 10,163 student records of which 1,238 were excluded for lack of a reported math placement, leaving 8,923 records. Of the total 8,923 students, the largest number of first semester students enrolled in fall 2017 (n = 2503) and the fewest students enrolled in fall 2019 (n = 1901).

Fall 2016 saw the largest percentage of students placed into pre-college level math (71.3%) and fall 2019 had the lowest percentage (37.8%) placed into pre-college math. When combining three years of data from fall 2016 through fall 2018, 62.0% of first-time students placed into pre-college math under the old math placement guideline criteria. Under the new math placement guideline criteria those percentages were reversed, with 62.2% of first-time students from fall 2019 placing into college-level math. Of the students enrolled in fall 2019, 68% of Asian students placed into college-level math compared with 52% of Hispanic students. A slightly higher percentage of

Black students (63.0%) were placed into college-level math compared to White students (62.1%).

Table 3

Math Placement by First Semester of Enrollment

Semester	Population (*n*)	Pre-College Level	College-Level
Fall 2016	2294	1635 (71.3%)	659 (28.7%)
Fall 2017	2503	1475 (58.9%)	1028 (41.4%)
Fall 2018	2225	1244 (55.9%)	981 (44.1%)
Fall 2016-2018	7022	4354 (62.0%)	2668 (38.0%)
Fall 2019	1901	719 (37.8%)	1182 (62.2%)

Table 4

Math Course Placement by Ethnicity

		Ethnicity						
		White	Black	Hispanic	Asian	Unknw	Other	Total
FA 16-18	Pre-Coll	(65.2%) 2383	(59.9%) 233	(64.6%) 754	(54.9%) 158	(52.9%) 701	(63.8%) 125	(62.0%) 4354
	College	(34.8%) 1273	(40.1%) 156	(35.4%) 414	(45.1%) 130	(47.1%) 624	(36.2%) 71	(38.0%) 2668
	Total	3656	389	1168	288	1325	196	7022
FA 19	Pre-Coll	(37.9%) 432	(37.0%) 47	(47.6%) 88	(32.0%) 31	(32.7%) 65	(36.8%) 56	(37.8%) 719
	College	(62.1%) 709	(63.0%) 80	(52.4%) 97	(68.0%) 66	(67.3%) 134	(63.2%) 96	(62.2%) 1182
	Total	1141	127	185	97	199	152	1901

Research Question/Hypothesis 1

To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in the number of college-level credits taken in their first semester?

H_0: There is no significant difference in the number of college-level credits a student registered for in their first semester based upon the guideline criteria (old placement guidelines or new placement guidelines).

To test the null hypothesis an independent-samples *t*-Test was conducted to compare the number of college-level credits students registered for in their first semester (old math placement criteria = fall 2016, fall 2017, fall 2018; new math placement criteria = fall 2019). There was a statistically significant difference in the number of college-level credits a student registered for in their first semester for fall 2016 (M = 9.919, SD = 4.750) compared to fall 2019 (M = 11.107, SD = 4.572); $t(4193) = -8.196$, $p = 0.00$. The significant result had an effect size of Cohen's $d = -0.2548$, which is classified as small, and statistically significant at the $p < .01$ level. While small, on average students in fall 2019 enrolled in one or more additional credits than their peers, under the old math criteria. The results suggest that math placement guidelines have an effect on the number of college-level credits a student registers for in their first semester. Specifically, the results suggest that students who were evaluated for math placement under the new guidelines, registered for more college-level credits in their first semester.

There was a significant difference in the number of college-level credits a student registered for in their first semester for fall 2017 (M = 9.539, SD = 4.6217) compared to

fall 2019 (M = 11.107, SD = 4.572); $t(4402) = -11.200$, $p = 0.00$. The significant result had an effect size of Cohen's $d = -0.3410$, which is classified as small, and statistically significant at the $p < .01$ level.

Levene's Test for Equality of Variances showed a significance level of $p = .018$ in the comparison of fall 2018 to fall 2019. Using equal variances not assumed, there was a significant difference in the number of college-level credits a student registered for in their first semester for fall 2018 (M = 10.149, SD = 4.7904) compared to fall 2019 (M = 11.107, SD = 4.572); $t(4073.849) = -6.561$, $p = 0.00$. The significant result had an effect size of Cohen's $d = -0.2045$, which is classified as small, and statistically significant at the $p < .01$ level.

In each year of the comparison between old math placement guidelines (fall 2016, fall 2017, and fall 2018) and new math placement guidelines (fall 2019), there was a significant difference in the number of college-level credits a student registered for in their first semester. While the effect size was classified as small for all three years, fall 2017 had the largest effect size with the lowest mean number of college-level credits. Overall, students evaluated under the new math placement guidelines registered for more college-level credits than students evaluated under the old math placement guidelines and the results were statistically significant. The null hypothesis was rejected.

Table 5

Mean and Standard Deviation for College-Level Credits

First Semester	M	SD
Fall 2016	9.919	4.7501
Fall 2017	9.539	4.6217
Fall 2018	10.149	4.7904
Fall 2019	11.107	4.5721
Fall 2016 – 18	9.856	4.7238

Research Question/Hypothesis 2

To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in the completion of the first semester of coursework?

H_0: There is no significant difference in the completion of the first semester of coursework between the two groups (old placement guidelines or new placement guidelines).

A standard binary logistic regression was performed to ascertain the effects of age, HSGPA, gender, ethnicity, enrollment status and SES on the likelihood students would persist through their first semester. Each of the semesters (fall 2016, fall 2017, fall 2018, and fall 2019) were evaluated separately. For fall 2016, based on a classification threshold predicted probability of target group membership as .5, results indicated that the logistic regression model was statistically significant, $_X^2(10) = 160.386$, $p < .001$. The model explained 17.4% (Nagelkerke R^2) of the variance in first semester persistence

and had a positive predictive value of 91.4%. For fall 2017, results indicated that the logistic regression model was statistically significant, $x^2(11) = 158.107$, $p < .001$. The model explained 14.7% (Nagelkerke R^2) of the variance in first semester persistence and had a positive predictive value of 89.5%. For fall 2018, results indicated that the logistic regression model was statistically significant, $x^2(11) = 128.145$, $p < .001$. The model explained 13.7% of the variance in first semester persistence and had a positive predictive value of 89.8%. For fall 2019, results indicated that the logistic regression model was statistically significant, $x^2(11) = 185.136$, $p < .001$. The model explained 20.1% of the variance in first semester persistence and had a positive predictive value of 86.7%.

Evaluating the combined years of fall 2016 – fall 2018, when old math placement guidelines were used to determine placement, the model explained 14.1% (Nagelkerke R^2) of the variance in first semester persistence and had a positive predictive value of 90.1% compared to fall 2019, where the model explained 20.1% (Nagelkerke R^2) of the variance in first semester persistence and had a positive predictive value of 86.7%.

Controlling for all model variables, the regression models for persistence were first evaluated by separating the years fall 2016, fall 2017, and fall 2018 compared to fall 2019, and then additionally, controlling for all model variables, a second regression model for persistence was evaluated with the combined years fall 2016 - fall 2018, compared to fall 2019. Ethnicity, HSGPA, enrollment status, and financial aid were found to have a statistically significant effect on persistence for all models. Age also had a statistically significant effect on persistence for all model years except fall 2018 ($p = .098$). Gender was the only IV that was not statistically significant in any of the models.

Table 6A is the model of all variables for the years fall 2016, fall, 2017, fall 2018 and fall 2019. Table 6C is the model of all variables for the combined years, fall 2016 – fall 2018 and fall 2019.

Table 6A

Regression Models 2016, 2017, 2018, 2019 for Persistence

Term		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B)	
								Low	Upper
FA 2016	Gender [0=M,1=F]	.308	0.181	2.893	1	.089	1.361	0.954	1.94
	Ethnic [0=White]			12.3	5	.031			
	Ethnic [1= Black]	-.94	0.322	8.514	1	.004**	0.391	0.208	0.735
	Ethnic [2=Hisp]	.037	0.247	0.022	1	.882	1.037	0.639	1.683
	Ethnic [3= Asian]	-.43	0.476	0.823	1	.364	0.649	0.256	1.65
	Ethnic [4=Unkn]	-.27	0.227	1.439	1	.230	0.762	0.489	1.188
	Ethnic [5= Other]	-.8	0.453	3.158	1	.076	0.447	0.184	1.086
	Age	-.17	0.036	22.13	1	.000**	0.846	0.789	0.907
	HSGPA	.107	0.015	53.96	1	.000**	1.113	1.082	1.146
	Enroll [0= FT,1=PT]	-.87	0.241	13.13	1	.000**	0.417	0.26	0.67
	FinAid [0=N,1=Y]	.614	0.18	11.63	1	.001**	1.847	1.298	2.629
	Constant	-3.25	1.379	5.545	1	.019	0.039		
FA 2017	Gender [0=M,1=F]	.158	0.159	0.994	1	.319	1.171	0.858	1.599
	Ethnic [0=White]			10.99	5	.052			
	Ethnic [1= Black]	-.69	0.293	5.45	1	.020**	0.504	0.284	0.896
	Ethnic [2=Hisp]	-.44	0.195	5.028	1	.025**	0.646	0.441	0.946
	Ethnic [3= Asian]	-.24	0.425	0.327	1	.567	0.784	0.341	1.804

	Ethnic [4=Unkn]	.11	0.209	0.278	1	.598	1.116	0.741	1.682
	Ethnic [5= Other]	-.1	0.441	0.053	1	.817	0.903	0.38	2.144
	Age	-.11	0.027	17.32	1	.000**	0.892	0.846	0.942
	HSGPA	.083	0.013	41.82	1	.000**	1.087	1.06	1.114
	Enroll [0= FT,1=PT]	-.8	0.214	13.91	1	.000**	0.45	0.296	0.684
	Fin Aid [0=N]			26.07	2	.000			
	Fin Aid [1=Y]	.71	0.16	19.66	1	.000**	2.033	1.486	2.782
	Fin Aid [2= Excel]	1.82	0.616	8.783	1	.003**	6.21	1.856	20.78
	Constant	-2.61	1.199	4.749	1	.029	0.073		
FA 2018	Gender [0=M,1=F]	-.23	0.165	1.865	1	.172	0.798	0.577	1.103
	Ethnic [0=White]			13.11	5	.022			
	Ethnic [1= Black]	-.74	0.271	7.371	1	.007**	0.479	0.281	0.815
	Ethnic [2=Hisp]	-.41	0.206	4.009	1	.045**	0.661	0.441	0.991
	Ethnic [3= Asian]	.571	0.743	0.59	1	.442	1.77	0.412	7.598
	Ethnic [4=Unkn]	-.25	0.258	0.917	1	.338	0.781	0.471	1.295
	Ethnic [5= Other]	-.85	0.401	4.528	1	.033**	0.426	0.194	0.935
	Age	-.04	0.024	2.733	1	.098	0.961	0.916	1.007
	HSGPA	.093	0.014	45.65	1	.000**	1.097	1.068	1.127
	Enroll [0= FT,1=PT]	-0.6	0.221	7.458	1	.006**	0.547	0.354	0.843
	Fin Aid [0=N]			19.95	2	.000			
	Fin Aid [1=Y]	.775	0.174	19.95	1	.000**	2.172	1.545	3.052
	Fin Aid [2= Excel]	18.9	4514.	0.000	1	.997	17709	0.000	
	Constant	-4.53	1.254	13.08	1	0	0.011		
FA 2019	Gender [0=M,1=F]	-.02	0.166	0.015	1	.902	0.98	0.708	1.356
	Ethnic [0=White]			16.41	5	.006			

	Ethnic [1= Black]	.21	0.356	0.348	1	.555	1.234	0.614	2.478
	Ethnic [2=Hisp]	-.79	0.234	11.36	1	.001**	0.455	0.287	0.719
	Ethnic [3= Asian]	.296	0.472	0.394	1	.530	1.344	0.533	3.388
	Ethnic [4=Unkn]	.128	0.297	0.185	1	.667	1.136	0.635	2.033
	Ethnic [5= Other]	-0.49	0.268	3.326	1	.068	0.614	0.363	1.037
	Age	-0.15	0.036	17.37	1	.000**	0.861	0.802	0.924
	HSGPA	.085	0.014	38.08	1	.000**	1.089	1.06	1.118
	Enroll [0= FT,1=PT]	-1.14	0.204	31.25	1	.000**	0.319	0.214	0.476
	Fin Aid [0=N]			23.97	2	.000			
	Fin Aid [1=Y]	.848	0.174	23.71	1	.000**	2.335	1.66	3.284
	Fin Aid [2= Excel]	.010	0.559	0	1	.985	1.01	0.338	3.021
	Constant	-2.26	1.374	2.694	1	.101	0.105		

a. Variable(s) entered on step 1: Gender Ethnic, Age, HSGPA, Enroll, Fin Aid.

** Statistically significant at the 95% confidence level.

Table 6C

Regression Models 2016 - 2018 and 2019 for Persistence

Term		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B) Low	Upper
FA 16-18	Gender [0=M,1=F]	.084	0.096	0.769	1	0.381	1.088	0.902	1.312
	Ethnic [0=White]			27.01	5	.000			
	Ethnic [1= Black]	-.774	0.168	21.27	1	.000**	0.461	0.332	0.641
	Ethnic [2=Hisp]	-.310	0.122	6.456	1	.011**	0.734	0.578	0.932
	Ethnic [3= Asian]	-.149	0.285	0.272	1	0.602	0.862	0.493	1.507
	Ethnic [4=Unkn]	-.087	0.131	0.44	1	0.507	0.917	0.709	1.185
	Ethnic	-.584	0.248	5.559	1	.018**	0.558	0.343	0.906

	[5= Other]								
	Age	-.098	0.016	37.41	1	.000**	0.907	0.879	0.936
	HSGPA	.091	0.008	136.5	1	.000**	1.095	1.079	1.112
	Enroll[0= FT,1=PT]	-.749	0.129	33.91	1	.000**	0.473	0.367	0.608
	Fin Aid [0=N]			58.85	2	0			
	FinAid [1=Y]	.614	0.18	11.63	1	.001**	1.847	1.298	2.629
	Fin Aid [2=Excel]	2.05	0.593	12.02	1	.001**	7.828	2.446	25.046
	Constant	-3.25	1.379	5.545	1	0.019	0.039		
FA 19	Gender [0=M,1=F]	-.02	0.166	0.015	1	0.902	0.98	0.708	1.356
	Ethnic [0=White]			16.41	5	0.006			
	Ethnic [1= Black]	.21	0.356	0.348	1	0.555	1.234	0.614	2.478
	Ethnic [2=Hisp]	-.788	0.234	11.36	1	.001**	0.455	0.287	0.719
	Ethnic [3= Asian]	.296	0.472	0.394	1	0.53	1.344	0.533	3.388
	Ethnic [4=Unkn]	.128	0.297	0.185	1	0.667	1.136	0.635	2.033
	Ethnic [5= Other]	-.488	0.268	3.326	1	0.068	0.614	0.363	1.037
	Age	-.15	0.036	17.37	1	.000**	0.861	0.802	0.924
	HSGPA	.085	0.014	38.08	1	.000**	1.089	1.06	1.118
	Enroll[0= FT,1=PT]	-1.14	0.204	31.25	1	.000**	0.319	0.214	0.476
	Fin Aid [0=N]			23.97	2	.000**			
	FinAid [1=Y]	.848	0.174	23.71	1	.000**	2.335	1.66	3.284
	Fin Aid [2=Excel]	.01	0.559	0	1	0.985	1.01	0.338	3.021
	Constant	-2.26	1.374	2.694	1	0.101	0.105		

a. Variable(s) entered on step 1: Gender Ethnic, Age, HSGPA, Enroll, Fin Aid.

** Statistically significant at the 95% confidence level.

Ethnicity

Evaluating students who were assessed using the old math placement guidelines, Hispanic students were 26.6% less likely to persist (95% CI .578, .932, $p = .011$), and Black students were 53.9% less likely to persist (95% CI .332, .641, $p < .001$) compared to White students. With the implementation of the new math placement guidelines, a positive beta ($\beta = .210$) was found for Black students, indicating for the first time in four years, a positive or potential for improvement compared to White students. Although the result was not statistically significant, it portends possible improvement in college-level math placement. Hispanic students were 54.5% less likely to persist when assessed using the new math placement guidelines, which was statistically significant and a poorer outcome compared with the old math placement guidelines. White students were 1.362 times more likely to persist under the old math placement criteria, and were 2.197 times more likely to persist under the new math placement guidelines, compared to Hispanic students. Hispanics were the only ethnic group that showed a statistically significant difference (95% CI .287, .719, $p = .001$) among students evaluated using the new math placement guidelines when compared to Whites. Placing more Hispanic students into college-level math courses did not improve their persistence, which is noteworthy when weighing the implications of the new math placement guideline criteria.

No other ethnic group showed a statistically significant difference in persistence compared to White students in any year except in fall 2018, where those students who were evaluated under the old math placement guidelines and who identified as Other, were 57.4% less likely to persist than Whites (95% CI .194, .935, $p = .033$). The logistic regression model for the combined years (fall 2016 – fall 2018) found those whose ethnic

group was identified as Other were 44.2% less likely to persist compared to Whites (95% CI .343, .906, $p = .018$).

Table 7

Regression Result by Ethnicity Predicting First-Term Persistence

Ethnicity Fall 2016 - 2018	β	S.E.	Wald X^2	df	Sig.	Exp(B)
White*			27.012	5	.000	
Black	-.774	.168	21.273	1	.000**	.461
Hispanic	-.310	.122	6.456	1	.011**	.734
Asian	-.149	.285	.272	1	.602	.862
Unknown	-.087	.131	.440	1	.507	.917
Other	-.584	.248	5.559	1	.018**	.558
Ethnicity Fall 2019	β	S.E.	Wald X^2	df	Sig.	Exp(B)
White*			16.409	5	.006	
Black	.210	.356	.348	1	.555	1.234
Hispanic	-.788	.234	11.363	1	.001**	.455
Asian	.296	.472	.394	1	.530	1.344
Unknown	.128	.297	.185	1	.667	1.136
Other	-.488	.268	3.326	1	.068	.614

*White was the reference category for ethnicity.
**Statistically significant at the 95% confidence level.

Age

Age was a continuous variable and had a statistically significant effect ($p < .001$) on first semester persistence for fall 2016, fall 2017, fall 2019, and for the combined

years fall 2016 – fall 2018. Older students had lower odds of persisting than younger students. Under both the old and new guidelines, the predicted probability of persisting was lower for older students. For each additional year in age, the odds of persisting decreased 15.4% in fall 2016 (95% CI .789, .907, $p < .001$) and 10.8% in fall 2017 (95% CI .846, .942, $p < .001$). For first-time students who enrolled during the combined years fall 2016 – fall 2018 (95% CI .879, .936, $p < .001$) the odds of persisting decreased 9.3% compared to 13.9% decreased odds of persisting for first-time students who enrolled in fall 2019 (95% CI .802, .924, $p < .001$). Students who enrolled in fall 2018 showed no statistical significance ($p = .098$) in persistence based on age.

The statistically significant results showed that regardless of the year of first-time enrollment, older students had decreased odds of persisting relative to younger students. Generally, evaluating students under the new math placement guidelines, which relied more heavily on high school transcript data and performance, had a negative effect on older students. Similarly, evaluating students under the old math placement guidelines, which relied on a single math test score, also had a negative effect on older students.

Table 8

Regression Results of Age Predicting First-Term Persistence

Age by Year	β	S.E.	Wald X^2	df	Sig.	Exp(B)
Fall 2016 - 2018	-.098	.016	37.414	1	.000**	.907
Fall 2019	-.150	.036	17.374	1	.000**	.861

**Statistically significant at the 95% confidence level.

High School GPA

A student's high school grade point average (continuous IV) had a statistically significant positive effect on first semester persistence for each year, regardless of which math placement guidelines students were evaluated under. Increasing the high school GPA increased student persistence and that increase was statistically significant. For students evaluated using the old math placement guidelines, with every unit of increase in GPA, the odds of persistence increased by 9.5% (95% CI 1.079, 1.112, $p < .001$), while under the new math placement guidelines for every unit of increase in GPA the odds of persisting increased by 8.9% (95% CI 1.060, 1.118, $p < .001$). An increasing high school GPA had a slightly larger influence on persistence under the old guidelines (fall 2016 – fall 2018) that relied more heavily on a standardized test for math placement. Under the new math guidelines, high school grades and courses completed determined placement and therefore the overall HSGPA may have had less impact on persistence since the entirety of the high school transcript was, in effect, already factored into math placement. HSGPA missing data results can be seen in Table 9 in Appendix B.

Table 10

Regression Results of HSGPA Predicting First-Term Persistence

HSGPA by Year	β	S.E.	Wald X^2	df	Sig.	Exp(B)
Fall 2016 - 2018	.091	.008	136.491	1	.000**	1.095
Fall 2019	.085	.014	38.082	1	.000**	1.089

**Statistically significant at the 95% confidence level.

Enrollment Status

Students who enrolled full-time were more likely to persist than students who were enrolled part-time and the results were statistically significant. Those students evaluated under the old math placement guidelines for the combined years fall 2016 – fall 2018, who attended full-time, were 2.116 times more likely to persist than those who attended part-time (95% CI 1.644, 2.723, $p < .001$). Those students evaluated under the new math placement guidelines who attended full-time, were 3.135 times more likely to persist than those who attended part-time (95% CI 2.100, 4.679, $p < .001$). The new math placement guidelines enabled students to register for a significantly greater number of college-level credits. Enabling students to enroll in more college-level credits may have impacted student desire to persist and might be a reason full-time students evaluated under the new guidelines had greater odds of persisting relative to part-time students, compared to full-time students evaluated under the old math placement guidelines. The percentage of students who attended full-time decreased successively in each year (fall 2016 = 85.7%, fall 2017 = 84.9, fall 2018 = 83.4%, and fall 2019 = 82.1%) yet those students who attended full-time under the new math guidelines persisted at a higher rate than those who enrolled full-time under the old math guidelines.

Table 11

Regression Results of Enrollment Status Predicting First-Term Persistence

F/T, P/T* Status by Year	β	S.E.	Wald X^2	df	Sig.	Exp(B)
Fall 2016 - 2018	.749	.129	33.917	1	.000**	2.116
Fall 2019	1.143	.204	31.250	1	.000**	3.135

*Part-Time Enrollment was the reference category.
**Statistically significant at the 95% confidence level.

SES/Financial Aid Eligibility

Applying and qualifying for grant-funded, need-based federal and/or state financial aid was the criteria used to determine low SES compared to middle/upper SES. This was not a sufficient criterion for comparison of SES within this model since SES could not be refined beyond low SES. Not receiving financial aid does not necessarily indicate medium or high SES just that students did not apply and/or receive financial aid. A more comprehensive evaluation of family income for all students would be necessary to adequately evaluate the effect between low, medium and high SES. The results did however, reveal statistically significant results between those receiving financial aid compared to those not receiving financial aid. Those students evaluated under the old math placement guideline criteria for the combined years fall 2016 – fall 2018 who received financial aid, were 1.993 times more likely to persist than those who did not receive financial aid. There were even greater odds of persisting for those students who were evaluated using the new math placement guidelines, those students were 2.335 times more likely to persist if they received financial aid. The percentage of students who received grant funded, need-based financial aid was higher for fall 2019 (45.7%) compared with the combined years of fall 2016 – 2018 (43.4%).

For each successive year of enrollment, fall 2016, fall 2017, fall 2018, and fall 2019, students who received financial aid had increasingly greater odds of persisting (1.847, 2.033, 2.172, and 2.335, respectively) compared to students who did not receive financial aid. The increased odds of persistence paralleled a similar increase in the percentage of students placing into college-level math (28.7%, 41.1%, 44.1%, 62.2%, respectively).

Receiving financial aid was a statistically significant factor in student persistence, with greater odds of persistence for students evaluated under the new math placement guidelines. Students who were able to register for more college-level credits and receive financial aid for those credits may be academically and financially motivated to complete their semester.

The Excelsior Scholarship, a state-funded program established in fall 2017, was intended for students from middle-income families. Those students who did not qualify for federal or state grant-funded, need-based financial aid were the target group for the program. In the first year of the program, only 122 first-time students were identified as qualified to receive the funding. In each of the successive years (fall 2018 and fall 2019) the number of qualified first-time students identified, dropped to 88 and 34, respectively. Only in the first year (fall 2017) of the program were the results statistically significant (95% CI 1.856, 20.781, $p = .003$) with the odds of students who received the Excelsior Scholarship 6.210 times more likely to persist than those who received no financial aid. The results were not statistically significant for fall 2018 or fall 2019. However, with the combined model for fall 2016 – fall 2018, there were statistically significant positive outcomes (95% CI 2.446, 25.046, $p = .001$) for students who received the Excelsior Scholarship. Those students were 7.828 times more likely to persist than those who received no financial aid. The total number of first-time students who were identified as Excelsior Scholarship recipients was small relative to the population. The Goodness of Fit Assumption was not met for each cell ($n < 5$). More data would be necessary to evaluate the impact on persistence.

Overall, receiving financial aid had a statistically significant effect on student persistence and a greater effect for students evaluated under the new math placement guidelines.

Table 12

Regression Results of Financial Aid Predicting First-Term Persistence

Fin.Aid Fall 2016-18	β	S.E.	Wald X^2	df	Sig.	Exp(B)
Fin. Aid (No)*			58.859	2	.000	
Fin. Aid (Yes)	.690	.098	49.578	1	.000**	1.993
Excelsior†	2.058	.593	12.024	1	.001**	7.828

Fin.Aid Fall 2019	β	S.E.	Wald X^2	df	Sig.	Exp
Fin Aid (No)*			23.968	2	.000	
Fin Aid (Yes)	.848	.174	23.705	1	.000**	2.335
Excelsior	.010	.559	.000	1	.985	1.010

*No Financial Aid received was the reference category.
**Statistically significant at the 95% confidence level.
†Excelsior Scholarship established fall 2017.

Controlling for all model variables, the regression models (fall 2016, fall 2017, fall 2018, fall 2016- fall 2018, and fall 2019) revealed statistically significant differences in persistence based on more than one independent variable within each model. The null hypothesis was rejected.

Research Question/Hypothesis 3

To what extent do the two groups of students (evaluated using old placement guidelines or evaluated using new placement guidelines) differ in enrollment into the second semester of coursework?

H_0: There is no significant difference in the enrollment of students into their second semester of coursework between the two groups (old placement guidelines or new placement guidelines).

To test the null hypothesis, a standard binary logistic regression was performed to ascertain the effects of age, HSGPA, gender, ethnicity, enrollment status and SES on the likelihood students would be retained, as evidenced by enrollment into the second semester. Each of the semesters (fall 2016, fall 2017, fall 2018, and fall 2019) were evaluated separately. For fall 2016, based on a classification threshold predicted probability of target group membership as .5, results indicated that the logistic regression model was statistically significant, $_X^2(10) = 131.289$, $p < .001$. The model explained 10.5% (Nagelkerke R^2) of the variance in second semester retention and had a positive predictive value of 82.0%. For fall 2017, results indicated that the logistic regression model was statistically significant, $x^2(11) = 166.908$, $p < .001$. The model explained 12.0% (Nagelkerke R^2) of the variance in second semester retention and had a positive predictive value of 80.5%. For fall 2018, results indicated that the logistic regression model was statistically significant, $x^2(11) = 182.910$, $p < .001$. The model explained 14.7% of the variance in second semester retention and had a positive predictive value of 80.0%. For fall 2019, results indicated that the logistic regression model was statistically

significant, $x^2(11) = 147.962$, $p < .001$. The model explained 13.6% of the variance in second semester retention and had a positive predictive value of 78.3%.

Evaluating the combined years of fall 2016 – fall 2018, when old math placement guidelines were used to determine placement, the model explained 11.9% (Nagelkerke R^2) of the variance in second semester retention and had a positive predictive value of 80.8%.

Controlling for all model variables, the regression models for retention were first evaluated by separating the years fall 2016, fall 2017, and fall 2018 compared to fall 2019, and then additionally, controlling for all model variables, a second regression model for retention was evaluated with the combined years fall 2016 through fall 2018, compared to fall 2019. Overall, high school GPA and enrollment status were the primary predictors of student retention and were statistically significant factors within the models ($p < .001$). Gender and age were not statistically significant in any models. Ethnicity showed some statistically significant results.

Table 13A is the model of all variables for the years fall 2016, fall, 2017, fall 2018 and fall 2019. Table 13C is the model of all variables for the combined years, fall 2016 – fall 2018 and fall 2019.

Table 13A

Regression Models 2016, 2017, 2018, 2019 for Retention

Term		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Low	Upper
FA 2016	Gender [0=M,1=F]	.012	.125	0.009	1	.924	1.012	0.791	1.294
	Ethnic [0=White]			5.731	5	.333			
	Ethnic [1= Black]	-.131	.287	0.207	1	.649	.878	0.5	1.54
	Ethnic [2=Hisp]	-.347	.162	4.566	1	.033**	.707	0.514	0.972
	Ethnic [3= Asian]	-.22	.336	0.429	1	.513	0.802	0.415	1.551
	Ethnic [4=Unkn]	-.15	.167	0.814	1	.367	0.86	0.621	1.193
	Ethnic [5= Other]	-.46	.371	1.597	1	.206	0.626	0.302	1.295
	Age	.007	.026	0.071	1	.79	1.007	0.956	1.061
	HSGPA	.084	.011	62.44	1	.000**	1.088	1.066	1.111
	Enroll [0=FT,1=PT]	-1.27	.188	45.82	1	.000**	0.281	0.194	0.405
	FinAid [0=N,1=Y]	.184	.125	2.178	1	.14	1.202	0.941	1.536
	Constant	-5.26	1.025	26.38	1	.000	0.005		
FA 2017	Gender [0=M, 1=F]	.1	.119	0.694	1	.405	1.105	0.874	1.396
	Ethnic [0=White]			5.239	5	.387			
	Ethnic [1= Black]	-.204	.256	0.636	1	.425	0.815	0.493	1.347
	Ethnic [2=Hisp]	-.227	.155	2.164	1	.141	0.797	0.588	1.078
	Ethnic [3= Asian]	-.13	.320	0.164	1	.685	0.878	0.47	1.644
	Ethnic [4=Unkn]	-.237	.149	2.524	1	.112	0.789	0.589	1.057
	Ethnic [5= Other]	-.501	.317	2.497	1	.114	0.606	0.326	1.128
	Age	.007	.025	0.072	1	.789	1.007	0.958	1.058
	HSGPA	.081	.010	66.49	1	.000**	1.085	1.064	1.106
	Enroll	-1.32	.180	53.76	1	.000**	0.267	0.188	0.38

	[0=FT,1=PT]								
	Fin Aid [0=N]			6.05	2	.049			
	Fin Aid [1=Y]	.005	0.119	0.001	1	0.97	1.005	0.795	1.269
	Fin Aid [2= Excel]	.855	0.352	5.91	1	.015**	2.351	1.18	4.684
	Constant	-5.14	0.988	27.01	1	.000	0.006		
FA 2018	Gender [0=M, 1=F]	-.09	0.127	0.503	1	.478	0.914	0.713	1.172
	Ethnic [0=White]			5.095	5	.404			
	Ethnic [1= Black]	-.141	0.231	0.375	1	.540	0.868	0.552	1.365
	Ethnic [2=Hisp]	-.054	0.161	0.111	1	.739	0.948	0.691	1.3
	Ethnic [3= Asian]	1.115	0.543	4.212	1	.040**	3.049	1.052	8.842
	Ethnic [4=Unkn]	-.078	0.196	0.156	1	.693	0.925	0.63	1.36
	Ethnic [5= Other]	-.114	0.367	0.096	1	.756	0.892	0.435	1.831
	Age	-.001	0.022	0.003	1	.954	0.999	0.956	1.043
	HSGPA	.105	0.011	90.88	1	.000**	1.11	1.087	1.135
	Enroll [0=FT,1=PT]	-1.14	0.18	40.46	1	.000**	0.319	0.224	0.453
	Fin Aid [0=N]			4.222	2	.121			
	Fin Aid [1=Y]	-.15	0.128	1.367	1	.242	0.861	0.67	1.107
	Fin Aid [2= Excel]	.663	0.441	2.262	1	.133	1.941	0.818	4.608
	Constant	-6.84	1.032	43.99	1	.000	0.001		
FA 2019	Gender [0=M, 1=F]	.151	0.133	1.282	1	.257	1.163	0.896	1.509
	Ethnic [0=White]			16.92	5	.005			
	Ethnic [1= Black]	-.292	0.247	1.395	1	.238	0.747	0.46	1.212
	Ethnic [2=Hisp]	-0.29	0.199	2.055	1	.152	0.752	0.509	1.11
	Ethnic [3= Asian]	1.268	0.489	6.733	1	.009**	3.553	1.364	9.257
	Ethnic [4=Unkn]	.513	0.248	4.27	1	.039**	1.671	1.027	2.718

	Ethnic [5= Other]	-.232	0.225	1.061	1	.303	0.793	0.51	1.233
	Age	-.033	0.031	1.095	1	.295	0.968	0.91	1.029
	HSGPA	.073	0.011	44.32	1	.000**	1.076	1.053	1.1
	Enroll [0=FT,1=PT]	-1.24	0.188	43.46	1	.000**	0.29	0.2	0.419
	Fin Aid [0=N]			0.003	2	.999			
	Fin Aid [1=Y]	.001	0.132	0	1	.996	1.001	0.772	1.297
	Fin Aid [2= Excel]	.026	0.476	0.003	1	.956	1.026	0.403	2.611
	Constant	-4.03	1.14	12.49	1	0	0.018		

a. Variable(s) entered on step 1: Gender Ethnic, Age, HSGPA, Enroll, Fin Aid.

** Statistically significant at the 95% confidence level.

Table 13C

Regression Models 2016 - 2018 and 2019 for Retention

Term		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Low	Upper
FA 16-18	Gender [0=M,1=F]	.012	0.071	0.031	1	.861	1.013	0.881	1.164
	Ethnic [0=White]			10.50	5	.062			
	Ethnic [1= Black]	-.18	0.146	1.508	1	.219	0.836	0.627	1.113
	Ethnic [2=Hisp]	-.218	0.092	5.679	1	.017**	0.804	0.672	0.962
	Ethnic [3= Asian]	.106	0.211	0.251	1	.616	1.111	0.736	1.679
	Ethnic [4=Unkn]	-.168	0.095	3.106	1	.078	0.845	0.701	1.019
	Ethnic [5= Other]	-.376	0.201	3.525	1	.060	0.686	0.463	1.017
	Age	.002	0.014	0.017	1	.895	1.002	0.975	1.03
	HSGPA	.089	0.006	219.7	1	.000**	1.093	1.081	1.106
	Enroll[0= FT,1=PT]	-1.23	0.105	138.7	1	.000**	0.292	0.238	0.358
	Fin Aid [0=N]			7.997	2	.018			
	FinAid	.009	0.071	0.014	1	.904	1.009	0.877	1.159

	[1=Y]								
	Fin Aid [2=Excel]	.767	0.272	7.942	1	.005**	2.154	1.263	3.672
	Constant	-5.63	0.578	94.71	1	.000	0.004		
FA 2019	Gender [0=M,1=F]	.151	0.133	1.282	1	.257	1.163	0.896	1.509
	Ethnic [0=White]			16.92	5	.005			
	Ethnic [1= Black]	-.292	0.247	1.395	1	.238	0.747	0.46	1.212
	Ethnic [2=Hisp]	-.285	0.199	2.055	1	.152	0.752	0.509	1.11
	Ethnic [3= Asian]	1.26	0.489	6.733	1	.009**	3.553	1.364	9.257
	Ethnic [4=Unkn]	.513	0.248	4.27	1	.039**	1.671	1.027	2.718
	Ethnic [5= Other]	-.232	0.225	1.061	1	.303	0.793	0.51	1.233
	Age	-.033	0.031	1.095	1	.295	0.968	0.91	1.029
	HSGPA	.073	0.011	44.32	1	.000**	1.076	1.053	1.1
	Enroll[0= FT,1=PT]	-1.24	0.188	43.46	1	.000**	0.29	0.2	0.419
	Fin Aid [0=N]			0.003	2	.999			
	FinAid [1=Y]	.001	0.132	0	1	.996	1.001	0.772	1.297
	Fin Aid [2=Excel]	.026	0.476	0.003	1	.956	1.026	0.403	2.611
	Constant	-4.03	1.14	12.49	1	.000	0.018		

a. Variable(s) entered on step 1: Gender Ethnic, Age, HSGPA, Enroll, Fin Aid.

** Statistically significant at the 95% confidence level.

Ethnicity

Hispanic students evaluated using old math placement guidelines were 19.6% less likely to register for the second semester compared to students identified as White. With the new placement guidelines there was no statistically significant difference in retention for students identified as Hispanic. No other ethnic group evaluated using old math placement guidelines showed a statistically significant difference in retention. However,

using new math placement guidelines, students identified as Asian had 3.553 times the odds of registering for the second semester compared to White students (p = .009), and those whose ethnicity was identified as Other, had 1.671 times the odds of registering for the second semester compared to White students (p = .039).

Table 14

Regression Results of Ethnicity Predicting Retention

Ethnicity Fall 2016 - 2018	β	S.E.	Wald X^2	df	Sig.	Exp(B)
White*			10.502	5	.062	
Black	-.180	.146	1.508	1	.219	.836
Hispanic	-.218	.092	5.679	1	.017**	.804
Asian	.106	.211	.251	1	.616	1.111
Unknown	-.168	.095	3.106	1	.078	.845
Other	-.376	.201	3.525	1	.060	.686
Ethnicity Fall 2019	β	S.E.	Wald X^2	df	Sig.	Exp(B)
White*			16.918	5	.005	
Black	-.292	.247	1.395	1	.747	.747
Hispanic	-.285	.199	2.055	1	.152	.752
Asian	1.268	.489	6.733	1	.009**	3.553
Unknown	.128	.297	.185	1	.667	1.136
Other†	.513	.248	4.270	1	.039**	1.671

*White was the reference category for ethnicity.
**Statistically significant at the 95% confidence level.
†Other includes: American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, International students, and two or more races.

Age and Gender

Age and gender were not statistically significant in either model for predicting student retention.

High School GPA

A student's high school grade point average (continuous IV) had a statistically significant positive effect on student retention for each year, regardless of which math placement guideline criteria students were evaluated under. Increasing the high school GPA increased student retention and that increase was statistically significant ($p < .001$) for each year (fall 2016, fall 2017, fall 2018, and fall 2019) and for the combined years (fall 2016 – fall 2018). Students evaluated under old math placement guidelines showed increased odds of retention each year (8.8%, 8.5%, and 11%), respectively. For the combined years fall 2016 – fall 2018, with every unit of increase in GPA, the odds of enrollment into the second semester increased by 9.3% (95% CI 1.081, 1.106, $p < .001$). Under the new math placement guidelines, for every unit of increase in GPA the odds of enrollment into the second semester only increased by 7.6% (95% CI 1.053, 1.100, $p < .001$). An increased high school GPA had a larger influence on retention under the old math placement guidelines which relied more heavily on a standardized test. For first-time students evaluated under new math placement guidelines, where high school performance and courses completed determined placement, HSGPA may have had less influence on retention considering high school grades were already factored into enrollment decisions. HSGPA missing data results can be seen in Table 9 in Appendix B.

Table 15

Regression Results of HSGPA Predicting Retention

HSGPA by Year	β	S.E.	Wald X^2	df	Sig.	Exp(B)
Fall 2016 - 2018	.089	.006	219.669	1	.000**	1.093
Fall 2019	.073	.011	44.322	1	.000**	1.076

**Statistically significant at the 95% confidence level.

Enrollment Status

Students who enrolled full-time in their first semester were more likely to be retained (enrolled in second semester) than students who were enrolled part-time, and the results were statistically significant at the .05 α level. Those students who attended full-time in the first semester, regardless of the year they enrolled, were more likely to be retained than those who attended part-time in the first-semester. The increased odds of retention for first-time, full-time students were relatively similar in each succeeding year (3.564, 3.745, 3.136, and 3.453, respectively). Students who attended full-time in their first-semester and were evaluated under the old math placement guidelines for the combined years fall 2016 – fall 2018, were 3.425 times more likely to retain than those who attended part-time (95% CI 2.791, 4.204, $p < .001$). Those students evaluated under the new guidelines were 3.453 times more likely to retain than those who attended part-time (95% CI 2.389, 4.992, $p < .001$). The impact of enrollment status on retention was relatively similar between the two groups (old and new math placement guidelines).

Full-time enrollment remains a statistically significant factor in both student persistence and in student retention.

Table 16

Regression Results of Enrollment Status Predicting Retention

F/T, P/T* Status by Year	β	S.E.	Wald X^2	df	Sig.	Exp(B)
Fall 2016 - 2018	1.231	.105	138.708	1	.000**	3.425
Fall 2019	1.239	.188	43.460	1	.000**	3.453

*Part-Time Enrollment is the reference category.
**Statistically significant at the 95% confidence level.

SES/Financial Aid Eligibility

Whether or not students received financial aid, no statistically significant effects ($p \leq .05$) were found for student retention. Only for students who first enrolled in fall 2017, did the Excelsior Scholarship have a statistically significant effect, with the odds of registering for the second semester 2.351 times higher for students who received the scholarship compared to students who received no financial aid. Those students who received federal and/or state grant-funded, need-based financial aid, showed no statistically significant difference in retention compared to students who received no financial aid.

Controlling for all model variables, the regression models for the old math placement guideline criteria and the new math placement guideline criteria, revealed statistically significant differences in retention based on more than one independent variable within each model. The null hypothesis was rejected.

Conclusion

Three research questions addressed the effect new math placement guidelines had on student enrollment, persistence and retention. Since community colleges are a pathway toward vocational, certificate, and degree programs for many nontraditional, low-income, first-generation, underrepresented students, it is critical to increase access to college-level courses through more accurate assessment and placement policies. The results of this analysis revealed the new math placement guidelines increased the number of students placed into college-level math and increased the number of college-level credits students enrolled in compared with students evaluated under the old math placement guidelines. The new math placement guidelines clearly improved access to college-level courses for all students and the results were statistically significant at the .05 α level.

The regression models showed mixed results with small effect sizes. Persistence was influenced by almost all independent variables in the model with notable results consistent with the literature. The retention models were less consequential, with fewer statistically significant independent variables and smaller effect sizes. The comparison between first-time students who were evaluated under the two different math placement guidelines produced statistically significant results at the .05 α level. The null hypotheses were rejected in favor of the alternative hypotheses.

Many factors effect community college student persistence and retention. This study included six variables in the regression models to evaluate the effect new math placement guidelines had on student outcomes. Enrollment status and financial aid were

found to have the strongest positive impact on student persistence for those evaluated under the new math placement guideline criteria. Ethnicity had mixed results with important implication for Hispanic students whose outcomes were not improved under the new math placement criteria. Age and HSGPA, the two continuous independent variables, were statistically significant for persistence regardless of which math placement guidelines were used for assessment. Age was not statistically significant for retention. Increasing age had a negative effect on persistence, and increasing HSGPA had a positive effect on both persistence and retention. Gender was the only IV with no statistical significance in any regression model. Understanding the effect of changes to math placement testing policies can provide important information to institutions working to improve student outcomes. The next chapter will discuss the implications and limitations of this study.

CHAPTER 5

The purpose of this study was to assess math placement and its effect on enrollment, persistence, and retention of first-time community college students who attended a public community college in the Northeast from fall 2016 through fall 2019. Chapter one described the challenges inherent in the mission of the community college as both a gateway to access higher education and as a gatekeeper, enrolling academically underprepared students in need of remediation. Chapter two described Laura Rendón's (1994) Validation Theory and Bean and Metzner's (1985) Model of Nontraditional Undergraduate Student Attrition which provided the theoretical framework used to examine math placement as a validating influence on community college student outcomes. Chapter three delineated the methods and procedures used for the analysis, and Chapter four presented the results from the evaluation of three research questions.

This chapter summarizes the implications and limitations found in the analysis of regression models of two different placement testing guideline policies. The analysis compared students' math placement using multiple measures of student academic performance, including high school grades, the highest course in the discipline completed, course grades, and state assessment grades, with students evaluated primarily using a single test score for placement. In addition to the regression models, an independent samples *t*-Test compared the mean number of college-level credits students registered for in their first semester.

When placement testing policies and practices reinforce negative attitudes about a nontraditional student's academic proficiency, it challenges their confidence, reinforcing

destructive thoughts about their ability to succeed academically and their qualifications to participate in the higher education arena. The study institutions' participation in student success programs, Achieving the Dream and Guided Pathways, initiated a change in policy to a more comprehensive evaluation of college-readiness that minimized reliance on a single test score to access college-level math courses. The validation of students as a consequence of this policy change and the resulting increase in college-level math placement and enrollment, accompanied by persistence and retention outcomes, are discussed along with recommendations for future practice and research.

Implications of Findings

The findings were significant for a number of factors and an important assessment of the impact the new guidelines had on student outcomes. The percentages of first-time students who placed into pre-college or college-level math courses were reversed between the old math guideline criteria (62.0% pre-college to 38.0% college-level) and the new math guideline criteria (37.8% pre-college to 62.2% college-level). Based on the combined percentages for the old math placement guideline years 2016, 2017 and 2018, approximately two-thirds of students across all ethnicities were deemed not ready for college-level math, while under the new math placement criteria, fall 2019, approximately the same percentage were placed into college-level math. This resulted in a statistically significant difference in the number of college-level credits a student registered for in their first semester between the two groups of students, those evaluated under the old placement criteria and those evaluated under the new placement criteria. Placement into college-level math courses was the initial validation point, which improved access for larger numbers of nontraditional students evaluated under the new

math placement guidelines. All students in this study were considered nontraditional based on the theoretical framework (Bean and Metzner, 1985). Taking more college-level credits improves time and financial costs associated with degree completion, costs that are often more detrimental for nontraditional students.

The gap between males and females placed into college-level math was still evident for those students evaluated using the new math placement guideline criteria. However, the number of females who placed into college-level math based on the new criteria increased by more than 20%. Likewise, the percentage of both Black students and Asian students placed into college-level math using the new math placement guideline criteria increased by 23%, and Hispanic students showed a 17% increase in college-level math placement. The new math placement guideline criteria improved placement into college-level math courses across all student groups. Using multiple measures to assess academic preparedness improved access for greater numbers of historically underrepresented student groups. This result has significant implications for colleges seeking to improve equity gaps by addressing structural inequities manifested through unexamined institutional policies' unintended consequences. Consistent with earlier research on the use of high school information improving the proportions of historically underrepresented students in college-level math classes (Scott-Clayton et al., 2014), this study supports the use of multiple measures to assess academic preparedness and improve equity gaps.

The increased number of students placed into college-level math due to new math placement guidelines also increased overall enrollment in college-level credits. The new math placement criteria had a statistically significant effect on the total number of college

credits students registered for in their first semester and increased the number of college-level credits, full-time students, were registered for in their first-semester. This impact was evident among historically underrepresented student groups. Full-time students who were evaluated using the old math placement criteria were registered for three or fewer college-level credits at a higher percentage than with the new guideline criteria, and that percentage was highest among Black (15.5%) and Hispanic (14.0%) students compared to White (9.8%) and Asian (6.9%) students. Those percentages were greatly improved for students using the new math placement criteria, although remaining disproportionately higher among Black (6.9%) and Hispanic (5.6%) students compared to White (2.8%) and Asian (3.0%) students. The consequence of full-time students registering for more college-level credits as a result of placement into college-level math may have far ranging repercussions. Math courses in particular, are a gateway to many lucrative, in-demand vocations and professions. Students interested in pursuing careers in the STEM field are no longer held back by enrollment in developmental math courses. For the majority of students, placement into developmental math means never earning a college degree (Bailey et al. 2015). Those students admitted to non-STEM degree programs can satisfy degree requirements with direct enrollment into the minimum necessary math courses, accelerating time to completion. Placement into pre-college math may validate students' negative perceptions of their math skills. For students who considered their math skills to be adequate, placement into pre-college math may create doubt, challenging their positive beliefs. Greater numbers of first-time students were likely validated by placement in college-level math and resulted in a significant increase in registration into college-level credits.

The additional cost of enrollment in courses that do not count toward degree requirements was eliminated for more students evaluated using the new math placement guideline criteria. These additional costs in terms of time and financial expenses function as roadblocks, stifling motivation for nontraditional students, those most vulnerable to drop out. For first-generation, underrepresented students, the decision to pursue a college education or career change takes tremendous resolve, a motivation that is fraught with insecurities and lack of "insider" knowledge. Providing academic validation through the evaluation of academic records, affirming prior HS course completions, recognizing students' self-assessed skill level, and reviewing math course options, may reduce self-doubt and bolster motivation. Simultaneously, the need for the institution to offer more sections of college-level math courses to meet the increased demands necessitates more academic support both in and out of the classroom. The more students are supported, the richer the academic and interpersonal experience, and it is most powerful when support is offered during the early stages of the academic experience (Rendón 1994). It is essential that validating agents (i.e., faculty, counselors, and advisors) actively reach out to students to offer assistance, encouragement and support. Adapting to the diversity of student needs through multifarious academic support, while responding to the growing numbers of students enrolled in college-level math courses is an obligation the institution must confront. Faculty and administrators are compelled to address shortcomings in course content, structure and student support to achieve the goal of increasing student success.

An increase of historically underrepresented students placed into college-level math courses and increasing the number of college-level credits enrolled in for the first

semester did not significantly improve overall persistence or retention rates among student groups, with some notable exceptions. Black students were 53.9% less likely to persist compared with White students using the old criteria, and the result was statistically significant. However, the results showed an improved relationship, 23.4% more likely to persist relative to Whites, under the new math placement criteria. Although not statistically significant, the positive direction is the first indication of increased persistence for Black students' in four years. Hispanic students were significantly ($p \leq .05$) less likely to persist than Whites under both placement criteria, in fact were less likely to persist relative to White students when evaluated under the new math placement guidelines. These results offer opportunities for understanding the distinct needs of different cohorts. This study underscores the need to address deficiencies among different student groups while simultaneously increasing access to college-level courses

Nontraditional-aged students had poorer outcomes than younger, traditional-aged students and those results were statistically significant regardless of the math placement guideline criteria under which they were evaluated. Older students had lower odds of persisting relative to younger students. The gap in years between high school and attending college might explain these disparate outcomes. Whether taking a math placement test without preparation or being evaluated based on a high school record, older students may have found their math placement not reflective of their ability. If past experiences are ignored in favor of a single test score or a deficient high school record, their apprehension and frustration may be heighten. Older students may feel unheard or discouraged, and result in greater attrition relative to younger students. Faculty, counselors and advisors must be cognizant of the various perspectives nontraditional-

aged students bring to campus, to provide appropriate support and validation. Some older students are apprehensive about enrolling in college simply by virtue of their age, identifying themselves as an outsider rather than a welcomed addition. They may have delayed college for economic, personal and/or academic reasons, or they may be returning to college after a prior attempt or to change career direction. Understanding the depth of experiences since graduating high school or receiving an equivalency diploma, and uncovering insecurities and motivations, becomes necessary to provide appropriate validation. Math placement that relies on a single test score, when the test is given without practice or a refresher, will not accurately assess the adult students' potential and may feed into their insecurities. Conversely, relying on high school records to evaluate math placement can inaccurately assess potential as well. Striking the right balance requires continued responsiveness by validating agents, variations in course delivery methods, and early, pre-enrollment support systems specifically for adult students. Nontraditional adult students face many external demands that may negatively impact their ability to earn a degree (Adelman, 2005). Macari, Maples, and D'Andrea (2005) found that nontraditional-aged students were often engaged in activities and responsibilities outside of college, which required a great deal of time and attention limiting campus involvement. The current study adds a unique perspective on adult student outcomes through the challenges of assessment and placement.

HSGPA had a statistically significant impact on student outcomes regardless of the year first-time students enrolled. This was not unexpected given the amount of research on prior high school academic performance as the best predictor of success in college (Adelman 1999; Caison 2005; Glynn, Sauer and Miller 2006; French, Homer,

Popovici, and Robins 2015). In this study, students evaluated under the old math placement guidelines had slightly greater odds of persistence and retention based on an increased HSGPA than those students evaluated under the new math placement guidelines. With the reliance on a single test score to determine math placement for students evaluated under the old guideline criteria, a higher HSGPA resulted in a greater likelihood of persistence and retention. Since high school grades and courses completed were already factored into placement decisions for students evaluated under the new math placement guidelines, an increasing HSGPA may have slightly less impact, although still improved the outcomes. The push for standardized testing both before and after admission is based on the belief that high school grading is not uniform, that grade inflation is evident, and that there are different grading standards within schools and between school districts (Sedlacek, 2004). The new math placement guidelines were the result of a policy initiative that in part, challenged those beliefs in favor of a comprehensive assessment of high school grades and performance. The inherent bias in the quality of the education received based on the school district students attended, must also be acknowledged and confronted. Not every transcript will be evaluated through the same lens; however, this study lends support to the importance of evaluating students holistically. It is important to recognize the range of support systems necessary to meet the demands of an academically diverse and growing number of first-semester students, with the overall intention of having greater numbers of students taking and completing college-level credits.

This study considered financial aid as an indicator of socio-economic status (SES). The receipt of federal and/or state grant-funded, need-based financial aid was

categorized as low SES. This was not sufficient to separate low SES from medium or high SES and therefore, an analysis of student outcomes based on SES was not performed. However, there were unexpected and statistically significant results for those students who received financial aid compared to those who did not receive financial aid. Regardless of the math placement guideline criteria first-time students were evaluated under, those who received financial aid were more likely to persist, and at a statistically significant level. The greatest likelihood of persistence occurred for those students evaluated under the new math placement guideline criteria. Hispanic students had the largest increase in the percentage (+ 11%) receiving financial aid in fall 2019. The percentages for Black students and White students remained relatively consistent across all four years. With more students likely validated by enrollment in college-level courses under the new math placement guidelines, the added incentive of receiving grant-funded aid may have provided increased motivation to persist. The largest statistically significant positive effect on persistence based on aid received, occurred for students evaluated in fall 2017, the initial year of a scholarship program designed for middle income families. For students who received either grant-funding or scholarship funding, the semesters' completion was necessary for continued financial support. Financial need may have provided an incentive for persistence. This study illuminates the varied support scaffolding necessary for institutions to reflect the myriad of factors impacting student outcomes.

Relationship to Prior Research

The current study affirms prior research on the effect the independent variables had on student outcomes. Those variables found to be most significant were HSGPA,

enrollment status, financial aid, age, and the use of multiple measures for math placement. There were mixed results for student outcomes based on ethnicity. The old math placement guideline criteria discounted students' high school record in favor of a single test score. The use of a single math test as the standard for placement discards the knowledge and skills accumulated in high school and function to track students into developmental math in college. This use of a single test disproportionately impacts marginalized, underrepresented student groups (Melguizo and Ngo (2015). The new math placement guideline criteria in the current study increased the number of students from all ethnic groups taking college-level courses. Through the use of multiple measures, specifically high school records, the current study showed improved ethnic and gender composition in college-level math placements. This supports the findings by Scott-Clayton, Crosta, and Belfield (2014) that the process for remedial course placement, through the use of high school transcript information, was a more valuable screening device that improved the racial and gender composition of college courses. The current study affirms the significance of the screening process on the composition of gateway math courses. Growing the numbers of historically underrepresented students placed into college-level math courses by validating their high school efforts is an encouraging policy outcome.

The current study supports the presence of equity gaps in math placement which have impacted Black and Hispanic students to a greater degree than White and Asian students. While the new math placement guidelines significantly improved the number of college-level credits first semester students registered for across all ethnic groups, some disparity between ethnic groups was still evident. Melguizo and Ngo (2015)

discovered that Black and Latino students consistently experienced the highest rates of math misalignment. Park et al. (2018), evaluated new placement guidelines and found similar disparities, further speculating whether academic advising might play a factor in how historically underrepresented students are encouraged or discouraged from enrollment into college-level math courses. The disparities in pre-college level math placement by ethnicity reflect the achievement gaps observed in the K-12 schools (Bowen et al., 2005), suggesting the gaps in math placement be partly addressed in coordination with the K-12 sector. The current study aligns with the literature on the existence of equity gaps influencing first semester enrollment patterns of historically underrepresented student groups based on math placement guideline criteria. Validating nontraditional students through a comprehensive assessment of their high school record may reduce equity gaps and improve career opportunities and earning potential.

The new math placement guidelines dramatically increased the number of students placed into college-level math by as much as 33% in a given year. In comparison, persistence and retention rates decreased slightly (4.8% and 3.5% respectively). Increasing the number of students who place into college-level math courses even while acknowledging lower persistence and retention rates initially, may ultimately improve the overall number of students taking and passing college-level math courses. As evidenced by Hu, Park, Woods, Richard, Tandberg, and Bertrand Jones (2016), college-level math course passing rates declined under a new optional developmental education policy, however, the net percentage of incoming students taking and passing college-level math courses increased. Rodriguez (2014) argued that colleges may have to tolerate lower pass rates, at least initially, in order to facilitate more students

attempting college math courses, leading to higher college-level math completion rates. The lower persistence and retention rates observed in the current study should be tolerated as suggested by the literature, at least initially, as the institution adapts to the improved access and reimagines enhanced support for underrepresented student groups.

The current study reflects existing research on HS academic performance as a significant predictor of student success in college. High school grade point average was a statistically significant factor in predicting student persistence and retention for both groups of students (old and new guidelines) in this study. It is logical that what students do in high school has a strong bearing on later academic experiences (Trusty & Niles, 2004). Research has consistently found a strong positive relationship between a students' performance in high school courses and their success in the first term of college (Williford, 2009) and first-year retention (Astin and Oseguera 2005; Glynn, Sauer and Miller 2006). Not surprisingly, HSGPA was a significant factor affecting student outcomes in the current study, adding support to the considerable literature.

Enrollment status was a statistically significant factor in affecting student outcomes. Full-time students evaluated under the new math placement guidelines were three times more likely to persist compared to part-time students. Those students evaluated under the old math placement guidelines were two times more likely to persist than part-time students. The benefit of enrolling in more college-level credits may explain the difference in persistence between the two groups of students (old and new guidelines). Retention rates were similar between the two groups of students, both were over three times as likely to retain compared to students who enrolled part-time. Schimid and Abell (2003) identified several risk factors that played a role in negatively impacting

persistence for community college students, including part-time enrollment, and working full-time. Part-time enrollment is associated with increased dropout (Horn, 1996) and poor outcomes, including completion rates (Darolia 2014; Skomsvold, Radford, and Berkner 2011). The current research lends support to these findings.

Receiving financial aid was a statistically significant factor in student persistence for all first-time students regardless of the year of enrollment, when compared to their peers who did not receive financial aid. The largest effect on students receiving financial aid was for those who were evaluated under the new math placement guidelines. Those students had 133.5% higher odds of persisting than students who did not receive financial aid. Students who were able to register for more college-level credits and receive financial aid for those credits may be academically and financially incentivized to complete their semester. Novak and McKinney (2011) found that among Pell-eligible students, those who filed a Free Application for Federal Student Aid (FAFSA) had 122% higher odds of persisting from the fall to spring semester than their peers who did not file. The underutilization of financial aid has been identified as a formidable barrier to access, persistence, and degree attainment among community college students (Advisory Committee on Student Financial Assistance, 2008). The current study adds to the importance of financial aid as a factor in student outcomes.

Limitations of the Study

The decision to analyze ex post facto data through logistic regression models provided the means to assess dichotomous student outcomes. Ex post facto research designs lack random assignment and specific treatment control. To further contextualize

the outcomes, qualitative assessment through focus groups, faculty interviews or student/faculty surveys could be informative.

At the time of this research, the new math placement guideline policy had been in effect for one year, limiting the ability to evaluate the trend across an extended period of time. The old guideline criteria were evaluated across three years. Further evaluation using new data from future years would strengthen the findings.

A worldwide pandemic restricted the researcher from assessing second semester completion rates and long-term retention. The second semester for students who entered in fall 2019 was spring 2020. COVID-19 occurred in March 2020, midway through the second semester. All students, faculty, and staff were restricted from campus, and all classes and services were adapted to online modalities. Many students and faculty were unfamiliar with the online learning environment. The consequence of this event on students' educational experiences cannot be overstated. The definition of retention in the current study was modified to limit the effect of the pandemic and its aftermath on student outcomes, narrowing the evaluation to enrollment into the second semester rather than completion of the second semester or enrollment into the third semester.

In any quantitative study, the researcher is limited by the integrity of the data provided by an institution. Data entry inconsistencies may limit the effect of the identified independent variables on student outcomes.

Recommendations for Future Practice

Future practice should focus on two fronts, support for students in entry-level, gateway math courses, and training for faculty, counselors and advisors. The primary

mission of community college is open access to affordable education and training. This study found significant positive effects in access to college-level math courses through the new placement guidelines. As a result, it is necessary to evaluate the academic support structure provided to students in entry-level, gateway math courses. Support must be re-envisioned, readily accessible, perhaps mandatory, to afford students the opportunity to succeed. Faculty and administrators within the mathematics department have the knowledge and experience to adapt to increasing numbers of students with disparate needs, and formulate a structured response. Rather than placing students in developmental math courses, many of the students now placed into college-level courses can be successful, particularly with additional academic reinforcement (i.e., tutoring, study groups). Finding ways to bolster nontraditional students as they navigate the college environment is imperative. Nontraditional-aged students and Hispanic students did not improve persistence and retention under the new math guidelines even though higher percentages placed into college-level math. The new math placement guidelines offer an opportunity to increase the total number of students who pass college-level math and improve equity gaps. Recognizing the need for diversity in support structures both in and out of the classroom may provide the scaffolding necessary to improve the persistence and retention rates found in this study.

Additional in-service training for faculty, counselors and advisors, to provide continuous review and evaluation of the new math placement guidelines may improve the consistency of course placements. Whenever a long standing practice is changed, there often can be resistance among those who believed the prior practice was “best practice”. Many faculty advisors have been placing students in math courses based on a single test

score for years, even decades. Changing the mindset of faculty advisors to a new perspective, one that requires advisors to review high school transcript data in greater detail, often using their judgement to make a placement decision, can be disconcerting. Advisors may lack confidence in their ability to assess a vast array of high school documents or they may believe an incorrect placement might result in reprimand from the administration. The comfort of relying on a cut-score to place students removes the responsibility for the decision. Others may have believed that the test score was a better indicator of ability, disregarding the students' high school record, particularly for older students or students from outside the local community. All high school transcripts are not the same, even within the same school district state- mandated math courses have changed over time, complicating the review of documents.

Further, an implicit bias among advisors concerning the quality of different high schools within the community may be present, with the value of a student's performance judged on the perceived quality of the high school attended. The potential for inequitable treatment of students based on these beliefs must be addressed through continued training rather than a return to a single placement test policy. Changing the trajectory of students' lives is multi-dimensional. It requires an acceptance that prior practices were harming students and that inequities exist, as evidenced in this study by the significant increase in students placed into college-level math under the new placement guidelines. The increased diversity of students taking gateway math courses shown in this study requires broad academic support in and out of the classroom, and a willingness to reshape policies and services to improve outcomes for all students.

Recommendations for Future Research

Identifying variables beyond those included in the current study would be valuable for a more complete understanding of factors effecting persistence and retention. In the current study which spans 2016 through 2019, the economy saw improvements in the unemployment numbers across all ethnic groups potentially impacting enrollment, persistence, and retention. Understanding the influence of outside factors, like employment and family obligations, on persistence and retention may provide a more complete model of nontraditional student success. For example, outcomes for Hispanic students were worse than for other ethnic groups. An examination of environmental factors that exert pressure, pulling these students away from college, may lead to better support systems that address the diverse student populations' needs.

Acknowledging the impact the new math placement guideline criteria had on faculty, counselors and advisors who are in direct contact with students, and assessing the consequences from their perspective would be valuable to understanding the new guidelines' efficacy. With the old math guidelines, placement decisions were simplified and math classrooms were comparatively homogenous. The new guidelines have increased access to college-level courses for all students, increasing both academic and ethnic diversity. Identifying preconceived views of student abilities, reactions to potential changes in faculty workload, implicit biases toward certain student groups or school districts, and challenges encountered during implementation would provide fuller context to the impact policy change had on student outcomes. Evaluating long-term effects on retention beyond the second semester, including the impact on graduation rates, would be valuable research on the implications of the new policy.

The effect of socio-economic status on student outcomes should be explored. The new guidelines increased the percentage of students placed into college-level math across all student groups through a more thorough evaluation of high school transcripts. These transcripts came from high schools across the socio-economic spectrum. To evaluate persistence and retention based on socio-economic status, the school districts students attended could be identified and categorized. These categorizations may provide a unique perspective on equity gaps, potentially uncovering student placement biases based on high schools attended.

Conclusion

This study adds to the body of literature on the use of holistic measures for assessment and placement. The new math placement guideline criteria in the current study improved the numbers of students placed into college-level math courses, including increasing the numbers for historically underrepresented students. This resulted in a statistically significant higher number of college-level credits entering students registered for their first semester. The validation of academic ability through multiple measures to evaluate and place students into college-level courses appears evident among all student groups. This study supports the literature on validation theory through early interactions with students, recognizing placement policies as a mechanism for validating student outcomes.

The regression models predicted statistically significant effects on student persistence and retention between students evaluated under the two different placement criteria. Most notably, enrollment status, HSGPA, age, ethnicity and financial aid were

found to have significant effects on predicting student outcomes. These findings have important implications for the institution on a number of fronts. To augment student success, enhanced academic support systems are required to assist larger numbers of students taking entry-level college math courses. The effect of more students, previously deemed "unqualified", now enrolling in college-level courses may require an examination of math course content and methodology. Recognizing the presence of unique learning styles potentially resulting from an increasing population not seen in entry-level math courses before now is essential. To adapt to a changing environment, central planning is necessary to reform course offerings, teaching methods, and enhance faculty training.

The effect sizes within the regression models were small, so attributing the independent variables' overall impact on persistence and retention was less consequential. However, studies have shown that using a single, high-stakes math test for placement into college-level courses is ineffective, especially for students who test at the margin of college-readiness (Bowen, 2018; Scott-Clayton & Rodriguez, 2012). Academically, ethnically, and economically diverse students continue to enroll in community colleges in record numbers. Improving the accuracy of math placement through the use of multiple measures, removing barriers to college-level math courses, and validating nontraditional students' sense of belonging are necessary actions. Institutions must address the academic and social support systems for growing numbers of students enrolling in college-level math courses by accepting responsibility for making sure those they admit actually succeed.

APPENDIX A

IRB Approval St. John’s University

Federal Wide Assurance: FWA00009066

Jun 5, 2020 8:30 AM EDT

PI: Karen Pepe

CO-PI: Ceceilia Parnther

Dept: Ed Admin & Instruc Leadership

Re: Initial - IRB-FY2020-609 The Impact of Math Placement on Community College Student Outcomes

Dear Karen Pepe:

The St John's University Institutional Review Board has rendered the decision below for The Impact of Math Placement on Community College Student Outcomes.

Decision: Exempt

PLEASE NOTE: If you have collected any data prior to this approval date, the data must be discarded.

Selected Category: Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).

The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

Sincerely,

Mabel Abraham, Ph.D.

Acting Chair, Institutional Review Board

Marie Nitopi, Ed.D.

IRB Coordinator

IRB Approval Study Institution

IORG 0006694

June 12, 2020

To: Karen Pepe

[redacted]

pepek@[redacted]

From: Dr. Courtney Brewer, co-chair

Institutional Review Board

[redacted]

brewerc@[redacted]

Re: The Impact of Math Placement Guidelines on Community College Student Outcomes

Dear Ms. Pepe,

After a review of your protocol, it was the decision of the Board that the study meets the federal guidelines for an exemption. Your proposal has been granted authorization. Please note the following information:

• IRB#: 20-011

• **Expiration Date: N/A**

Please note that changes to the protocol must be reported to the IRB immediately and that such changes may warrant a new review. An adverse event is any instance which places participants at risk or at a level or degree of potential harm outside of those indicated within the initial protocol. Should such an event occur, the College IRB must be notified within 48 hours of the event. This information will be forwarded to the Vice President for Planning and Institutional Effectiveness as well as to the Office for Human Research Protection.

Upon receipt of the adverse event report, the co-chairs of the IRB, in consultation with other members and administrators as appropriate, will require immediate suspension of the activity prior to review by the full membership.

Should you have any questions, feel free to contact either myself or my co-chairs, Dr. Helen Wittman and Rachael Millings. Best wishes on your research endeavors.

Sincerely,

Dr. Courtney Brewer, Associate Professor Co-chair, Institutional Review Board
brewerc@[redacted]

Rachael Millings, Assistant Professor Co-chair, Institutional Review Board millinr@[redacted]

Dr. Helen Wittmann, Assistant to the Vice President Co-chair, Institutional Review Board wittmah@[redacted]

APPENDIX B

Supplementary Tables

Table 6B

Regression Pre-Tests 2016, 2017, 2018, 2019 for Persistence

Omnibus Tests of Model Coefficients

Semester		Chi-square	df	Sig.
Fall 2016	Step	160.386	10	.000
	Block	160.386	10	.000
	Model	160.386	10	.000
Fall 2017	Step	158.107	11	.000
	Block	158.107	11	.000
	Model	158.107	11	.000
Fall 2018	Step	128.145	11	.000
	Block	128.145	11	.000
	Model	128.145	11	.000
Fall 2019	Step	185.136	11	.000
	Block	185.136	11	.000
	Model	185.136	11	.000

Model Summary

Semester	Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
FA 2016	1	1012.152[a]	.078	.174
FA 2017	1	1271.788[b]	.072	.147
FA 2018	1	1107.512[c]	.066	.137
FA 2019	1	1081.389[d]	.111	.201

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001 for split file Semester = FA 2016.
b. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001 for split file Semester – FA 2017.
c. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found for split file Semester = FA 2018.
d. Estimation terminated at iteration number 6 because parameter estimate changed by less than .001 for split file Semester FA 2019.

Hosmer and Lemeshow Test

Semester	Step	Chi-square	df	Sig.
FA 2016	1	2.823	8	.945
FA 2017	1	20.587	8	.008
FA 2018	1	4.524	8	.807
FA2019	1	11.918	8	.155

Classification Table[a]

			Predicted		
			1st Term Persist		Percentage
Semester	Observed		No	Yes	Correct
FA 2016	1st Term Persist	No	11	162	6.4
		Yes	7	1793	99.6
	Overall Percentage				91.4
FA 2017	1st Term Persist	No	11	213	4.9
		Yes	9	1885	99.5
	Overall Percentage				89.5
FA 2018	1st Term Persist	No	6	185	3.1
		Yes	6	1684	99.6
	Overall Percentage				89.8
FA2019	1st Term Persist	No	29	189	13.3
		Yes	21	1336	98.5
	Overall Percentage				86.7

a.The cut value is .500

Table 6D

Regression Pre-Tests 2016 - 2018 and 2019 for Persistence

Omnibus Tests of Model Coefficients

Semester		Chi-square	df	Sig.
FA 2016 - 2018	Step	413.477	11	.000
	Block	413.477	11	.000
	Model	413.477	11	.000
Fall 2019	Step	185.136	11	.000
	Block	185.136	11	.000
	Model	185.136	11	.000

Model Summary

Semester	Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
FA 16 - 18	1	3428.726[a]	.067	.141
FA 19	1	1081.389[b]	.111	.201

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001 for split file Semester 16-18& &19 = FA 16-18.
b. Estimation terminated at iteration number 6 because parameter estimate changed by less than .001 for split file Semester 16-18 & &19 = FA 19.

Hosmer and Lemeshow Test

Semester	Step	Chi-square	df	Sig.
FA 16 - 18	1	7.738	8	.459
FA 19	1	11.918	8	.155

Classification Table[a]

			Predicted		
			1st Term Persist		Percentage
Semester	Observed		No	Yes	Correct
FA 16 - 18	1st Term Persist	No	25	563	4.3
		Yes	27	5357	99.5
	Overall Percentage				90.1
FA 19	1st Term Persist	No	29	189	13.3
		Yes	21	1336	98.5
	Overall Percentage				86.7

a. The cut value is .500

Table 9

High School GPA Statistics of Valid and Missing Cases

Number (%)	Fall 2016	Fall 2017	Fall 2018	Fall2019
Valid	1973 (86.01%)	2118 (84.62%)	1881 (84.54%)	1575 (82.86%)
Missing	321 (13.99%)	385 (15.38%)	344 (15.46%)	326 (17.14%)
Total	2294 (100%)	2503 (100%)	2225 (100%)	1901 (100%)

Table 13B

Regression Pre-Tests 2016, 2017, 2018, 2019 for Retention

Omnibus Tests of Model Coefficients

Semester		Chi-square	df	Sig.
Fall 2016	Step	131.289	10	.000
	Block	131.289	10	.000
	Model	131.289	10	.000
Fall 2017	Step	166.908	11	.000
	Block	166.908	11	.000
	Model	166.908	11	.000
Fall 2018	Step	182.901	11	.000
	Block	182.901	11	.000
	Model	182.901	11	.000
Fall 2019	Step	147.962	11	.000
	Block	147.962	11	.000
	Model	147.962	11	.000

Model Summary

Semester	Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
FA 2016	1	1734.459[a]	.064	.105
FA 2017	1	1945.568[b]	.076	.120
FA 2018	1	1693.488[c]	.093	.147
FA 2019	1	1552.569[d]	.090	.136

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001 for split file Semester = FA 2016.
b. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001 for split file Semester = FA 2017.
c. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001 for split file Semester = FA 2018.
d. Estimation terminated at iteration number 5 because parameter estimate changed by less than .001 for split file Semester = FA 2019.

Hosmer and Lemeshow Test

Semester	Step	Chi-square	df	Sig.
FA 2016	1	11.275	8	.187
FA 2017	1	10.607	8	.225
FA 2018	1	14.898	8	.061
FA2019	1	12.534	8	.129

Classification Table[a]

Semester	Observed		Predicted 1st Term Persist No	Yes	Percentage Correct
FA 2016	1st Term Persist	No	21	336	5.9
		Yes	19	1597	98.8
	Overall Percentage				82.0
FA 2017	1st Term Persist	No	41	380	9.7
		Yes	34	1663	98.0
	Overall Percentage				80.5
FA 2018	1st Term Persist	No	38	336	10.2
		Yes	40	1467	97.3
	Overall Percentage				80.0
FA 2019	1st Term Persist	No	54	309	14.9
		Yes	33	1179	97.3
	Overall Percentage				78.3

a. The cut value is .500

Table 13D

Regression Pre-Tests 2016 - 2018 and 2019 for Retention

Omnibus Tests of Model Coefficients

Semester		Chi-square	df	Sig.
FA 2016 - 2018	Step	463.254	11	.000
	Block	463.254	11	.000
	Model	463.254	11	.000
Fall 2019	Step	147.962	11	.000
	Block	147.962	11	.000
	Model	147.962	11	.000

Model Summary

Semester	Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
FA 16 - 18	1	5394.097[a]	.075	.119
FA 19	1	1552.569[b]	.090	.136

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001 for split file Semester 16-18& &19 = FA 16-18.
b. Estimation terminated at iteration number 5 because parameter estimate changed by less than .001 for split file Semester 16-18 & &19 = FA 19.

Hosmer and Lemeshow Test

Semester	Step	Chi-square	df	Sig.
FA 16 - 18	1	29.212	8	.000
FA 19	1	12.534	8	.129

Classification Table[a]

			Predicted		
			1st Term Persist		Percentage
Semester	Observed		No	Yes	Correct
FA 16 - 18	Register 2nd Term	No	94	1058	8.2
		Yes	87	4733	98.2
	Overall Percentage				80.8
FA 19	Register 2nd Term	No	54	309	14.9
		Yes	33	1179	97.3
	Overall Percentage				78.3

a. The cut value is .500

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