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The Relationship Between Optional Developmental Education Enrollment and the Mathematics Achievement of Students at One Community College in Florida

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THE RELATIONSHIP BETWEEN OPTIONAL DEVELOPMENTAL EDUCATION ENROLLMENT AND THE MATHEMATICS ACHIEVEMENT OF STUDENTS AT ONE COMMUNITY COLLEGE IN FLORIDA

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ABSTRACT

THE RELATIONSHIP BETWEEN OPTIONAL DEVELOPMENTAL EDUCATION ENROLLMENT AND THE MATHEMATICS ACHIEVEMENT OF STUDENTS AT ONE COMMUNITY COLLEGE IN FLORIDA

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Although nearly half of community college students require some type of remediation, less than one-third of the students who start in developmental education graduate within eight years (Park, Tandberg, Hu, & Hankerson, 2016). As such, there is great uncertainty regarding the effectiveness of developmental education (Ari et al., 2016; Bailey et al., 2013). Additionally, because most institutions rely on standardized testing to determine student course placements, many critics blame placement testing procedures for the perceived ineffectiveness of developmental education (Fletcher, 2014; Jaggars & Hodara, 2013). However, rather than adjust placement procedures, some states moved away from mandated placement, and in 2013, the Florida legislature passed Senate Bill 1720, effectively eliminating college placement requirements for most students by making developmental education course enrollment optional.

This study examines the relationship between developmental education enrollment options and the mathematics achievement of students at one community college in Florida. Logistic regression analyses were used to examine the relationship between mathematics achievement (defined as course success and course grade) and developmental course enrollment. Logistic regression analyses were also conducted to examine the relationships between socioeconomic status, race/ethnicity, enrollment status, developmental course enrollment, and mathematics achievement.

The findings indicate that developmental course enrollment was not a significant predictor of mathematics achievement and student characteristics were not significant predictors of developmental enrollment or mathematics achievement. However, analyses of predicted probability statistics indicate that students in this study who enrolled in a developmental course were more likely than their peers to successfully complete their college-level mathematics course. Additionally, predicted probability statistics also indicated that students in this study who were non-White, Pell grant recipients, or enrolled full-time were less likely than their peers to enroll into developmental courses. Lastly, predicted probability statistics further indicated that non-White students who did not receive Pell and non-White students who were enrolled full-time were least likely to successfully complete their college-level mathematics course. Despite initial concerns regarding Florida's developmental education reform, the lack of statistically significant differences suggests overall students are just as likely to succeed in college-level mathematics courses whether or not they previously enrolled in developmental mathematics.

To my mother who taught me the value of education. No matter what may be taken from us in life, the knowledge we have gained will always remain.

To my husband who believed in me even when I didn’t believe in myself.

To those who have been tempted to let self-doubt and the passage of time deter them from achieving their goals. Our true circumstances are never as impossible as we build them up to be in our minds. The only way to get to the other side is to push through, and the best time to start pushing is now.

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CHAPTER I

INTRODUCTION

Developmental education is a critical component of most community colleges in the United States. Although defined in many ways, developmental education is most often described as non-credit bearing courses which provide students with the foundational skills they need to successfully complete a college degree (Bailey, Jeong, & Cho, 2010). Although developmental education aligns well with the commitment to open access shared by most community colleges, this curriculum has also been highly criticized as expensive and ineffective (Ari, Fisher-Ari, & Paul, 2016).

Background

In the United States, an estimated $7.1 billion dollars is spent on developmental education in institutions each year (Moker, Leeds, & Harris, 2018; Scott-Clayton, Crosta, & Belfield, 2014). Almost $4 billion dollars of this amount is spent in the community college sector (Scott-Clayton & Rodriguez, 2015). Some critics suggest developmental education causes taxpayers to be charged twice for the same service because tax dollars subsidize both K-12 system funding, and the federal financial aid dollars awarded to college students (Crisp & Delgado, 2014; Martin, Goldwasser, & Harris, 2017). Additionally, although developmental courses are priced the same as credit bearing courses, developmental courses are not applicable toward degree requirements. Most students who are assigned to developmental education can spend a year or more taking these courses before starting credit bearing coursework (Woods et al., 2016). This delay in access to credit bearing coursework creates an indirect cost for students in the form of foregone earnings (Crisp & Delgado, 2014).

In addition to having a high price tag, there is also much uncertainty regarding the effectiveness of developmental education (Ari et al., 2016; Bailey, Jaggars, & Scott-Clayton, 2013). Although nearly half of community college students require some type of remediation, less than one-third of the students who start in developmental education graduate within eight years (Park, Tandberg, Hu, & Hankerson, 2016). Furthermore, although several studies examining the impact of developmental education have been conducted, the results have been mixed (Ari et al., 2016; Bailey et al., 2013). After controlling for variances in placement policies and the tendency to attend colleges close to home, Bettinger and Long (2009) found students taking developmental courses at Ohio colleges were more likely to persist than students who were not assigned to developmental classes. In contrast, Calcogno and Long (2008) used data from Florida colleges for their study and found while students taking developmental courses might initially persist at higher rates, initial persistence did not lead to higher rates of degree completion.

Many critics blame placement testing procedures for the mixed results and assumed ineffectiveness of developmental education since most institutions rely on standardized test scores to determine a student’s college placement (Fletcher, 2014; Jaggars & Hodara, 2013). Although using test scores as a determinant may offer an efficient option for quickly placing students into classes, it is not always effective (Jaggars & Hodara, 2013). By relying on standardized test scores alone, institutions may be “over placing” students by incorrectly assigning them to courses for which they are not prepared (Methvin & Markham, 2015; Jaggars & Hodara, 2013). Alternatively, institutions might also be “under placing” students into developmental courses they do not need (Brathwaite & Edgecombe, 2018).

Rather than adjust the placement process, institutions in some states have moved away from mandated placements. In 2013 the Florida legislature passed Senate Bill 1720 (2013) and effectively eliminated placement requirements for most students by making placement testing and developmental education courses optional. This legislation also required institutions to offer developmental courses using at least two of the following modalities: modularized, compressed, contextualized, and co-requisite. Under this legislation, any students who graduated with a standard diploma from a Florida public high school in 2007 or later (or are active duty military personnel) are designated as “exempt students” (Alexander, 2013). Exempt students are not required to complete placement testing or enroll into developmental courses (Alexander, 2013). These students also have additional options for how to begin the reading, writing, and mathematics coursework needed for their degrees.

Exempt students can choose to take developmental courses or enter directly into gateway courses. Gateway courses are the first courses which provide transferrable credit. Exempt students have the options to take any of the following gateway courses: Written Communication I - ENC 1101, Mathematics for Liberal Arts I - MGF 1106, Mathematics for Liberal Arts II - MGF 1107, and Intermediate Algebra - MAT 1033 (Alexander, 2013). While there is only one college-level reading and writing course (ENC 1101), students have several mathematics course options which are typically dictated by their academic program. MAT 1033 is designed for students who are pursing academic programs which require higher level mathematics courses such as College Algebra or Calculus. MAT 1033 is classified as a credit bearing elective course and cannot be used to fulfill a student’s mathematics course requirement (Florida Department of Education, 2018b). Conversely, MGF 1106 and MGF 1107 are designed for students who are pursuing academic programs in the social science or humanities fields which do not require higher level mathematics. Both MGF 1106 and MGF 1107 can be used to fulfill a student's mathematics course requirement (Florida Department of Education, 2018b).

Because exempt students can "opt out" of developmental coursework, they can avoid the costs typically associated with developmental education. They also enjoy the added benefit of avoiding under placement based on test scores. Nevertheless, the potential for students to over-place themselves still exists, given exempt students have the option to enroll directly into gateway courses for which they may lack the foundational skills needed to be successful. Non-exempt students are still required to take Florida's common placement test, the Postsecondary Educational Readiness Test (PERT). Additionally, unlike exempt students, non-exempt students are also required to take the reading, writing, and mathematics courses which correspond with their PERT score placements.

Research Problem

Although Florida has received much attention for moving forward with what some would consider a radical process, there is limited information regarding whether Senate Bill 1720 (2013) has been successful (Pain, 2016). Additionally, because nearly twice as many students in Florida have placed into developmental mathematics courses as compared to developmental writing or reading courses, the implications of Senate Bill 1720 (2013) related to students' academic performance in mathematics courses are of particular interest (Hu, Park, Woods, Tandberg, Richard, et al., 2016). Furthermore, because Blacks and Hispanics are more likely than other racial groups to place into developmental education, the impact of Senate Bill 1720 (2013) on Black students and Hispanic students should also be investigated (Bahr, 2010; Crisp, Salis Reyes, & Doran, 2015; Crisp & Nora, 2012; Davis & Palmer, 2010).

There is extensive literature on the achievement gap between Black and Hispanic students as compared to White students (Bahr, 2010; Davis & Palmer, 2010; Kotok, 2017; Roscoe, 2015). Academic achievement gaps between Black, Hispanic, and White children have been shown to start as early as kindergarten (Bahr, 2010; Paschall, Gershoff, & Kuhfeld, 2018; Roscoe, 2015). These gaps continue to widen as students progress through middle and high school (Houser & An, 2015). The gap exists among high-achieving and low-achieving Black, Hispanic, and White students (Kotok, 2017). Because higher level mathematics courses often serve as an opening to college preparations and the growing Science, Technology, Engineering, and Math (STEM) fields, when Black and Hispanic students are left behind it can have lasting effects on these students' futures (Davis & Palmer, 2010; Houser & An, 2015; Kotok, 2017).

Although Black and Hispanic students will be the primary interest of this study, there are additional variables identified in the literature which may also impact mathematics achievement. Socioeconomic status contributes to achievement gaps with poor students performing lower than non-poor students (Houser & An, 2015). Nevertheless, socioeconomic status differences do not fully account for achievement gaps given non-poor Blacks and non-poor Hispanics still performed lower than poor-Whites (Paschall et al., 2018). Socioeconomic status and racial differences are often exacerbated as more schools become re-segregated, especially in the inner cities (National Research Council, 2006; Rothstein, 2015). Because schools are funded based on property taxes, schools in the lowest income areas receive less funding (Davis & Palmer, 2010; National Research Council, 2006). Black and Hispanic populations are often higher in low-income areas and urban areas (National Research Council, 2006). As such, many Black and Hispanic students are faced with poorer quality schools and fewer opportunities for advanced courses, thus further perpetuating the academic achievement gaps between Black and White students (Crisp et al., 2015; Rothstein, 2015). Because poverty is more likely to occur across multiple generations in Black and Hispanic families, it can create a cycle of negative outcomes for these populations (Paschall et al., 2018; National Research Council, 2006; Rothstein, 2015).

Enrollment patterns are another variable related to academic achievement. Academic momentum, or the pace at which students enroll, has been shown to increase achievement outcomes (Attewell, Heil, & Reisel, 2012). Researchers have found students who enroll in full-time course loads and avoid enrollment gaps, are more likely to graduate than students who take smaller course loads (Attewell et al., 2012). Because underprepared students and low-SES students are more likely to attend on a part-time basis, enrollment status is another variable which should be considered in studies about the academic achievement of Black and Hispanic students who place into developmental education courses (Attewell et al., 2012; Crisp et al., 2017).

Purpose

Given the aforementioned, the purpose of this study was to examine the relationship between developmental education course enrollment and the mathematics achievement of students at one community college in Florida. For this study, mathematics achievement was operationally defined using two measures: gateway mathematics course success and gateway mathematics course grade. Gateway mathematics course success was defined as a student receiving a passing course grade of A, B, or C in an introductory college-level math course (MGF 1106 or MGF 1107). Gateway mathematics courses grades include each type of the following course grades: A, B, C, D, F/WF, or W.

Other variables included in this study were: socioeconomic status (determined by whether or not a student received a Pell grant), race/ethnicity (non-White or White), part-time (defined as less than 12 credit hours) or full-time (defined as 12 or more credit hours) enrollment status, and developmental course enrollment (defined as whether a student took MAT 0028 or opted out). Because MAT 1033 is a credit bearing elective course which cannot be used to meet a student's mathematics course requirement, it was not included in this study. Furthermore, because MAT 1033 is also considered a pre-requisite to MGF 1106 and MGF 1107, excluding MAT 1033 from the study ensured courses at equivalent levels were being compared.

Research Questions

Therefore, the following research questions were used to guide this study:

1. To what extent is the developmental course (MAT 0028) enrollment of students at a community college in Florida predictive of mathematics achievement (course success and course grade), after the implementation of Senate Bill 1720?
2. To what extent are student characteristics (socioeconomic status, race/ethnicity, and enrollment status) predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida, after the implementation of Senate Bill 1720?
3. To what extent does race/ethnicity moderate the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement (course success and course grade) of students at a community college in Florida, after the implementation of Senate Bill 1720?

Professional Significance

The results of this study could be used to determine if there is a relationship between the implementation of Senate Bill 1720 (2013) and any unintended negative changes in the mathematics achievement of Black and Hispanic students at one community college in Florida. Although some initial studies have been conducted to explore the impact of Senate Bill 1720

(2013), much of this research has used aggregated data (Hu, Park, Woods, Richard, et al., 2016; Regional Educational Laboratory Southeast, 2015; Waschull, 2018). Because Hispanic students are overrepresented in community colleges (Crisp et al., 2017), and nearly fifty percent of Black students also enroll in community colleges, there is a need for research which sheds light on the experiences of these students in the community college setting (Sandoval-Lucero, Maes, & Klingsmith, 2014; Strayhorn, 2012). This study will provide the opportunity for an investigation of the relationship between the implementation of Senate Bill 1720 (2013) and the academic performance of two racial/ethnicity groups which have been historically disadvantaged.

Additionally, while other researchers of this topic have focused on course performance in MAT 1033, this study will be geared toward the enrollment patterns and course outcomes for students who opt to take the non-algebraic mathematics course track. Because exempt students with a MAT 0028 placement can bypass two math courses in order to start with MGF 1106 and MGF 1107 courses, the results of this study could be used to determine whether students are doing so to their detriment or if the course sequence structure might need to be altered. The aforementioned knowledge would be useful for academic advisors, mathematics department faculty, and community college administrators and could precipitate altered advising practices and evidence-based decision making.

Overview of the Methodology

The researcher will use a quantitative, nonexperimental correlational design to examine the difference in mathematics achievement for community college students in Florida after the implementation of Senate Bill 1720 (2013) (Leedy & Ormrod, 2015). The following independent variables will be included in this study: socioeconomic status, race/ethnicity, part-time or full-time enrollment, and developmental course enrollment. Mathematics achievement will be the dependent variable and includes two measures: gateway mathematics course success and gateway mathematics course grade.

In order to conduct this study, archival data were obtained from a large public community college in the West Central region of Florida which was selected using convenience sampling. The requested data did not have personally identifiable student information and included the following data: race, gender, first term enrollment hours, Pell grant award receipt, mathematics course grades, and enrollment history. Students included in the analyzed sample included students who fit within the following parameters: graduated from a public Florida high school in 2007 or later; had a PERT score placement of MAT 0028; and first enrolled in Fall of 2014, 2015, 2016, or 2017. Students with prior college-level mathematics credit were excluded from the sample. Binomial and multinomial logistic regression techniques were used to analyze the data.

Delimitations

Because this study is designed to focus on the mathematic achievement of students within a single community college in Florida, the scope was limited to this population. Given the aforementioned, while the results of this study indicate important considerations for students at this community college, the results are not broadly generalizable to other student groups, institutions, or other state college systems.

Because Senate Bill 1720 (2013) has been in effect since 2014, the researcher requested data for all available years from 2014 through 2018 (the latest data available at the start of this study), to allow for sufficient analysis of mathematics achievement measures after the implementation of Senate Bill 1720 (2013). Because this is not a longitudinal study and community college graduation rates are often measured at the three-year mark (Juszkiewicz, 2020), the researcher did not have data on graduation rates for all students in this study.

Definitions of Terms

The following are operationally defined terms and variables which will be used throughout this dissertation and for analysis in this study:

- Black – racial classification for individuals of African descent; for the purposes of this study students will be defined as Black if they indicated their race was "Black" or "African American" on their college admissions application
    - Although there are alternate terms which can be used instead of "Black", this term was selected because it is included in much of the literature and in state reports in Florida (Florida Department of Education, n.d.). Additionally, due to regional differences, the term "Black" would be preferred over "African American" for a lot of the population included in this study (Sigelman, Tuch, & Martin, 2005).
- Community college – because community colleges in Florida also offer baccalaureate degrees, for the purposes of this study a community college will be defined using the Carnegie Classification of Institutions of Higher Education term "baccalaureate/associate's college: associate's dominant": a "four-year college[s] (by virtue of having at least one baccalaureate degree program) which conferred more than 50 percent of degrees at the associate's level" (Indiana University School of Education, para. 6, 2021)
- Course success - final course grade of A, B, or C

- Developmental education – for the purposes of this study, developmental education can be used interchangeably with the term "remediation"; non-credit bearing courses which provide students with the foundational skills they need to successfully complete a college degree (Bailey et al., 2010; Scott-Clayton & Rodriguez, 2015)
- Elective – a course for which students can earn transferrable academic credit, but which does not fulfill general education course requirements
- Exempt – any student who graduated with a standard diploma from a Florida public high school in 2007 or later, or is an active duty military member (Alexander, 2013)
- Full-time enrollment – registration in a course load of 12 or more credit hours (Florida Department of Education, n.d.)
- Gateway course – a course for which students can earn transferrable academic credit and which can be applied toward fulfilling degree requirements
- General education mathematics course – a mathematics course which can be used to fulfill a student's mathematics requirement for their degree; includes MGF 1106 and MGF 1107
- Hispanic – ethnic classification for individuals of "Cuban, Mexican, Puerto Rican, South or Central American, or Spanish culture or origin" (United States Census Bureau, 2021); for the purposes of this study students will be defined as Hispanic if they indicated their ethnicity was "Hispanic or Latino" on their college admissions application
    - Although there are alternate terms which can be used instead of "Hispanic", this term was selected because it is included in much of the literature and in state reports in Florida (Florida Department of Education, n.d.). Additionally, due to

regional differences, the term "Hispanic" would be preferred over "Latino/a" for a lot of the population included in this study (Lopez, Krogstad, & Passel, 2021).

- MAT 0028 – Developmental Mathematics II; developmental course which is the pre-requisite for MAT 1033 (Florida Department of Education, 2018b); mathematics course placement for students who score between 96-113 on the PERT
- MAT 1033 – Intermediate Algebra; elective course which is the pre-requisite for MGF 1106 and MGF 1107 (Florida Department of Education, 2018b)
- MGF 1106 – Mathematics for Liberal Arts I; general education mathematics course with MAT 1033 prerequisite (Florida Department of Education, 2018b)
- MGF 1107 – Mathematics for Liberal Arts II; general education mathematics course with MAT 1033 prerequisite (Florida Department of Education, 2018b)
- Part-time enrollment – registration in course load of less than 12 credit hours (Florida Department of Education, n.d.)
- Pell grant – federal student aid which does not need to be repaid and is awarded to undergraduate students based on their financial need (Federal Student Aid, 2018).
- PERT scores – student results on the Postsecondary Educational Readiness Test (PERT)
- Postsecondary Educational Readiness Test (PERT) – common placement test used in Florida to determine student course placements for mathematics, reading, and writing (Florida Department of Education, 2018a)
- Senate Bill 1720 (2013) – legislation passed by the Florida legislature in 2013 which makes placement testing and developmental education courses optional for exempt students

- Socioeconomic status (SES) – binary measure of societal and economic standing as determined by whether or not a student received a federal Pell grant (Brathwaite & Edgecombe, 2018)

Summary

Developmental education has come under considerable scrutiny due to its high costs and mixed effectiveness. Placement testing has been cited as one of the reasons for the poor outcomes of developmental education. To combat these concerns, Florida implemented developmental reform legislation which allows most students to opt out of placement testing and developmental coursework. Although this legislation could result in savings and improved outcomes, the actual impact of the policy is still being explored. Because many Black and Hispanic students start their education at the community college and in developmental coursework, it is important to determine the impact of Florida's reform efforts on this demographic. As such, for this study the researcher will explore the mathematics achievement of community college students in Florida. In the next chapter, the researcher will provide a review and analysis of existing literature relevant to this study.

CHAPTER II

LITERATURE REVIEW

The purpose of this study is to examine the relationship between developmental education enrollment options and the mathematics achievement of students at one community college in Florida. In order to provide context for this study and to facilitate a broader understanding of the current state of developmental practices and trends, the researcher conducted a literature review. In this chapter the researcher provides a review of the existing literature on the history of developmental education, challenges and trends related to developmental education, community college placement testing procedures and critiques, developmental education curriculum and instruction practices, developmental mathematics course options, and a review of studies related to the demographics and persistence of students who enroll in developmental courses.

History of Developmental Education

Developmental education has been a component of higher education institutions since Harvard University started implementing admissions requirements in the mid-1600s (Arendale, 2002). Although issues related to developmental education may be viewed by some as a new phenomenon, many of these concerns have been around for decades. As such, this section is provided to offer brief historical context for the expansion, recognition, and subsequent criticism of developmental education.

Morrill Acts. While postsecondary enrollments were lower in the years leading up to the Civil War, the passage of the Land-Grant College Act of 1862 (also known as the first Morrill Act) swiftly expanded the realm of higher education as states received the resources necessary to establish land grant institutions (Arendale, 2002). Because land grant institutions were designed to “serve the industrial classes,” the creation of these institutions provided higher education access for a group of citizens who had often been excluded from postsecondary education (Boylan & White, 1987). Given their more practical focus, land grant institutions also sparked a curricular shift away from a strictly classical curriculum.

The passage of the Agricultural College Act of 1890 (also known as the second Morrill Act) precipitated the widespread establishment of Historically Black Colleges and Universities (HBCUs) as Southern states were forced to either remove discriminatory admission practices from their current institutions or provide separate educational facilities for Black students (Casazza, 1999; Jones & Richards-Smith, 1987). With the creation of HBCUs, a surge of Black students entered the realm of higher education. Given the prior impact of slavery, many of the first Black students had not received primary or secondary education and entered postsecondary institutions largely underprepared. As such, HBCUs developed strong developmental programs to address the academic deficits of their students (Arendale, 2002).

Junior colleges. Following the passage of the Land-Grant College Act of 1862 and the Agricultural College Act of 1890, the realm of higher education continued to expand with the introduction of junior colleges (later termed community colleges) in 1901 (Arendale, 2002). Once four-year colleges started to receive state and federal funding, the need for institutions to fully admit all students, regardless of academic preparedness level, was swiftly diminished. As such, many colleges transformed their preparatory departments into junior colleges (Cafarella, 2014). Junior colleges thus became responsible for ensuring students were academically prepared prior to admittance to “senior” level (third and fourth year) postsecondary education (Bastedo, Altbach, & Gumport, 2016). Additionally, because junior colleges often had lower tuition rates than four-year colleges, many students from lower socioeconomic backgrounds benefitted from starting their postsecondary education in the junior college sector.

Because of the variance in secondary education offerings across the nation, postsecondary admissions requirements also varied (Boylan, 1988). In response to these inconsistencies, the College Entrance Examination Board (CEEB) was created in 1890 to assist four-year colleges with developing college entrance examinations as a standardized way to sort students by academic preparedness level (Arendale, 2002; Cafarella, 2014). Once junior colleges were introduced, these standardized examinations were used by four-year colleges to determine which students could start at the four-year level, and which would be referred to the junior college instead. In addition to providing academic preparation for student seeking to transfer to senior institutions, junior colleges also offered occupational training and vocational programs (Bastedo et al., 2016).

World War II. Although higher education was expanded with the proliferation of land-grant institutions and junior colleges, postsecondary institutions experienced another explosion of growth following World War II. The passage of the Servicemen's Readjustment Act of 1944 (also known as the G.I. Bill) granted millions of veterans funding for education and training (Cafarella, 2014). Although it was assumed few veterans would take advantage of the education funding, by 1946 over one million veterans had enrolled in college (Cafarella, 2014). Given the influx of this new student demographic, the need for developmental education was strengthened as institutions were forced to create more study skills and reading courses to meet the needs of returning veterans (Cafarella, 2014).

Community colleges. Amidst the enrollment boom associated with the G.I. Bill, higher education experienced another shift when the 1947 Higher Education for American Democracy report (also known as the Truman Commission Report) was issued (Bastedo et al., 2016). Through this document the commission called for the creation of a nationwide community college system focused on meeting community needs through technical, general, and continuing education options. Taking hold of the new terminology contained in the report, states began shifting away from having junior colleges and by 1950, nearly half of all states had created a community college system (Bastedo et al., 2016).

Between 1965 and 1970, community colleges experienced massive growth and an average of one new community college opened each week (Cafarella, 2014). This growth was spurred by the influx of the “baby boom” generation who reached college-going age in the early 1960s (Boylan, 1988). The passage of the Civil Rights Act of 1964 also caused a new population of Black students to seek postsecondary education (Davis & Palmer, 2010). Because there were so many students pursuing postsecondary education during this time, four-year institutions took the opportunity to be more selective in their admissions. Students who were not granted admission into four-year institutions often turned to community colleges as an alternative means of accessing postsecondary education (Boylan, 1988). The introduction of financial aid funding with the passage of the Higher Education Act of 1965 also increased access since students who previously could not afford postsecondary education were now able to do so. Thus, in the wake of increased selectivity at senior institutions, and with the introduction of federal financial aid programs, community colleges were able to not only expand, but also continue to maintain their commitment to open access while increasing their developmental education offerings (Boylan & White, 1987; Cafarella, 2014).

Recognition of developmental education. Although the number of community colleges began to level off in the late 1970s and early 1980s, this period also marked the beginning of developmental education as a recognized academic discipline (Cafarella, 2014). In 1976, the W. K. Kellogg Foundation established the National Center for Developmental Education (NCDE). Soon after, in 1984, the National Center for Education Statistics (NCES) published a report on developmental education, providing developmental education with a national spotlight. In 1990, the NCDE conducted a national study investigating the methods, courses, structures, and student outcomes of developmental education, and by 2003 the NCES reported that 98% of community colleges, and 80% of four-year institutions offered developmental courses (Cafarella, 2014). During this same period, nearly 80% of all community college students required remediation in at least one subject (Bastedo et al., 2016). In recent years, the concentration of community college students enrolled in developmental courses has increased as many states have restricted developmental education funding at four-year colleges, and instead shifted the burden to community colleges (Cafarella, 2014). Although developmental education benefitted from a national platform, this recognition also came with its share of challenges and criticism, the most prominent of which is the achievement gap based on race and income.

Developmental Education and Student Demographics

Developmental education is ideally designed to increase access by creating opportunities for underprepared students to gain the skills they need to be successful in college-level coursework (Bahr, 2010). Unfortunately, in its current structure developmental education has instead created substantial barriers for certain student populations, especially in the subject of mathematics (Bahr, 2010). Students who are Black, Hispanic, low-income, or enrolled on a part-time basis are most likely to need remediation, and least likely to complete their degree when compared to their White, higher-income, or full-time enrolled peers. (Crisp et al., 2017; Davis & Palmer, 2010; Strayhorn, 2014).

Racial achievement gaps. The academic achievement gaps between Black and White students and Hispanic and White students have been well-documented (Bahr, 2010; Davis & Palmer, 2010; Kotok, 2017; Olszewski-Kubilius, Steenbergen-Hu, Thomson, & Rosen, 2017; Roscoe, 2015). These gap starts as early as kindergarten, widen through 8th grade, and continue through 12th grade (Olszewski-Kubilius et al., 2017). Black and Hispanic students are also underrepresented in the top percent of their class at all education levels (Olszewski-Kubilius et al., 2017). Many explanations have been offered for why an achievement gap exists including: inequalities related to socioeconomic status, the proliferation of academic tracking, lower parental involvement, poor primary and secondary school quality, less access to college preparation programs, and inadequate school facilities (Ladson-Billings, 1997; Owens, 2018). These reasons aside, the Black-White and Hispanic-White achievement gaps still exist, and there have been no significant changes on 4th grade student assessment measures since 2007 (Houser & An, 2015). Additionally, both 4th and 8th grade gaps remained stable from 2013-2015 (Olszewski-Kubilius et al., 2017).

While the achievement gap between Black and White students and Hispanic and White starts in kindergarten, it also continues into the college years (Bahr, 2010). Although it has been shown that Black and Hispanic students typically do not perform as well as other students on standardized tests, it is still common practice for colleges to require students to take standardized placement tests (Hu, Park, Woods, Richard, et al., 2016). Additionally, even though Black and Hispanic students enroll in college at a rate which matches their proportional representation in society, they are still disproportionately assigned to developmental courses (Bahr, 2010). As high as 62% of Black students and 63% of Hispanic students are assigned to developmental courses compared with 36% of White students (Bahr, 2010). Moreover, using data from California community colleges, Bahr (2010) found only 17% of White students were placed into the lowest level of developmental mathematics as compared to 40% of Black students and 31% of Hispanic students. Because students assigned to the lowest developmental levels are least likely to graduate or transfer, Black and Hispanic students experience a decreased likelihood of ever finishing their degree and have a smaller share in any potential rewards which stem from completing developmental courses (Bahr, 2010; Crisp et al., 2017).

Furthermore, while there has been a growing demand for graduates who majored in science, technology, engineering, and mathematics (STEM), Black and Hispanic students are underrepresented in this population (Crisp et al., 2017; Davis & Palmer, 2010). Because a significant proportion of Black and Hispanic students start in developmental mathematics courses, many of these students are unlikely to finish the mathematics course sequence needed to graduate with a STEM degree (Kotok, 2017).

Income achievement gap. While the racial achievement gap has received much attention over the years, a significant gap between low- and high-income students also exists (Owens, 2018; Schenke, Nguyen, Watts, Sarama, & Clements, 2017). Because many schools receive funding based on property tax revenue, school quality varies by neighborhood with low-income students receiving less access to quality schools (Owens, 2018). Without quality educational resources, the academic achievement of low-income students quickly drops below, and stays below, the academic achievement level of their higher-income peers (Rittle-Johnson, Fyfe, Hofer, & Farran, 2017).

The income achievement gap has continued to grow over the years, and according to Houser and An (2015), low-income students are four times more likely to enter school with lower skill levels than students from middle-income families. Low-income students also tend to exhibit no skills growth from kindergarten to 1st grade (Houser & An, 2015). The income achievement gap has remained stable throughout students' primary and secondary schooling (Paschall et al., 2018). Additionally, at the collegiate level, students from high-income backgrounds tend to perform better than low-income students (Silverman & Seidman, 2012). Because college is viewed as a means by which low-income students can improve their financial outlook, the fact that many of these students are unlikely to complete their degree or transfer is an area of great concern (Hodara & Xu, 2016).

Low-income Black and Hispanic students. Researchers have found a close relationship between socioeconomic status and race (Houser & An, 2015; Owens, 2018). Many Black and Hispanic students grow up in poverty, a trend which is often multigenerational (National Research Council, 2006; Rothstein, 2015). Additionally, because school districts are determined by neighborhood, schools often become segregated when Black students from poor neighborhoods are districted to attend the same school (Rothstein, 2015). Additionally, Hispanic children are increasing segregated in school districts whose enrollments are at least 10% Hispanic (Fuller et al., 2019). From 2005-2015, the percentage of Black students who attend a mostly minority school rose from 34% to 39% (Rothstein, 2015). Moreover, the percentage of Black students who attend schools with mostly low-income students also rose from 43% to 59% over the same period (Rothstein, 2015).

Black students are also ten times more likely than White students to live in low-income neighborhoods with less chance of mobility across generations (Rothstein, 2015). Similarly, Hispanic students are more likely than White students to live in low-income neighborhoods (Rothstein, 2015). Additionally, in the wake of the recession, middle-class Hispanic families were more likely to fall into poorer neighborhoods (Fuller et al., 2019). Between 2007 and 2013, the net worth of Hispanic households dropped from $23,600 to $13,700 as compared to a drop from $192,500 to $141,000 for White households (Fuller et al., 2019).

Even when comparing families with the same income, the achievement gap between Black and White families still exists given low-income White families are more likely to attend middle-income schools, while high income Black families are more likely to live in neighborhoods which are in closer proximity to low-income Black families (Paschall et al., 2018). Within-race achievement differences also exist with high-income Black students performing better than low-income Black students, but lower than low-income White students (Paschall et al., 2018). Similarly, high-income Hispanic students also performed better than low-income Hispanic student, but worse than low-income White students (Paschall et al., 2018). At the postsecondary level, a greater proportion of Black and Hispanic students are low-income with more than 60% of Black students and half of Hispanic students needing Pell grant funding (Hicks, West, Amos, & Maheswari, 2014). Low-income Black and Hispanic students are also disproportionately represented in developmental courses (Royer & Baker, 2018; Ulmer, Means, Cawthon, & Kristensen, 2016).

Student enrollment patterns. Enrollment patterns are another variable related to academic achievement. Academic momentum, or the pace at which students enroll, has been shown to increase achievement outcomes (Attewell, et al., 2012). Researchers have found students who enroll in full-time course loads and avoid enrollment gaps, are more likely to graduate than students who take smaller course loads (Attewell et al., 2012). Additionally, Black and Hispanic students who attend college part-time are less likely to persist (Crisp & Nora, 2012; Urias & Wood, 2014). Bailey, Jeong, and Cho (2010) found that Black students who were attending part-time were also less likely to complete their developmental course sequence.

Because underprepared students and low-income students are more likely to attend on a part-time basis, enrollment status is another variable which should be considered in studies about the academic achievement of Black and Hispanic students who place into developmental education courses (Attewell et al., 2012).

Criticisms of Developmental Education

Even though developmental education is a component of most community college institutions within the United States, there have been significant critiques as to the value, necessity, and effectiveness of developmental education (Ari, et al., 2016). These critiques are most often related to the high financial, opportunity, and psychological costs, and the mixed student achievement results associated with developmental education.

Financial costs. Developmental education is costly for institutions, taxpayers, and students. Although other estimates vary, Scott-Clayton, Crosta, and Belfield (2014) calculated an estimated $7.1 billion dollars is spent on developmental education in institutions in the United States each year. More than half of this amount was spent in the community college sector (Scott-Clayton & Rodriguez, 2015). Furthermore, some critics suggest developmental education causes taxpayers to be charged twice for the same service (Martin, Goldwasser, & Harris, 2017; Valentine, Konstantopoulos, & Goldrick-Rab, 2017). Because taxpayers pay into the K-12 system where students are initially assigned to learn foundational skills, if students later take developmental courses, taxpayers are paying a second time when the cost of remediation is subsidized through federal financial aid (Martin et al., 2017). The cost to taxpayers is further intensified when students do not finish their degree and amounts to nearly $4 billion for students at community colleges (Jones, 2015).

Students also have direct financial costs related to developmental education. According to a 2008 report by Strong American Schools, students were paying $1,607-$2,008 for remediation. This amount has continued to increase over the years with Barry and Dannenberg (2016) reporting over 500,000 students spent an average of $3,750 on developmental courses in the 2011-2012 academic year. Although the amounts varied from state to state, collectively students in the United States paid over $1.3 billion for developmental classes in 2013-2014, with over $920 million of the amount paid by community college students (Schak, Metzger, Bass, McCann, & English, 2017). Not only are immediate out-of-pocket expenses high, but on average, students borrow nearly $3,000 in loans per developmental course for a total of $380 million in yearly federal student loan debt related to developmental education (Schak et al., 2017). The cost of developmental courses is further exacerbated because these courses are not applicable to students' degree requirements.

Opportunity costs. Although there are significant financial costs associated with developmental education, there are also opportunity costs related to lost time and effort (Hodara & Xu, 2016). Most students who are assigned to developmental courses can spend a year or more taking classes before starting college credit-bearing coursework (Woods et al., 2016). Additionally, according to Bailey and Cho (2010), a significant percentage of students never reach college-credit classes, with 28 percent of students referred to developmental math never enrolling, and 30 percent of the students who do enroll, either failing their course or withdrawing. Because many students taking developmental courses either experience delayed time to degree completion or fail to graduate at all, these students have an additional indirect cost in the form of foregone earnings (Crisp & Delgado, 2014). Students also lose out on the work experience they could have gained had they been employed instead of taking developmental classes (Hodara & Xu, 2016).

Psychological costs. In conjunction with the financial and opportunity costs, students also experience negative psychological effects related to developmental education. After surveying 243 students assigned to multiple levels of developmental courses at a small southeastern college, Martin, Goldwasser, and Harris (2017) found students who took two or more developmental courses had lower academic self-concepts than students who took one or less developmental courses. According to Hodara and Xu (2016), the stigma and negative peer effects related to developmental education can also negatively affect students' motivation, learning, and labor market outcomes as they self-assign into low-skilled jobs. Additionally, many academically underprepared students believe they are not as good as other students, simply because they placed into developmental courses (Perrin, 2013). Developmental education placement may also cause students to feel discouraged about attending college and result in students stopping out or dropping out of college (Ngo & Melguizo, 2016).

Mixed student achievement results. Although the costs of developmental education are high, some might view these costs as necessary investments if the completion of developmental education courses yielded positive student achievement results. However, less than one-third of community college students who start in developmental education graduate within eight years, even though nearly half of community college students require some type of remediation (Park, et al., 2016). Conversely, nearly 40% of community colleges students who do not require remediation successfully complete a degree over the same time period (Bailey & Cho, 2010). Of the 1.7 million students who enroll into developmental courses each year, only about 10% graduate, with 70% of the students never completing their first college-level course (Jones, 2015;

Royer & Baker, 2018). Although several studies have been conducted to examine the impact of developmental education, findings related to student achievement measures such as college-level course completion, credit accumulation, persistence, and graduation have been mixed (Bettinger & Long, 2009; Boatman & Long, 2010; Crisp & Delgado, 2014).

After controlling for variances in placement policies and the inclination to attend colleges close to home, Bettinger and Long (2009) found students taking developmental courses at Ohio colleges were more likely to persist than student who were not assigned to developmental classes. In a study investigating whether mathematics remediation in community colleges works, Bahr (2008) found students who complete mathematics remediation attain similar outcomes as their peers who were not placed into remediation. Nevertheless, Bahr (2008) also indicated over three-fourths of the students who are placed into developmental mathematics did not complete their developmental sequence, and less than 20% eventually earned a credential or transferred. As such, Bahr (2008) determined that although mathematics remediation did work well, it only did so for a small portion of the large group assigned to mathematics remediation.

Using data from the Beginning Postsecondary Students Longitudinal 04/09 study, Crisp and Delgado (2014) received mixed results when comparing developmental and non-developmental students. Although the developmental students in their study were slightly more likely to persist to their second year of college, there were also less likely to ultimately transfer as compared to their non-developmental peers. While Crisp and Delgado (2014) found both positive and negative results, in a study of the effect of developmental education in Texas community colleges and four-year institutions, Martorell and McFarlin (2011) found no evidence that developmental education has a positive effect on student outcomes. In contrast, using data from Florida colleges, Calcagno and Long (2008) reported that while students taking developmental courses might initially persist at higher rates, no effect was found as it relates to increased degree completion.

Not only have results been mixed across studies, but within studies as well. In a regression discontinuity study of students who placed one or two courses below college level in reading, writing, or math, Boatman and Long (2017) found students who placed two courses below college level in reading persisted at higher rates in their first and second years than students who placed one course below in reading. Conversely, students who placed two courses below college level in math persisted at lower rates by completing 11.5 fewer credit hours than their peers who placed one course below them (Boatman & Long, 2017).

As can be seen from the various studies referenced above, there has been no clear consensus on whether developmental education is effective. Additionally, because several of the studies were conducted nearly a decade ago, it raises the question as to whether these findings are still relevant given the myriad of changes and reforms which have occurred in developmental education in recent years. As such, new studies are needed to assess the current state and effectiveness of developmental education.

Placement Testing

Many critics cite ineffective placement testing procedures as a potential reason for some of the negative student achievement results tied to developmental education (Fletcher, 2014; Jaggars & Hodara, 2013; Methvin & Markham, 2015). Most institutions rely solely upon standardized test scores to determine a student's college placement (Collins, 2008). The use of test scores as a determining factor in course placement may offer an efficient option for quickly placing students into classes, however it is not always the most effective means of doing so (Jaggars & Hodara, 2013). By relying on standardized test scores alone, institutions may be incorrectly assigning students to developmental education, thus causing students to lose significant amounts of time and money (Methvin & Markham, 2015).

Except in the case where a student already earned college-level credit in the areas of English and math, most community colleges require students to complete placement testing prior to enrolling into college-level courses (Scott-Clayton et al., 2014). Although there are exceptions in some states (i.e., Florida), the aforementioned is still the case even when students are entering college directly out of high school. This is often a point of contention for both legislators and institutional leaders given the common assumption that students should be graduating from high school with the basic academic skills necessary for success in college, rather than entering college with significant skills deficits (Pretlow & Wathington, 2013; Scott-Clayton et al., 2014).

Regardless of the skills they acquired in high school, most institutions use scores on standardized tests such as the ACCUPLACER, COMPASS, ACT, or SAT, to determine student course placements (Collins, 2008; Guy, Puri, & Cornick, 2016; Melguizo, Kosiewicz, Prather, & Bos; 2014; Ring, 2016). The ACCUPLACER was developed by CollegeBoard over 30 years ago and is used by 62% of community colleges, making it the most commonly used placement test (Hughes & Scott-Clayton, 2011; Scott-Clayton, 2012). In their 2009 study, Mattern and Packman conducted a meta-analysis of 47 placement validity studies and found the ACCUPLACER was more accurate when course success was defined as earning a grade of “B or higher” as opposed to the standard passing grade of “C or higher”. Additionally, only 58-84% of students who took the ACCUPLACER were placed correctly once cut scores were applied. Although Mattern and Packman (2009) determined there was at least a moderate relationship between ACCUPLACER scores and course success, it was recommended for multiple measures such as high school GPA to be used in conjunction with the test to yield more accurate placements.

The COMPASS was previously the second most common placement exam and was used by 46% of community colleges (Hughes & Scott-Clayton, 2011; Scott-Clayton, 2012). In their 2014 analysis of the validity of the COMPASS, Westrick and Allen found high school GPA was more accurate than the COMPASS when predicting whether a student would earn a grade of “B or higher” and using both the COMPASS and high school GPA was more accurate than using either measure individually. COMPASS was phased out by ACT in 2016 and replaced with the new CollegeReady program they introduced in 2017 (ACT Newsroom, n.d.).

The ACT and SAT are well known placement exams offered by ACT and College Board respectively, however these exams are more commonly used for college entry scores at four-year institutions, rather than as placement exams for community colleges (Pain, 2016). Although all of the aforementioned tests are used nationwide, several states such as Texas and Florida instead developed their own placement examinations using sound psychometric techniques (Hughes & Scott-Clayton, 2011; Zujovic, 2018).

Regardless of which placement test an institution uses, students’ placement scores are generally compared against a cutoff score (Ngo & Melguizo, 2016). Cutoff scores are score values developed by an institution or state system and used to determine whether students should go directly into college-level courses or instead start with developmental courses (Guy et al., 2016; Ring, 2016). Cutoff scores typically vary between institutions often resulting in inconsistencies throughout community college systems (Fletcher, 2014; Jaggars & Hodara, 2013). In the state of Florida, cutoff scores were determined by the state system after receiving feedback from faculty regarding which skills were necessary for students to be successful in their gateway courses. Although the state set the scores used to determine whether a student is assigned to developmental or college-level course, individual institutions were given the latitude to assign the cutoff scores used to determine which level of a developmental course a student must take, and alternatively, which level of credit-bearing coursework a student was eligible for (i.e. – developmental mathematics I or II and college algebra or trigonometry).

Inaccurate placements. Although there are other readily available means besides standardized tests by which students could be placed, institutions have largely relied upon placement testing due to the ease of delivery and speed of scoring (Fletcher, 2014). Researchers have found many students may be getting under placed into developmental courses as a result of an institutional reliance on a single measure for determining student course placements (Jaggars, Hodara, Cho, & Xu, 2015). Unfortunately, these misplacements usually result in negative consequences for students in the form of wasted money, added time to degree, and potential discouragement (Jaggars & Hodara, 2013).

Under placement occurs when a student is incorrectly assigned to a developmental course even though they could have been successful in a college-level course (Scott-Clayton et al., 2014). Conversely, over placement occurs when a student is incorrectly assigned to a college-level course even though they are unlikely to succeed in the course. In their study of two large community college systems, Scott-Clayton et al. (2014) found under placement was more common than over placement given nearly 25% of students who took the math placement test, and nearly 33% of students who took the English placement test, were severely under placed into developmental courses. Scott-Clayton et al. (2014) also found when high school transcript information is used as part of the placement process, students were less likely to be under placed or over placed.

There are arguably practical reasons against using multiple measures to determine student course placements such as the cost and time needed to individually review each student's record and the increased need for personalized advising (Jaggars et al., 2015). Scott-Clayton et al. (2014) indicated institutions might have additional arguments against using multiple measures such as greater concern for over placing students than under placing them, faculty reluctance toward failing students, and the potential indirect subsidy obtained as a result of it costing less to offer developmental courses than college-level courses. Regardless of the reasoning, there is a growing sector of research indicating not only are standardized placement tests largely inaccurate, but the use of multiple measures can offer a simple alternative to better ensure students are placed appropriately (Hu, Park, Woods, Richard, et al., 2016; Schak et al., 2017). As such and given the negative impacts and significant costs associated with incorrect course placements, many institutions are now shifting toward the use of multiple measures (such as GPA, high school coursework, and class rank) when trying to determine if a student will be successful in college level courses (Methvin & Markham, 2015; Park, Woods, et al., 2016). In their study of national developmental education practices, Rutschow and Mayer (2018) found the use of multiple measures for mathematics placement in community colleges had grown tremendously over the past few years increasing from 27% of surveyed institutions in 2011, to 57% of surveyed institutions in 2016.

Curriculum and Instruction

Although placement testing is one area potentially impacting student success in developmental courses, placement testing is often viewed as only one part of a larger problem (Fletcher, 2014; Methvin & Markham, 2015). Developmental course curriculum and instruction has been cited as another part of the problem related to developmental education (Ariovich & Walker, 2014; Hern & Snell, 2014). Because time spent in developmental courses represents an expense in time and money, there is intense pressure for students to not only complete these courses quickly, but to also leave developmental courses fully prepared for the college-level coursework which lies ahead (Perrin, 2013).

Many developmental students are not successful when they transition to college-level courses because most developmental courses are designed with a limited focus on acquiring basic skills (Perrin, 2013). As such, students may complete their developmental courses with an understanding of basic skills, but they are often not taught how to apply what they learned to college credit courses. Moreover, while many of the faculty hired to teach developmental courses are content experts, few have been trained on how to teach students who have varying academic skills and needs (Perrin, 2013).

The increased transition of developmental courses to an online format is also an area of concern. Developmental students are less likely to demonstrate self-regulated learning (SRL) strategies such as planning, goal setting, and self-monitoring (Bol, Campbell, Perez, & Yen, 2016; Bol & Garner, 2011). However, SRL strategies have been linked to academic achievement and are considered critical for the successful completion of online courses. As such, developmental students who lack SRL strategies may be more likely to fail their online developmental courses (Bol & Garner, 2011).

Traditional developmental courses. When delivered in the traditional modality, developmental courses are a series of lecture-based courses each lasting for a full semester and are designed so students who finish the entire course sequence are then considered prepared to enter college-level coursework (Kosiewicz, Ngo, & Fong, 2016). Because sequences often include as many as three separate levels, students assigned to the lowest level of developmental courses could spend as much as an entire year taking classes which offer no transferrable credit (Hodara & Jaggars, 2014). Additionally, because the developmental sequence expands across multiple semesters, there are also many exit points during which students can potentially drop out prior to completing a college-level course (Hern & Snell, 2014). Many of the students who successfully finish their developmental sequences are still unlikely to complete college-level courses. Because developmental courses tend to be designed with a curricular overemphasis on procedural skills, rather than contextual skills, students are often left ill-prepared to take what they learned in those courses and later apply it with new concepts in college-level courses (Quarles & Davis, 2017).

Accelerated courses. In order to combat some of the issues associated with traditional developmental courses, accelerated courses offer students the opportunity to complete their developmental sequences in less time (Jaggars et al., 2015). By condensing the same course material into half-semester sections, students can complete developmental coursework more quickly resulting in time savings for students (Kosiewicz et al., 2016). Although accelerated courses shorten the time students spend in non-credit courses, because it is the same content offered in less time it does not address any of the curricular concerns noted with traditional courses (Hodara & Jaggars, 2014). Additionally, because students are still required to complete the same number of developmental course levels, this modality also does not lessen the number of exit points during which students might decide to drop out of college (Hern & Snell, 2014).

Compressed courses. Although often used interchangeably with accelerated courses, compressed courses are when multiple developmental levels are condensed into single courses (Kosiewicz et al., 2016). At an institution where students might have otherwise been required to complete three or four levels of developmental courses, compressed options might combine two levels into a single course allowing students to proceed through their sequence at a faster pace and at lower costs (Jaggars et al., 2015; Kosiewicz et al., 2016). Additionally, because compressed courses condense developmental levels, these courses also lessen the number of points at which a student might exit, thus improving the chances of students completing their developmental sequence and gaining access to college-level courses (Quarles & Davis, 2017).

The “FastStart” Math program at Community College of Denver serves as a nationally recognized example of a compressed course modality (Hodara & Jaggars, 2014; Jaggars et al., 2015). In this program, the college’s original sequence of three developmental math courses was condensed into pairs so students starting at the lowest level could complete their math sequence in as few as two semesters (Jaggars et al., 2015). In a comparison between FastStart students and students taking the traditional course modality, Jaggars, Hodara, Cho, and Xu (2015) found FastStart students were more likely than their peers to eventually complete college-level courses.

Modularized courses. Unlike accelerated and compressed courses, modularized courses (also known as the emporium model) include certain curricular differences from traditional courses (Ariovich & Walker, 2014). In modularized courses, mathematics content is separated into different modules and offered to students though computer software rather than lectures (Ariovich & Walker, 2014). Students begin the course by taking a diagnostic to determine which modules they have mastery of and which they need to work on. Students can bypass modules they have mastered and spend more time on the modules in which they have deficits (Ariovich & Walker, 2014). As such, modularized courses offer a personalized alternative to the traditional developmental course modality. Because students can work at their own pace, they can also progress through their developmental sequence more quickly. One negative associated with this modality is all instruction is offered through computer software. As such, students may not receive the formal instruction typically offered in traditional lecture-based courses and students are largely responsible for their own learning (Ariovich & Walker, 2014). The heavy reliance on technology might also be a barrier for those students who are not technologically savvy as well as students who cannot afford access to a home computer and reliable high-speed internet connection (Ariovich & Walker, 2014). Thus, while modularized courses do address some of the concerns related to traditional courses, they are not likely to meet the needs of all students.

In their study comparing the performance of students in a traditional four-course developmental sequence to those in a redesigned three-course modularized sequence, Okimoto and Heck (2015) found students in the modularized sequence were more likely to pass each developmental course and enroll in the subsequent developmental course than students in the traditional course format. Additionally, students taking the modularized sequence were also more likely to eventually enroll into college-level courses (Okimoto & Heck, 2015). Although Okimoto and Heck (2015) did not have clear explanations as to why the odds of success were different for the two group of students, Ariovich and Walker (2014) might offer some insight.

Ariovich and Walker (2014) conducted focus groups with faculty and students who taught or took a modularized math course. Although responses varied, both faculty and students cited the individualized content and mastery requirements as reasons for student success. While a review of initial comparisons indicated students in the traditional course modality were more likely to pass the developmental courses, in later analysis researchers found students who took the modularized course modality were more likely to do better in subsequent developmental courses and had developed a better understanding of course material (Ariovich & Walker, 2014).

Contextualized courses. Although accelerated, compressed, and modularized course modalities might address complaints related to the significant time investments associated with traditional developmental courses, contextualized courses are instead designed to address curricular concerns (Kosiewicz et al., 2016). In contextualized courses, instruction is focused on the real-life application of skills (Perrin, 2013). Rather than only learning rules about grammar in an English class and practicing those skills out of context, students might instead be directed to review newspaper articles or medical textbooks to focus on how grammar is important to journalists or biology majors. This curricular shift in focus from procedural to conceptual allows students to more readily develop the skills needed to apply the information learned in their developmental courses to the new content they will face in their college-level classes (Quarles & Davis, 2017).

Co-requisite courses. Co-requisite developmental courses allow students to enroll directly into college-level English and math courses while taking a developmental course at the same time (Kosiewicz et al., 2016). In this model, the developmental course serves as a supplemental resource for students to continue to develop the skills they need to successfully complete their college-level course (Kosiewicz et al., 2016). The developmental course modality may allow a student additional time to practice concepts or the opportunity to receive more basic support from an instructor without the college-level instructor slowing down the speed of the course or the developmental student falling behind (Jaggars et al., 2015). Because this model does not require the developmental course to be taken first, it also allows for students to immediately begin earning transferrable college-credit. Since the co-requisite course is also aligned with the college-level course, students are directly applying the skills they develop as the course progresses, rather than learning basic skills out of context as was the case with the traditional course modality (Jaggars et al., 2015).

The Accelerated Learning Program (ALP) at Community College of Baltimore County serves as a nationally recognized example of a co-requisite course model (Hodara & Jaggars, 2014; Jaggars et al., 2015). In this program, students who placed into the top level of developmental writing could enroll directly into college-level English if they simultaneously enrolled into a developmental writing course (Jaggars et al., 2015). Both courses were taught by the same instructor and the developmental course was used as an opportunity for students to spend more time on assignments and skills needed to successfully complete their college-level English class (Jaggars et al., 2015). When compared with students taking traditional developmental writing options, the ALP students were more likely to complete college-level English and accrued more college-level credit than their peers (Jaggars et al., 2015).

Challenges to course redesign. As can be noted from the various types of developmental course models discussed above, institutions face a variety of options for how they can deliver developmental courses (Kosiewicz et al., 2016). Each modality also has positives and negatives, making it difficult to determine which course types might best serves students (Cafarella, 2016). Additionally, because some modalities may not benefit all students, there is a tradeoff which occurs when one course modality is selected over another (Hodara & Jaggars, 2014). As such, it is necessary for decision makers to take considerable thought before selecting course modalities (Hodara & Jaggars, 2014).

Given the research related to developmental course completion and subsequent student performance, it seems especially important for administrators, faculty, and legislators to take a hard look at the developmental education course models and curriculum to see what improvements can be made. While several options are readily available to choose from, this decision must be made in conjunction with individual institutional assessments as one model does not fit all. Full consideration of the costs for institutions, students, and faculty should also be noted because a curriculum choice affects each group differently. Additional research is needed to see which models work best and under what conditions. Although each of the course modalities can be found in Florida community colleges, this study will focus on the accelerated course modality, as it is the most popular course type used in Florida and other states (Park, Woods, Hu, Jones, & Tandberg, 2017).

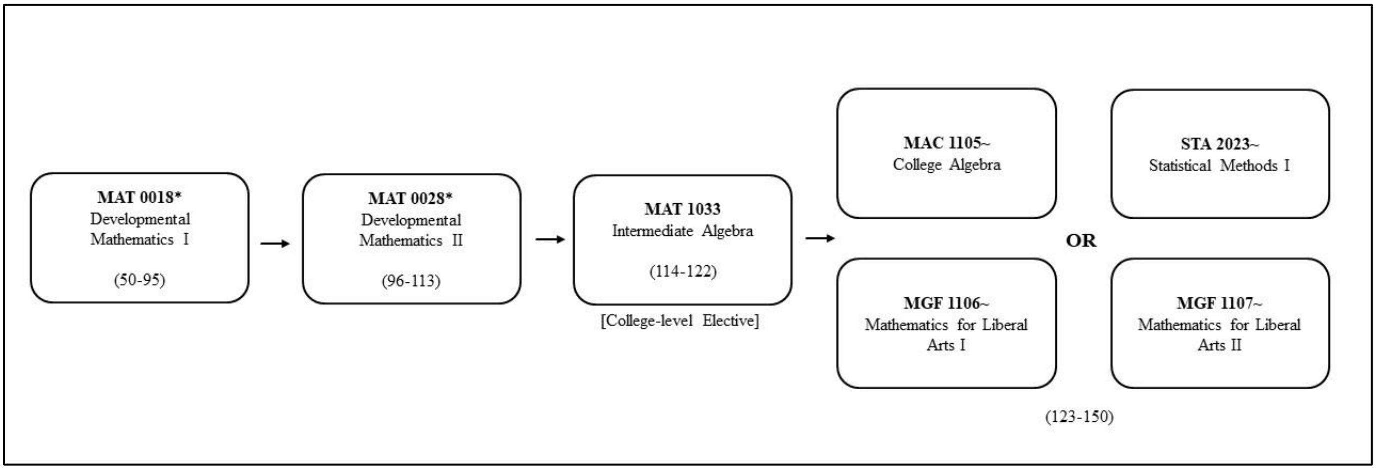
Developmental Education in Florida

Florida, like other states throughout the nation, is not immune to the developmental education criticisms cited in the previous section. During the 2005-2006 academic year, more than 78% of Florida community college students took at least one developmental course at a cost of $129.8 million (Hu, Tandberg, Park, Collins, et al., 2014). In the 2009-2010 academic year, approximately 70% of entering community colleges students enrolled in at least one developmental course costing a total of $154 million, $73 million of which was paid by students in the form of tuition and fees (Underhill, 2013). Additionally, in a 2016 report from the Center for American Progress, Florida was listed as having the highest remediation rate with 93% of first-time students enrolled in developmental courses (Jimenez, Sargrad, Morales, & Thompson, 2016). Although students in Florida were enrolling in developmental courses in large numbers, only about half of those who enrolled successfully completed their developmental sequence (Underhill, 2013).

Postsecondary education readiness test. Florida has tried several approaches in an attempt to address developmental education issues. After Florida's ACCUPLACER contract expired in 2008, rather than have the company rebid, the Florida Department of Education's Division of Florida Colleges seized the opportunity to instead develop a shared definition of college readiness and create a common placement test (Smith & Holcombe, 2010). Thus in 2010, Florida rolled out its new Postsecondary Education Readiness Test (PERT) which was to be used by all Florida colleges when making placement determinations (Smith & Holcombe, 2010). The cutoff scores for the test were identified based on selection of Freshman Composition Skills I (ENC 1101) and Intermediate Algebra (MAT 1033) as the first transferrable writing and mathematics credit benchmarks (Smith & Holcombe, 2010). After selecting ENC 1101 and MAT 1033 as the benchmarks, faculty were asked to identify what skills students would need prior to entry into the courses. The PERT was then built to assess whether students had the skills necessary to be successful in ENC 1101 and MAT 1033 as defined by college faculty members (Smith & Holcombe, 2010). Students who needed to develop additional skills prior to enrolling in these courses would be assigned to developmental courses in reading, writing, or mathematics (Smith & Holcombe, 2010). For mathematics placements, the PERT was also built to assess whether students had skills which surpassed the material covered in MAT 1033 (Smith & Holcombe, 2010). Those students who had higher level mathematics skills could also use the PERT for placement into the next highest mathematics course level (Smith & Holcombe, 2010). Course sequencing and placement score cutoffs are listed in Figure 1.

Figure 1

PERT Mathematics Placement Scores and Course Flowchart



Note: PERT scores range from 50-150; Developmental courses are denoted with a "*" and general education courses are denoted with a "`".

After developing a common definition for college readiness which could be measured by the PERT, the Florida legislature took additional steps to address developmental education enrollment issues (Underhill, 2013). Thus, in an effort to combat the high numbers of students needing developmental education, and to improve the alignment between high school and college expectations, in 2011 Florida began requiring mandatory PERT testing during students' 11^{th} grade year (Woods, Park, Hu, & Jones, 2018). Students who tested below college ready were required to enroll into college readiness classes during their 12^{th} grade year (Underhill, 2013). Unfortunately, this mandated testing requirement was short lived and subsequently removed in 2015 (Woods et al., 2018).

Florida Senate Bill 1720 (2013)

Although Senate Bill 1720 (2013) has been previously described, in this section the researcher provides a discussion of how this legislation relates to the variables and student demographics which will be included in this study. In a move which could potentially address many of the issues related to developmental education, the Florida legislature passed Senate Bill 1720 in 2013 and essentially eliminated placement requirements for most students by making placement testing and developmental education courses optional. Effective Fall 2014, under Senate Bill 1720 (2013) any Florida public high school student who entered 9th grade in 2003 or later and graduated with a standard high school diploma, and any student who is active duty military, would be designated as an "exempt" student. Exempt students would not be required to complete placement testing or to enroll into developmental courses (Alexander, 2013).

In addition to the exemption component of Senate Bill 1720 (2013), the law also contained other requirements including: submission of annual accountability reports, development of meta-majors, use of multiple measures to determine course placements, mandatory advisement of developmental education options, creation of developmental courses of at least two modalities (modularized, compressed, contextualized, or co-requisite), and identification of gateway courses. As defined in Senate Bill 1720 (2013), meta-majors are "a collection of programs of study or academic discipline groupings which share common foundational skills" (p. 28). Meta-majors are used to develop academic pathways so students can take courses which would be applicable to multiple related majors as they determine the specific major they wished to pursue. Meta-majors were determined by the Florida State Board of Education and include the following eight categories: arts, humanities, communication, and design; business; education; health sciences; industry/manufacturing and construction; public safety; science, technology, engineering, and mathematics (STEM); and social and behavioral sciences and human services (Alexander, 2013).

Developmental course modalities. In addition to changing who will be required to take developmental courses, the passage of Senate Bill (1720) also impacted which types of developmental courses would be offered (Hu, Jones, Bower, Nix, et al., 2016). Instead of offering full semester traditional modality developmental courses, Florida colleges were now required to offer developmental course options in at least two of the following modalities: modularized, compressed, contextualized, or co-requisite. Each modality is defined in Senate Bill 1720 (2013) as follows:

- Modularized instruction that is customized and targeted to address specific skill deficiencies
- Compressed courses that accelerate student progression from developmental instruction to college-level coursework
- Contextualized developmental instruction that is related to meta-majors
- Co-requisite developmental instruction or tutoring that supplements credit instruction while a student is concurrently enrolled in a credit-bearing course

Although colleges can choose from any of the modalities, the compressed and modularized formats are most common because they were easier and faster to implement (Hu, Woods, et al., 2015; Waschull, 2018). According to Hu, Woods, et al. (2015), modularized courses are typically taught via computerized methods and usually accomplished through software purchases. Modularized courses often mimic “flipped courses” in which students learn most of the material from home or online and use class time to work on homework assignments (Hu, Woods, et al., 2015, p. 24).

Compressed courses were developed by removing the least important topics from the traditional format to shorten the courses to allow completion in half the time (Hu, Woods, et al., 2015). Compressed courses were also popular because they shortened the amount of time a student would need to be in a developmental course and allowed for students who were required to complete multiple developmental levels to still do so in a single semester (Hu, Woods, et al., 2015). It is important to note, as implemented in Florida, compressed courses are most aligned with the accelerated modality described in a previous section, however for the sake of simplicity, these courses will be referred to as compressed for the remainder of this study. The compressed course of interest in this study is Developmental Mathematics II (MAT 0028). This course is the highest developmental mathematics course and serves as the prerequisite to Intermediate Algebra (MAT 1033).

Gateway courses. In addition to choosing between developmental course options, exempt students can also elect to enter directly into a gateway course. In Senate Bill 1720 (2013) gateway courses are defined as “the first course that provides transferrable, college-level credit allowing a student to progress in his or her program of study”. Gateway courses were identified by the Florida State Board of Education and are listed in Table 1. Freshman Composition Skills I (ENC 1101) serves as the only gateway course for reading and writing and requires placement above the cutoff in both areas prior to enrolling (Pain, 2016). Conversely, students have several gateway mathematics course options to choose from which are typically dictated by their meta-major. College Algebra (MAC 1105) is the gateway mathematics course for business and STEM meta-majors, while Mathematics for Liberal Arts I and II (MGF 1106 and MGF 1107) are best suited for most arts, humanities, communications, and design; education; public safety; and social and behavioral science and human services majors (Alexander, 2013).

Although College Algebra (MAC 1105) and Statistical Methods I (STA 2023) were identified as gateway courses by the Florida State Board of Education, exempt students are not allowed to enroll directly into these courses. Instead, students must complete Intermediate Algebra (MAT 1033) prior to enrolling in MAC 1105 or STA 2023. MAT 1033 is considered a college-level elective rather than a college-level mathematics course so while it does yield transferrable credit, it will not fulfill a student's mathematics requirement. Although MAT 1033 is also considered a pre-requisite for Mathematics for Liberal Arts I and II (MGF 1106 and MGF 1107), exempt students can enroll directly into these gateway courses without first completing MAT 1033. Because MGF 1106 and 1107 are both considered college-level courses into which exempt students can immediately enroll, they will serve as the gateway courses for this study.

Table 1

Listing of Gateway Courses

Number	Title	Prerequisite	Content
ENC 1101	Freshman Communication Skills I	ENC 0022 and REA 0019 or suitable placement score	Process of writing, grammar mechanics, description, narration, exposition, theses, outlines, transitions, paragraphs, conclusions
MAC 1105	College Algebra	MAT 1033 or suitable placement score	Functions, graphing, operations, absolute value, exponents and logarithmic properties, equations, inequalities, curve fitting, modeling
MAT 1033[a]	Intermediate Algebra	MAT 0024/0028 or suitable placement score	Factoring, algebraic fractions, radical, exponents, complex numbers, quadratic equations, inequalities, graphs, functions
MGF 1106	Mathematics for Liberal Arts I	MAT 1033 or suitable placement score	Systematic counting, probability, statistics, history of mathematics, geometry, sets, logic
MGF 1107	Mathematics for Liberal Arts II	MAT 1033 or suitable placement score	Financial mathematics, linear and exponential growth, numbers and number systems, history of mathematics, elementary number theory, voting techniques, graph theory
STA 2023	Statistical Methods I	MAT 1033 or suitable placement score	Probability, random variables, hypothesis testing, confidence interval estimate, small sample methods, correlation, simple linear regression, nonparametric statistics

Note. [a] MAT 1033 was not identified as a gateway course by the Florida State Board of Education. Nevertheless, exempt students can enroll directly into MAT 1033, MGF 1106, and MGF 1107, but must complete MAT 1033 before entering MAC 1105 and STA 2023.

Florida developmental education student demographics. In 2001, 42.9% graduating Black high school students and 56.3% of Hispanic high school students graduated with college ready math scores (Florida Department of Education, 2017). Although the college ready math percentages increased for these groups over the years, Black-White and Hispanic-White achievement gaps still exists with 69.4% of Black high school graduates and 76.8% of Hispanic high school graduates scoring college ready compared to 85.2% of White high school graduates (Florida Department of Education, 2017). Black community college students in Florida were also twice as likely to be assigned to developmental classes in the 2011-2012 academic year (Pain, 2016). Low-income students constituted a majority of developmental course enrollment as well with 65% of students receiving Pell grant in 2011 (Pain, 2016).

Although Black student enrollment in developmental courses significantly decreased after the passage of Senate Bill 1720 (2013), Black students were still inversely and disproportionately enrolled in developmental courses when compared to White students (Hu, Park, Woods, Richard, et al., 2016). Conversely, Hispanic students were equally placed across preparedness levels (Hu, Park, Woods, Richard, et al., 2016). Hu, Park, Woods, Richard, et al. (2016) found that low-income, Black, and Hispanic students were less likely to complete MAT 1033. Low-income students also had lower passing rates in all developmental courses after Senate Bill 1720 (2013) was implemented (Hu, Park, Woods, Richard, et al., 2016). College administrators perceived low-income students will be less likely to enroll into developmental courses without financial aid to cover the costs and expressed concerns that the new technology requirements related to modality changes might create a barrier for those students who do not have a home computer or cannot afford high-speed internet access (Hu, Richard, et al., 2016). Because low-income, Black, and Hispanic students have been more likely to place into developmental courses, the impact of Senate Bill 1720 (2013) on these student populations should be examined. Additionally, given these populations are more likely to enroll on a part-time basis, it was important to include enrollment status as a factor in the present study as well.

Potential outcomes. Exempt students can opt out of developmental coursework and have the benefit of avoiding the financial, opportunity, and psychological costs typically associated with developmental education. Exempt students also gain the added benefit of avoiding under placement since they can self-assign into gateway courses. Alternatively, this freedom to choose creates the potential for students to over-place themselves when they elect to take gateway courses for which they are not prepared. In addition to the potential student benefits mentioned above, Senate Bill 1720 (2013) could also lead to positive institutional outcomes as well in the form of: reduced costs from offering less developmental courses, increased student outcomes if students successfully progress through degree requirements more quickly, and higher funding on student outcome performance funding measures. Unfortunately, although Florida has received much attention for moving forward with this legislation, there is limited information available indicating whether Senate Bill 1720 (2013) has been successful (Pain, 2016).

Research from the Center for Postsecondary Success. In 2016, the Florida State University Center for Postsecondary Success (CPS) received a $3.2 million Institute of Education Science grant to use a mixed methods approach to assess the effects of Senate Bill 1720 (2013) on students, faculty, staff, and institutions (Institute of Education Sciences, 2016). To date, Principal Investigator Shouping Hu and his team have published over a two dozen articles detailing their findings. These researchers have conducted site visits, document reviews, focus groups, interviews, surveys, and quantitative analysis of student data. Participants have included students, faculty, administrators, academic advisors, and other college personnel.

Surveys were administered to college administrators on four separate occasions to assess how colleges intended to implement Senate Bill 1720 (2013) and how well implementation goals aligned with actual results (Hu, Moker, Harris, Park, & Jones, 2017). The researchers found that although administrators were skeptical about whether the new legislation changes would help improve student success, they still saw value in putting advising at the forefront and using multiple measures to determine student placement recommendations (Hu, Park, Tandberg, et al., 2014). Administrators were also more likely to prefer the modularized and compressed course modalities, and experienced advising challenges such as longer session times, and more advising appointment requests (Hu, Woods, et al., 2015). Focus group analyses yielded information about the added complexity required in advising, increased funding and offerings of support services, unexpected challenges related to financial aid and veteran benefits, and differences in how various student populations were impacted by the legislative changes (Hu, Jones, Bower, Nix, et al., 2016; Hu, Jones, Bower, Park, et al. 2015; Hu, Moker, Harris, et al., 2017).

In a quantitative analysis comparing student cohorts from 2009-2010 and 2014-2015, Hu, Park, Woods, Richard, et al. (2016) found students in the later cohort were less likely to take developmental courses and more likely to either enroll in gateway courses or avoid taking reading, writing, and mathematics courses altogether. Although more students were enrolling into gateway courses, students were also less likely to pass gateway courses (Hu, Park, Woods, Richard, et al., 2016). Furthermore, although there was a larger proportion of first-time students passing gateway courses, this seemed to be more a function of the increased overall enrollment in these courses rather than an indication that students were doing better (Hu, Park, Woods, Richard, et al., 2016). Hu, Richard, et al., (2016) found similar results when analyzing data from students who enrolled between 2011 and 2014 and discovered pass rates in developmental courses had also improved. In a study focused only on student performance in MAT 1033, Park et al., (2017) found students were equally likely to enroll in MAT 1033, take a developmental mathematics course, or take no mathematics course during their first term. Students who took MAT 1033 as a co-requisite course were more likely to pass than students who took only MAT 1033 (Park et al., 2017). In a quantitative study conducted by Woods et al., (2018), the researchers found students in gateway courses were more likely to pass MAT 1033 if they completed higher level mathematics courses during high school. Additionally, while students who had higher levels of high school preparation were more likely to pass, the pass rates were still low with only 47.6% of students passing MAT 1033 (Woods et al., 2018).

Summary

Developmental education has been a component in postsecondary education since the 1600s when Harvard started offering tutoring to students who needed to learn Latin and Greek. As student demographics shifted and access to higher education became more open, the need for developmental education was heightened. Institutions responded to this need by progressing from offering tutoring, to creating preparatory departments, to eventually viewing developmental education as a part of the larger college curriculum. Unfortunately, as the number of students who needed remediation increased, the cost of developmental education grew as well and developmental education received significant criticism related to high student, institutional, and taxpayer costs.

Along with financial concerns, the mixed student achievement results associated with developmental education also drew attention. Some researchers found developmental education could positively impact students by increasing student persistence (Bettinger & Long, 2009; Bahr, 2008). Other researchers found developmental students were negatively impacted by being less likely to transfer or complete a degree (Calcagno & Long, 2008; Boatman & Long, 2017). And some researchers found no evidence that developmental education had any effect on students (Martorell & McFarlin, 2011).

Although many explanations have been offered as to why developmental education has yielded mixed student achievement results, placement testing, and curricular issues have frequently been cited as major factors contributing to the issues in developmental education. Jaggars and Hodara (2013) highlighted under placement and over placement as major concerns related to placement testing and advocate for the use of multiple measures for a more accurate determination of student course placement. Additionally, Jaggars, Hodara, Cho, and Xu (2015) found course modality makes a difference with students in compressed mathematics courses being more likely to successfully complete college-level courses than students enrolled in traditional format developmental mathematics courses.

In order to combat the developmental education issues mentioned above, the Florida legislature passed Senate Bill 1720 in 2013 which changed who was required to take developmental courses and what type of developmental course would be offered. Because this radical move could potentially lead to cost savings and improved student outcomes, it is important to investigate how students have responded to this legislation. Using funding from a national grant, Hu and his team of researchers at the Center for Postsecondary Success have published over two dozen articles detailing the mixed method approaches they used to investigate the impact of Senate Bill 1720. In quantitative comparison between student cohorts, Hu, Park, Woods, Richard, et al. (2016) found that later student cohorts were more likely to proceed directly into gateway courses and less likely to pass these courses. Additionally, although the overall passage rate in gateway courses had improved, this finding seemed to be more the result of a significant increase in enrollment numbers, rather than an indication that students were more academically prepared (Hu, Richard, et al., 2016).

Gaps in the literature. Although Hu and his team have taken a broad approach in investigating the impact of Senate Bill 1720 (2013), there are still important areas which require attention. While many of the CPS studies included measures of students' performance in reading, writing, and mathematics, mathematics performance was often limited to information about MAT 1033. Additionally, although MAT 1033 has the highest enrollment of the available gateway course options, it is still just one of three courses which students might choose to take. MGF 1106 and MGF 1107 are mathematics course options most likely to be taken by students whose meta-majors do not require higher level mathematics. As such, a singular focus on MAT 1033 may limit the extent to which the results of these studies can be applied to students who do not intend to major in business or STEM fields. Additionally, while demographics information has been included in several CPS studies, only limited attention has been given to what relationship may exist between Senate Bill 1720 and the academic performance of various student populations such as minorities and low-income students. These studies also do not include enrollment status (full-time or part-time) as a potential indicator of academic performance.

Considering these observations, this study is designed to fill a gap in the current literature by intentionally focusing on the academic performance of Black and Hispanic community college students in Florida. The addition of socioeconomic status and enrollment status as variables will also add to the literature in these areas. Furthermore, because nearly twice as many students in Florida placed into developmental mathematics courses as compared to developmental reading or writing courses, a continued focus on mathematics achievement is necessary (Hu, Park, Woods, Tandberg, Richard, & Hankerson, 2016). The shift in focus to other gateway mathematics courses (MGF 1106 and MGF 1107) will allow for a fuller view of the relationship between Senate Bill 1720 (2013) and students' mathematics achievement.

In the next chapter the researcher will provide a restatement of the purpose and research questions. Chapter III will also include a description of the research design, research setting, participants, and data collection procedures.

CHAPTER III

METHODOLOGY

In this chapter the researcher will provide a detailed description of the research design and methods used in this study. After restating the purpose and research questions, the researcher will describe the research design, setting, participants, and data collection procedures. The researcher will conclude the chapter with information about data analysis procedures that will lead into the results described in Chapter IV.

Purpose Statement

The purpose of this study was to examine the relationship between developmental education course enrollment options and the mathematics achievement of students at one community college in Florida after the implementation of Senate Bill 1720 (2013). For this study, mathematics achievement was operationally defined using two measures: gateway mathematics course success and gateway mathematics course grade. Gateway mathematics course success was defined as a student receiving a passing grade (A, B, or C) in an introductory college-level course (MGF 1106 or MGF 1107). Gateway mathematics courses grades included each type of the following course grades: A, B, C, D, F/WF, or W. Other variables included in this study were: socioeconomic status (determined by whether or not a student received a Pell grant), race/ethnicity (White or non-White), part-time (defined as less than 12 credit hours) or full-time (defined as 12 or more credit hours) enrollment status, and developmental course enrollment (defined as whether a student took MAT 0028 or opted out).

Research Questions and Hypotheses

Therefore, three research questions were used to guide this study. Corresponding hypotheses were also developed for each question based on the extant literature:

1. To what extent is the developmental course (MAT 0028) enrollment of students at a community college in Florida predictive of mathematics achievement (course success and course grade), after the implementation of Senate Bill 1720?
    a. Due to the mixed results presented in the literature (Ari et al., 2016; Bailey et al., 2013; Bettinger & Long, 2009; Calcogno & Long, 2008), there was not enough evidence or support to make a hypothesis regarding this research question.
2. To what extent are student characteristics (socioeconomic status, race/ethnicity, and enrollment status) predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida, after the implementation of Senate Bill 1720?
    a. *Hypothesis 2* – Student characteristics (socioeconomic status, race/ethnicity, and enrollment status) will be predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida after the implementation of Senate Bill 1720.
3. To what extent does race/ethnicity moderate the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement (course success and course grade) of students at a community college in Florida, after the implementation of Senate Bill 1720?
    a. *Hypothesis 3* – Race/ethnicity moderates the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement of students at a community college in Florida after the implementation of Senate Bill 1720.

Research Design

The researcher used a quantitative, nonexperimental correlational design to examine the difference in mathematics achievement for community college students in Florida after the implementation of Senate Bill 1720 (2013) (Leedy & Ormrod, 2016). In correlational designs, researchers investigate “the extent to which differences in one characteristic or variable are associated with differences in one or more other characteristics or variables” (Leedy & Ormrod, 2016, p. 137). A correlational design is commonly used in the social sciences; however, because this design does not include direct manipulation of independent variables, it cannot be used to make conclusions about cause and effect (Leedy & Ormrod, 2015; Sprinthall, 2012).

It would be both impractical and unethical to randomly assign students to developmental or credit-bearing mathematics courses given the potential financial, psychological, and time-related consequences which could arise (Barry & Dannenberg, 2016; Crisp & Delgado, 2014; Martin, Goldwasser, & Harris, 2017). Additionally, because Senate Bill 1720 (2013) was implemented in 2014, it was not possible to conduct an experiment to investigate differences in the mathematics achievements of students who had already completed mathematics courses (Leedy & Ormrod, 2016). As such, the researcher used a correlational design employing archival data as an alternative method for investigating potential differences. Table 2 summarizes the study design and methods.

Table 2

Type and Coding of Variables

Research Question	Dependent Variables	Independent Variables	Moderating Variable	Analysis
RQ1	Course Success	Developmental Course Enrollment		Binary logistic regression
	Course Grade	Developmental Course Enrollment		Multinomial logistic regression
RQ2	Developmental Course Enrollment	Socioeconomic Status (Pell recipient, Pell non-recipient), Race/Ethnicity (non-White, White), Enrollment Status (full-time, part-time)		Binary logistic regression
RQ3	Course Success	Socioeconomic Status (Pell recipient, Pell non-recipient), Enrollment Status (full-time, part-time)	Race/Ethnicity (non-White, White)	Binary logistic regression
	Course Grade	Socioeconomic Status (Pell recipient, Pell non-recipient), Enrollment Status (full-time, part-time)	Race/Ethnicity (non-White, White)	Multinomial logistic regression

Dependent variables. The dependent variables for this study were mathematics achievement and developmental course enrollment. Mathematics achievement included two measures: gateway mathematics course success and gateway mathematics course grade. Gateway mathematics course success was defined as a student receiving a passing grade (A, B, or C) on their first attempt of MGF 1106 or MGF 1107. This variable was dummy coded as a dichotomous dependent variable such that grades of A, B, or C are coded as 1 and all other grades are coded as 0. For analysis of the gateway mathematics course grade measure of mathematics achievement, final course grades were recoded as the following: A = 4, B = 3, C = 2, D = 1, W = 0, F or WF = -1. Although W grades do not have an impact on a student's GPA, they are still considered final course grades and as such were included in this study. Because W grades do not carry a negative GPA impact, they were recoded with a value of 0 rather than assigned the same value as F grades. Developmental course enrollment was a dichotomous variable determined by whether a student took MAT 0028 (coded as 1) or opted out (coded as 0).

Independent variables. This study included four independent variables: developmental course enrollment, socioeconomic status, race/ethnicity, and enrollment status. Developmental course enrollment was a dichotomous variable determined by whether a student took MAT 0028 (coded as 1) or opted out (coded as 0). Although there are multiple developmental mathematics courses which a student could potentially place into, MAT 0028 was selected as the focus of this study because it is the highest-level developmental mathematics course offered at the research site with a designated Postsecondary Educational Readiness Test (PERT) placement score range of 96-113. The aforementioned score range is also just below the minimum PERT score (114) established by the Florida State Board of Education as the standard score students must earn to be designated as ready for college level coursework (Florida Department of Education, 2018a).

Socioeconomic status was a dichotomous variable with students categorized as receiving a Pell grant (coded as 1) or not receiving a Pell grant (coded as 0). Because students are awarded Pell grants based on income factors, it is often used as an indicator of socioeconomic status (Pain, 2016).

Race/ethnicity was dummy coded as a dichotomous dependent variable created by designating all White students as 0, and non-White students as 1. Although the researcher's original intention was to analyze every race/ethnicity category identified in the sample, upon review of descriptive statistics for the qualified sample, several race/ethnicity categories were too small to be included in the full data analysis and were subsequently excluded from the sample: Unknown (n = 2), Multiracial (n = 15), American Indian (n = 2), and Asian (n = 5). Additionally, students who identified as Black (n = 42) or Hispanic (n = 65), were collapsed into a single race/ethnicity category (non-White) given their similarity of experience as described in the extant literature (Bahr, 2010; Houser, 2015; Kotok, 2017; Crisp & Nora, 2012; Roscoe, 2015).

For this study, enrollment status was a dichotomous variable with students categorized as being enrolled part-time (coded as 0) or full-time (coded as 1). Although there are some parts of the country in which full-time enrollment is defined as at least 15 credit hours, in Florida, full-time enrollment is defined as 12 or more credit hours (Florida Department of Education, n.d.). As such enrollment in less than 12 credits hours will be considered part-time enrollment. Student enrollment status was determined based on their enrollment hours during their first semester.

Research Setting

This study was conducted using archival data from a public community college in West Central Florida. This institution, referred to as West Central Community College of Florida (WCCCF) for the purposes of this study, was founded in 1957 and is one of 28 public community colleges included in the Florida College System (FCS) (Florida Department of Education, 2017). WCCCF has three campuses and offers vocational, certificate, associate, and bachelors level programs (Florida Department of Education, 2017). WCCCF was selected for this study using convenience sampling. During 2015-2016, WCCCF had an annualized, unduplicated headcount of 19,290 students and approximately 7,409 full-time-equivalent (FTE) students (Florida Department of Education, 2017).

Participants

After receiving exempt status from both the Darden College of Education Human Subjects Committee at Old Dominion University and the WCCCF Institutional Review Board, the researcher requested WCCCF de-identified data for students who had been enrolled at WCCCF, had a Postsecondary Educational Readiness Test (PERT) score on file, had not earned prior college-level mathematics credit, and had attempted an introductory college-level math course (MGF 1106 or MGF1107). The following information for each student was also included in the dataset: race/ethnicity, gender, first term enrollment hours, Pell grant award receipt (yes or no), mathematics course grades, mathematics course enrollment history, PERT score, high school name, and high school graduation year. Gender information was used to describe the sample. PERT scores, high school name, and high school graduation year were used to verify that students met the qualifications for Senate Bill 1720 (2013) exemption status and had a mathematics placement of MAT 0028.

Inclusion and exclusion criteria. To be included in the final sample for this study, students had to fit within the following parameters: graduated from a public Florida high school in 2007 or later; had a Postsecondary Educational Readiness Test (PERT) score placement of MAT 0028 (defined by the research site as a PERT score of 96-113); and first enrolled in Fall of 2014, 2015, 2016, or 2017. In order to have been eligible to opt out of developmental math courses under Senate Bill 1720 (2013), students must have entered a public Florida high school in 2003 or later and subsequently graduated from a public Florida high school with a standard high school diploma. Because most students graduate high school after 4 years, limiting data to students who graduated from a public Florida high school in 2007 or later best ensured that students who met the Senate Bill 1720 (2013) requirements were included in the study. Additionally, because a central focus of this study is related to developmental course enrollment options, it was necessary to include only students who had a developmental math course placement (PERT score of 96-113), and thus would have had the option to enroll or not enroll into the MAT 0028 developmental math course. Data were also limited to Fall 2014, 2015, 2016, and 2017 because Fall 2014 was the first term that Senate Bill 1720 (2013) was fully implemented and Fall 2017 was the most recent data available at the time of this study. Additionally, because there may be other factors which differentiate students who choose to start during the Fall semester rather than the Spring semester, only data from students starting in Fall semesters was requested.

Data Collection and Protections

Data for this study was provided by WCCCF as Microsoft Excel and Microsoft Access files. Once received, the files were downloaded onto a password-protected flash drive and locked in a file cabinet when not in use. Since the data did not contain personally identifiable student information and because the institution was only identified using the WCCCF pseudonym, neither students nor the institution faced risk of liability.

Data Analysis

The data for this study was analyzed using SPSS version 28 statistical software. Because this study included binary and polytomous categorical dependent variables, two types of regression were used: binary logistic regression and multinomial logistic regression. Binary categorical variables are often coded using the values of “0” and “1”, however this violates the assumption of normal distribution which is often necessary for other statistical tests (Kleinbaum & Klein, 2010). Because logistical regression is designed to model the probability of an outcome rather than predicting an outcome, it serves as a more appropriate method for data analysis when binary variables are included (Kleinbaum & Klein, 2010). Similarly, multinomial logistic regression is a more appropriate method for data analysis of polytomous categorical variables (Garson, 2016). Because the research questions for this study included different types of variables, the analysis of each research question is separately addressed below.

Research question 1 analysis. Research Question 1 was focused on developmental course enrollment after the implementation of Senate Bill 1720. As such, student data were divided into two categories: students who enrolled in MAT 0028 prior to taking MGF 1106 or MGF 1107 (coded as 1), and students who enrolled directly into MGF 1106 and MGF 1107 (coded as 0). Binary logistic regression analysis was performed for each group to separately analyze course success. Because course grade was a polytomous variable, multinomial logistic regression was used to analyze this variable for each category.

Research question 2 analysis. Research Question 2 was focused on student characteristics and developmental course enrollment. Because the student characteristics included in this study (socioeconomic status, race/ethnicity, and enrollment status) were all binary categorical variables, binary logistic regression was conducted to examine whether these variables were predictive of a student's decision to take MAT 0028.

Research question 3 analysis. Socioeconomic status, race/ethnicity, and enrollment status were included as variables in the models for Research Question 3. Additional variables were also created for analysis of the interaction effect of race/ethnicity with socioeconomic status (SES*Race) and enrollment status (Hours_Enrolled*Race). Course success and course grade were separately analyzed and compared. Binary logistic regression was used for analysis of course success. Multinomial regression was used for analysis of course grade.

Overall model fit. The likelihood ratio test and the pseudo-R^2 were used to assess model fit. The likelihood ratio test assesses the deviance (-2 log likelihood statistic) for the null model and the fitted model (Garson, 2016). If the likelihood ratio test was significant, at least one of the independent variables in the model had a significant effect on the dependent variable (Garson, 2016). Additionally, although SPSS provides output for multiple pseudo-R^2 statistics, Nagelkerke's pseudo-R^2 was used because it is the most widely reported (Garson, 2016). Unlike the R^2 statistics used in linear regression, the pseudo-R^2 is not a measure of the percent of variance explained (Garson, 2016). Instead, Nagelkerke's pseudo-R^2 values indicate the effect size of the overall measure: weak (0.0-0.3), moderate (0.3-0.6), or high (0.6 or higher) (Garson, 2016).

Contribution of predictor variables. The Wald statistic was used to test the significance of each predictor variable. A significant result for the Wald test is an indication that the independent variable significantly contributed to the prediction of the outcome variable in the model (Laerd Statistics, 2017). The odds ratio, reported as "Exp(B)" in SPSS, is a measure of variable effect size and indicates the change in odds for each one unit increase in the independent variable (Garson, 2016). However, the odds ratio was not interpreted for independent variables which had parameter estimates that were not statistically significant.

Predicted probability statistics. Predicted probability values were saved as a part of the SPSS output and were described for independent variables which had parameter estimates that were not statistically significant. While these values were useful in providing added description about the independent variables in this study, they should not be used to draw any generalizable conclusions regarding the effects of the independent variables.

CHAPTER IV

RESULTS

In this chapter the researcher will report the results of the statistical analysis. This chapter will be divided into four sections. In the first section the researcher will describe the sample characteristics. In the second section the researcher will present the results of the descriptive statistics and logistic regression analyses for predicting mathematics achievement by developmental course enrollment. In the third section the researcher will present the results of the descriptive statistics and logistic regression analyses for predicting developmental course enrollment by student characteristics. In the final section the researcher will present the results of the descriptive statistics and logistic regression analyses for predicting mathematics achievement by student characteristics (socioeconomic status and enrollment status) when moderated by race/ethnicity.

Sample Characteristics

The initial dataset for this study was comprised of 8,283 students. However, after applying the inclusion criteria identified in Chapter III, the final sample analyzed for this study included 317 students. In the sample there were more females (n = 184, 58.0%) than males (n = 133, 42.0%). More participants identified as White (n = 210, 66.2%) as compared to non-White (n = 107, 33.8%). There were more students who were Pell recipients (n = 166, 52.4%) than Pell non-recipients (n = 151, 47.6%). More students were enrolled full-time (n = 212, 66.9%) than part-time (n = 105, 33.1%). There were more students who did not take the developmental course (n = 263, 83.0%) than those who did (n = 54, 17.0%) and more students were successful in their introductory college-level math course (n = 200, 63.1%) than unsuccessful (n = 117, 36.9%). Table 3 lists the final grade frequency distribution in the introductory college-level math course.

Table 3

Final Course Grade Frequency Distribution

Grade	Frequency	Percent
A	19	6.0
B	81	25.6
C	100	31.5
D	33	10.4
W	32	10.1
F/WF	52	16.4
Total	317	100.0

Mathematics Achievement by Developmental Course Enrollment

The first research question was to what extent was the developmental course (MAT 0028) enrollment of students at a community college in Florida predictive of mathematics achievement (course success, and course grade), after the implementation of Senate Bill 1720? Due to the mixed results presented in the literature (Ari et al., 2016; Bailey et al., 2013; Bettinger & Long, 2009; Calcogno & Long, 2008), there was not enough evidence or support to make a hypothesis regarding this research question.

Binary logistic regression analysis predicting course success by developmental course enrollment. The binary logistic regression model was not statistically different from the null model ($X^2(1) = 2.411$, $p = .121$). As indicated in Table 4, enrollment in MAT 0028 was not a significant predictor of introductory college-level math course success ($p = .129$). Additionally, the Nagelkerke pseudo-R^2 for this model was 0.010 and indicates a weak effect size for the overall model. Although there was not a statistically significant difference in the course success of students based on developmental course enrollment, predicted probability statistics indicated that students who took MAT 0028 were more likely (72.2%) than students who did not take MAT 0028 (61.2%), to successfully complete their introductory college-level math course.

Table 4

Results from Binary Logistic Regression on Course Success by Developmental Course Enrollment

Variable	B	Std. Error	Wald	Sig.	Exp(B)	95% Confidence Interval	
						Lower Bound	Upper Bound
MAT 0028 enrollment [a]	-.499	.329	2.299	.129	.607	.318	1.157

Note. [a] The reference category is: No MAT 0028 enrollment.

Multinomial logistic regression analysis predicting course grade by developmental course enrollment. The multinomial logistic regression model was not statistically different from the null model ($X^2(5) = 3.456$, $p = .630$). As indicated in Table 5, enrollment in MAT 0028 was also not a significant predictor of any introductory college-level math course final grade. Additionally, the Nagelkerke pseudo-R^2 for this model was 0.011 and indicates a weak effect size for the overall model.

Although there was not a statistically significant difference in the course grade of students based on developmental course enrollment, predicted probability statistics indicated that students who took MAT 0028 were less likely to earn a grade of F/WF (11.1%), W (7.4%), and D (9.3%), than were student who did not take MAT 0028 (17.5%, 10.6%, and 10.6%, respectively). Students who took MAT 0028 were also slightly less likely to earn a grade of C (31.5%) than students who did not take the course (31.6%). Additionally, students who took MAT 0028 were more likely to earn a grade of A (7.4%) and B (33.3%) than students who did not take MAT 0028 (5.7% and 24.0%, respectively).

Table 5

Results from Multinomial Logistic Regression on Course Grade by Developmental Course Enrollment

							95% Confidence Interval	
Grade [a]		B	Std. Error	Wald	Sig.	Exp(B)	Lower Bound	Upper Bound
A	[1st_Course=0]	-.264	.623	.180	.672	.768	.227	2.602
	[1st_Course=1]	0[b]						
B	[1st_Course=0]	-.333	.377	.779	.378	.717	.342	1.502
	[1st_Course=1]	0[b]						
D	[1st_Course=0]	.137	.554	.061	.804	1.147	.387	3.395
	[1st_Course=1]	0[b]						
W	[1st_Course=0]	.360	.597	.364	.546	1.434	.445	4.621
	[1st_Course=1]	0[b]						
F/WF	[1st_Course=0]	.451	.509	.785	.376	1.570	.579	4.260
	[1st_Course=1]	0[b]						

Note. [a] The reference category is: C. [b] This parameter is set to zero because it is redundant.

Developmental Course Enrollment by Student Characteristics

The second research question was to what extent were student characteristics (socioeconomic status, race/ethnicity, and enrollment status) predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida, after the implementation of Senate Bill 1720? The researcher hypothesized that student characteristics (socioeconomic status, race/ethnicity, and enrollment status) would be predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida after the implementation of Senate Bill 1720.

Binary logistic regression analysis predicting developmental course enrollment by socioeconomic status. The binary logistic regression model was not statistically different from the null model ($X^2(1) = .960$, $p = .327$). As indicated in Table 6, socioeconomic status was not a statistically significant predictor of developmental course enrollment ($p = .328$). Additionally, the Nagelkerke pseudo-R^2 for this model was 0.005 and indicates a weak effect size for the overall model. Although there was not a statistically significant difference in developmental course enrollment based on socioeconomic status, predicted probability statistics indicated that students who received a Pell grant (15.1%) were less likely to enroll in a developmental math class than students who did not receive a Pell grant (19.2%).

Table 6

Results from Binary Logistic Regression on Developmental Course Enrollment by Socioeconomic Status

						95% Confidence Interval	
Variable	B	Std. Error	Wald	Sig.	Exp(B)	Lower Bound	Upper Bound
Socioeconomic Status [a]	-.293	.300	.957	.328	.746	.415	1.342

Note. [a] The reference category is: Pell non-recipient.

Binary logistic regression analysis predicting developmental course enrollment by race/ethnicity. The binary logistic regression model was not statistically different from the null model ($X^2(1) = .504$, $p = .478$). As indicated in Table 7, race/ethnicity was not a statistically significant predictor of developmental course enrollment ($p = .482$). Additionally, the Nagelkerke pseudo-R^2 for this model was 0.003 and indicates a weak effect size for the overall model. Although there was not a statistically significant difference in developmental course enrollment based on race/ethnicity, predicted probability statistics indicated that non-White students (15.0%) were less likely to enroll in a developmental math class than White students (19.0%).

Table 7

Results from Binary Logistic Regression on Developmental Course Enrollment by Race/Ethnicity

Variable	B	Std. Error	Wald	Sig.	Exp(B)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Race/Ethnicity [a]	-.228	.325	.494	.482	.796	.421	1.505

Note. [a] The reference category is: White.

Binary logistic regression analysis predicting developmental course enrollment by enrollment status. The binary logistic regression model was not statistically different from the null model ($X^2(1) = .124$, $p = .725$). As indicated in Table 8, enrollment status was not a statistically significant predictor of developmental course enrollment ($p = .724$). Additionally, the Nagelkerke pseudo-R^2 for this model was 0.001 and indicates a weak effect size for the overall model. Although there was not a statistically significant difference in developmental course enrollment based on enrollment status, predicted probability statistics indicated that full-time students (16.5%) were less likely to enroll in the developmental course than part-time students (19.0%).

Table 8

Results from Binary Logistic Regression on Developmental Course Enrollment by Enrollment Status

Variable	B	Std. Error	Wald	Sig.	Exp(B)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Enrollment Status [a]	-.111	.314	.125	.724	1.117	.895	1.656

Note. [a] The reference category is: Part-time.

Mathematics Achievement by Moderated Student Characteristics

The third research question was to what extent did race/ethnicity moderate the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement (course success and course grade) of students at a community college in Florida, after the implementation of Senate Bill 1720? The researcher hypothesized that race/ethnicity moderated the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement of students at a community college in Florida.

Binary logistic regression analysis predicting course success by socioeconomic status moderated by race/ethnicity. As indicated in Table 9, socioeconomic status moderated by race/ethnicity was not a statistically significant predictor of developmental course enrollment ($p = .189$). Although there was not a statistically significant difference in introductory college-level math course success based on socioeconomic status moderated by race, predicted probability statistics indicated that non-White students who did not receive a Pell grant (41.4%) were least likely to successfully complete their introductory college-level math class as compared to non-White students who received a Pell grant (61.5%), White students who did not receive a Pell grant (65.6%), and White students who received a Pell grant (68.2%). The Wald test result for race/ethnicity did reach statistical significance ($p = .019$), suggesting that being a non-White student, rather than a White student, reduces the odds of success in an introductory college-level math course by a factor of .371, however the effect size is very small. Additionally, in cases where the Wald test results contradict the likelihood ratio test, it is generally recommended to adhere to the likelihood ratio results since they are more reliable for small samples (Garson, 2016).

Table 9

Results from Binary Logistic Regression on Course Success by Socioeconomic Status (SES) Moderated by Race/Ethnicity

Variable	B	Std. Error	Wald	Sig.	Exp(B)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
SES*Race	.701	.534	1.722	.189	2.015	.708	5.737
Race/Ethnicity	-.993	.422	5.521	.019	.371	.162	.848
Socioeconomic Status	.118	.298	.156	.692	1.125	.628	2.017

Binary logistic regression analysis predicting course success by enrollment status moderated by race/ethnicity. As indicated in Table 10, enrollment status moderated by race/ethnicity was not a statistically significant predictor of developmental course enrollment ($p = .465$). Although there was not a statistically significant difference in introductory college-level math course success based on enrollment status moderated by race, predicted probability statistics indicated that non-White students who were enrolled full-time (52.8%) were least likely to successfully complete their introductory college-level math class when compared to non-White students who were enrolled part-time (62.9%), White students who were enrolled full-time (66.4%), and White students who were enrolled part-time (67.1%).

Table 10

Results from Binary Logistic Regression on Course Success by Enrollment Status (Hours) Moderated by Race/Ethnicity

Variable	B	Std. Error	Wald	Sig.	Exp(B)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Hours*Race	-.383	.524	.533	.465	.682	.244	1.906
Race/Ethnicity	.189	.433	.190	.663	1.208	.517	2.819
Enrollment Status	.032	.311	.011	.918	1.033	.561	1.900

Multinomial logistic regression analysis predicting course grade by socioeconomic status moderated by race/ethnicity. As indicated in Table 11, socioeconomic status moderated by race/ethnicity was also not a significant predictor of any introductory college-level math course final grade. This result is also supported by the likelihood ratio test ($X^2(5) = 4.081$, $p = .538$) in which the SES*Race variable was not found to be statistically significant predictor. Although there was not a statistically significant difference in introductory college-level math course grade based on socioeconomic status moderated by race, predicted probability statistics indicated that non-White students who did not receive a Pell grant performed the worst at all grade levels as they were least likely to receive A (3.4%), B (13.8%), or C (24.1) grades, but were most likely to receive D (17.2%), W (17.2%), or F (24.1) grades when compared to White students who received Pell, White students who did not receive Pell, and non-White students who received Pell. A full listing of the predicted probability statistics is provided in Table 12.

Table 11

Results from Multinomial Logistic Regression on Course Grade by Socioeconomic Status (SES) Moderated by Race/Ethnicity

							95% Confidence Interval	
Grade [a]		B	Std. Error	Wald	Sig.	Exp(B)	Lower Bound	Upper Bound
A	[SES*Race=.00]	.529	1.358	.152	.697	1.698	.119	24.323
	[SES*Race =1.00]	0[b]						
	[Race/Ethnicity=0]	.228	1.145	.040	.842	1.256	.133	11.854
	[Race/Ethnicity=1]	0[b]						
	[Pell recipient=0]	-.396	.572	.480	.489	.673	.220	2.064
	[Pell recipient=1]	0[b]						
B	[SES*Race =.00]	-.599	.785	.583	.445	.549	.118	2.558
	[SES*Race =1.00]	0[b]						
	[Race/Ethnicity=0]	.422	.669	.398	.528	1.526	.411	5.664
	[Race/Ethnicity=1]	0[b]						
	[Pell recipient=0]	.173	.366	.223	.636	1.189	.580	2.435
	[Pell recipient=1]	0[b]						

D	[SES*Race =.00]	-.154	.906	.029	.865	.857	.145	5.059
	[SES*Race =1.00]	0[b]						
	[Race/Ethnicity=0]	-1.025	.684	2.240	.134	.359	.094	1.373
	[Race/Ethnicity=1]	0[b]						
	[Pell recipient=0]	.431	.599	.517	.472	1.538	.475	4.978
	[Pell recipient=1]	0[b]						
W	[SES*Race =.00]	.957	.888	1.163	.281	2.605	.457	14.844
	[SES*Race =1.00]	0[b]						
	[Race/Ethnicity=0]	-.929	.678	1.879	.170	.395	.15	1.491
	[Race/Ethnicity=1]	0[b]						
	[Pell recipient=0]	-.062	.511	.015	.904	.940	.345	2.559
	[Pell recipient=1]	0[b]						
F/WF	[SES*Race=.00]	.732	.788	.886	.347	2.080	.453	9.558
	[SES*Race =1.00]	0[b]						
	[Race/Ethnicity=0]	-.619	.599	1.068	.302	.538	.166	1.742
	[Race/Ethnicity=1]	0[b]						
	[Pell recipient=0]	.143	.422	.115	.734	1.154	.505	2.638
	[Pell recipient=1]	0[b]						

Note. [a] The reference category is: C. [b] This parameter is set to zero because it is redundant.

Table 12

Predicted Probabilities for Multinomial Logistic Regression on Course Grade by Socioeconomic Status Moderated by Race/Ethnicity

Socioeconomic Status	Race	Grade	Predicted Probability
Pell non-recipient	White	A	5.7%
		B	27.9%
		C	32.0%
		D	8.2%
		W	9.0%
		F	17.2%
	Non-White	A	3.4%
		B	13.8%
		C	24.1%
		D	17.2%
		W	17.2%
		F	24.1%
Pell recipient	White	A	9.1%
		B	25.0%
		C	34.1%
		D	5.7%
		W	10.2%
		F	15.9%

Non-White	A	3.8%
	B	26.9%
	C	30.8%
	D	16.7%
	W	9.0%
	F	12.8%

Multinomial logistic regression analysis predicting course grade by enrollment status moderated by race/ethnicity. As indicated in Table 13, enrollment status moderated by race/ethnicity was also not a significant predictor of any introductory college-level math course final grade. This result is also supported by the likelihood ratio test ($X^2(5) = 2.705$, $p = .745$) in which the Hours*Race variable was not found to be statistically significant predictor. Although there was not a statistically significant difference in introductory college-level math course success based on enrollment status moderated by race, predicted probability statistics indicated that White students who were enrolled full-time performed the best in four of the six grade categories as they were most likely to receive A (8.6%) and B (30.0%) grades, but were least likely to receive D (7.1%) and W (7.1%) grades when compared to non-White students who were enrolled part-time, White students who were enrolled full-time, and non-White students who were enrolled full-time. A full listing of the predicted probability statistics is provided in Table 14.

Table 13

Results from Multinomial Logistic Regression on Course Grade by Enrollment Status (Hours) Moderated by Race/Ethnicity

Grade [a]		B	Std. Error	Wald	Sig.	Exp(B)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
A	[Hours*Race=.00]	.251	1.223	.042	.837	1.286	.117	14.132
	[Hours*Race=1.00]	0[b]						
	[Race/Ethnicity=0]	.405	.904	.201	.654	1.500	.255	8.817
	[Race/Ethnicity=1]	0[b]						
	[Hours=0]	.491	.590	.691	.406	1.633	.514	5.192
	[Hours=1]	0[b]						
B	[Hours*Race=.00]	-.049	.679	.005	.943	.952	.252	3.603
	[Hours*Race=1.00]	0[b]						
	[Race/Ethnicity=0]	.049	.546	.008	.929	1.050	.360	3.059
	[Race/Ethnicity=1]	0[b]						
	[Hours=0]	.385	.383	1.012	.314	1.470	.694	3.113
	[Hours=1]	0[b]						
D	[Hours*Race=.00]	-.154	.876	.031	.860	.857	.154	4.776
	[Hours*Race=1.00]	0[b]						
	[Race/Ethnicity=0]	-.875	.719	1.483	.223	.417	.102	1.705
	[Race/Ethnicity=1]	0[b]						
	[Hours=0]	.203	.609	.111	.739	1.225	.372	4.038
	[Hours=1]	0[b]						
W	[Hours*Race=.00]	.251	.927	.073	.786	1.286	.209	7.914
	[Hours*Race=1.00]	0[b]						
	[Race/Ethnicity=0]	-.470	.775	.368	.544	.625	.137	2.852
	[Race/Ethnicity=1]	0[b]						
	[Hours=0]	-.203	.581	.122	.727	.817	.262	2.548
	[Hours=1]	0[b]						
F/WF	[Hours*Race=.00]	-1.169	.863	1.832	.176	.311	.057	1.688
	[Hours*Race=1.00]	0[b]						
	[Race/Ethnicity=0]	.773	.749	1.067	.302	2.167	.500	9.395
	[Race/Ethnicity=1]	0[b]						
	[Hours=0]	.370	.439	.710	.399	1.448	.612	3.423
	[Hours=1]	0[b]						

Note. [a] The reference category is: C. [b] This parameter is set to zero because it is redundant.

Table 14

Predicted Probabilities for Multinomial Logistic Regression on Course Grade by Enrollment Status Moderated by Race/Ethnicity

Enrollment Status	Race	Grade	Predicted Probability
Part-time	White	A	8.6%
		B	30.0%
		C	28.6%
		D	7.1%
		W	7.1%
		F	18.6%
	Non-White	A	5.7%
		B	28.6%
		C	28.6%
		D	17.1%
		W	11.4%
		F	8.6%
Full-time	White	A	6.4%
		B	25.0%
		C	35.0%
		D	7.1%
		W	10.7%
		F	15.7%
	Non-White	A	2.8%
		B	20.8%
		C	29.2%
		D	16.7%
		W	11.1%
		F	19.4%

Summary

Due to the mixed results presented in the literature (Ari et al., 2016; Bailey et al., 2013; Bettinger & Long, 2009; Calcogno & Long, 2008), there was not enough evidence or support to make a hypothesis regarding research question one. The results from the binary and multinomial logistic regression analyses indicated that developmental course enrollment was not a statistically significant predictor of course success or introductory college-level math course final grades. However, predicted probability statistics indicated that students who took MAT 0028 were more likely than students who did not take the developmental math course to successfully complete their introductory college-level math course. Similarly, predicted probability statistics also indicated that students who took MAT0028 were more likely to earn grades of A, B, or C, and less likely to earn grades of D, W, or F, than students who did not take the developmental math course.

The hypothesis for research question two was that student characteristics (socioeconomic status, race/ethnicity, and enrollment status) would be predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida after the implementation of Senate Bill 1720. The results from the binary and multinomial logistic regression analyses did not support this hypothesis given socioeconomic status, race/ethnicity, and enrollment status were not found to be statistically significant predictors of developmental course enrollment. However, predicted probability statistics indicated that students who received a Pell grant, were non-White, or were enrolled full-time, were less likely to enroll into a developmental math class than students who did not receive a Pell, were White, or were enrolled part-time.

The hypothesis for research question three was that race/ethnicity would moderate the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement of students at a community college in Florida after the implementation of Senate Bill 1720. This results from the binary and multinomial logistic regression analyses did not support this hypothesis given there was no statistically significant difference found in introductory college-level math course success or introductory college-level math course grade based on socioeconomic status or enrollment status when moderated by race. However, predicted probability statistics indicated that non-White students who did not receive a Pell grant and non-White students who were enrolled full-time were least likely to successfully complete their introductory college-level math class when compared to other students. Similarly, predicted probability statistics also indicated that non-White students who did not receive a Pell grant performed the worst in the introductory college-level math course as they were least likely to receive A, B, or C grades, but were most likely to receive D, W, or F grades. Additionally, predicted probability statistics indicated that non-White students who were enrolled full-time performed the worst in the introductory college-level math course in several grade categories given they were least likely to earn A or B grades and were most likely to earn F grades when compared to other students.

Chapter V will include a discussion of the study findings as it relates to the existing literature, study limitations, and recommendations for future research. Implications for policy and practice will also be discussed.

CHAPTER V

DISCUSSION

This concluding chapter is organized into five major sections. In the first section the researcher briefly reiterates the purpose of the study and the research questions. In the second section the researcher discusses how the findings of this study correspond to the existing literature. In the third section the researcher identifies the study limitations. In the fourth section the researcher addresses implications for policy and practice. In the final section the researcher provides recommendations for future research before providing concluding remarks.

Purpose Statement and Research Questions

Although developmental education has been a key component of most community college in the United States, it has also been greatly criticized due to its high cost and perceived ineffectiveness (Ari, Fisher-Ari, & Paul, 2016). Additionally, while an estimated $7.1 billion dollars is spent on developmental education in institutions each year (Moker, Leeds, & Harris, 2018; Scott-Clayton et al., 2014), several studies on the impact of development education have yielded mixed results (Ari et al., 2016; Bailey et al., 2013). Placement testing procedures have often been cited as a reason for the assumed ineffectiveness of developmental education and some states have implemented reforms to try to address this issue. In 2013, the Florida legislature passed Senate Bill 1720 (2013) and eliminated placement testing requirements for most students by making placement testing and developmental education course enrolment optional. Because over 70% of Florida community college students enrolled in at least one developmental course, and over 60% of that enrollment was in developmental math courses in particular, Senate Bill 1720 (2013) could have significant implications for student enrollment and mathematics achievement patterns in Florida community colleges (Underhill, 2013).

Additionally, because some student populations (Black, Hispanic, and low-income) are disproportionately represented in both community colleges and developmental education courses (Bahr, 2010; Crisp, et al., 2017; Pain, 2016; Sandoval-Lucero, Maes, & Klingsmith, 2014; Strayhorn, 2012), research which sheds light on how these student populations are impacted by Florida's developmental education reform could be particularly insightful.

Given the aforementioned, the purpose of this study was to examine the relationship between developmental education course enrollment and the mathematics achievement of students at one community college in Florida after the implementation of Senate Bill 1720.

This study addressed the following research questions:

1. To what extent is the developmental course (MAT 0028) enrollment of students at a community college in Florida predictive of mathematics achievement (course success and course grade), after the implementation of Senate Bill 1720?
2. To what extent are student characteristics (socioeconomic status, race/ethnicity, and enrollment status) predictive of the developmental course (MAT 0028) enrollment of students at a community college in Florida, after the implementation of Senate Bill 1720?
3. To what extent does race/ethnicity moderate the relationship between student characteristics (socioeconomic status and enrollment status) and the mathematics achievement (course success and course grade) of students at a community college in Florida, after the implementation of Senate Bill 1720?

Findings Related to the Literature

There were no statistically significant findings for the research questions included in this study. However, some observations of interest did arise when reviewing predicted probability statistics results. In this section, study results will be discussed in relation to the existing literature. The findings are organized around the study research questions.

Research question 1 – Mathematics achievement by development course enrollment. Results of the first research question indicated that developmental math course enrollment was not a statistically significant predictor of course success or introductory college-level math course final grades. As such, students who completed the developmental math course were neither positively nor negatively impacted by that enrollment decision. Given the topic which this study was designed to investigate, the lack of a significant finding for research question one could actually be considered a positive result. If students were not detrimentally impacted by their choice to bypass a developmental course, it could be an indication that perhaps having developmental education as a hard requirement, may be unnecessary. These findings are also consistent with prior studies (Boatman & Long, 2018; Calcagno & Long, 2008). Using data from the Tennessee Board of Regents and Tennessee Higher Education Commission, Boatman and Long (2018) found that being placed into a developmental math course did not have a statistically significant effect on a student's subsequent successful college-level math course completion. Similarly, in their study using data from 100,000 students in Florida, Calcagno and Long (2008) found that there was not a statistically significant difference in the likelihood of a student subsequently completing a college-level math course if their math placement was initially just below college-level.

Because there was not a statistically significant finding for research question one, predicted probability statistics were reviewed to provide added description about the effect of developmental math course enrollment in this study. However, it should be noted that the predicted probability observations described here and in this rest of this chapter are not generalizable to other students. As such, their relevance should be limited to students who were enrolled between 2014-2017, and the observations garnered from the predicted probability statistics may not be applicable to students enrolled in later years.

The results for research question one did not show developmental math course enrollment to be a significant predictor of gateway math course success, however, predicted probability statistics indicated that students in this study who took a developmental course were more likely to pass and earn higher grades in their introductory college-level math course when compared to students in this study who did not take a developmental course. As such, while the variance in course success and course grades were not fully explained by our model, there is an indication that students included in this study gained some benefit from developmental math course enrollment. Hu, Richard, and colleagues (2016) had similar observations in their study finding that first-time-in-college students who took a developmental math class at a Florida community college in 2014 (when Senate Bill 1720 was implemented) had higher odds of subsequently passing their gateway math course.

Overall, the findings and observations from research question one, as supported by the literature, are positive for two reasons: (1) students' mathematics achievement was not negatively impacted by their developmental math course enrollment decisions, and (2) in some instances, students in this study may have benefited from taking a developmental course. Nevertheless, these results are counter to the initial perceptions held by college administrators, faculty, and advisors when Senate Bill 1720 (2013) was first announced. The results of surveys, focus groups, and site visits conducted by researchers from the Center for Postsecondary Success revealed concerns from many college personnel that allowing students to opt out of developmental education would result in lowered academic performance as underprepared students chose to bypass developmental courses in large numbers (Brower et al., 2017; Hu et al., 2018; Hu et al., 2019). However, while those predicted shifts in enrollment patterns did occur (developmental math course enrollment declined steadily each year), there were not significant declines in mathematics achievement (Hu et al., 2019). In fact, first-year cohort-based passing rates in gateway math courses increased from 16.7% in 2013 to 22.35% in 2016 (Park-Gaghan, Mokher, X. Hu, Spencer, & S. Hu, 2020).

The increased cohort passing rates are not entirely surprising given prior literature which documents the under placement issues associated with placement testing (Jaggars, et al., 2015; Jaggars & Hodara, 2013; Scott-Clayton et al., 2014). Course under placements occur when students who are otherwise likely to pass college-level courses, earn placement scores which assign them into developmental courses (Jaggars, et al., 2015; Jaggars & Hodara, 2013; Scott-Clayton et al., 2014). Additionally, because enactment of Senate Bill 1720 (2013) also required institutions to redesign developmental course offerings using multiple modalities, and to provide enhanced academic advising, some of the student success observed for this reform may be the result of institutional improvements to course and student support offerings.

Research question 2 - Developmental course enrollment by student characteristics. Results of the second research question indicated that there were no statistically significant differences in developmental course enrollment based on socioeconomic status, race/ethnicity, or enrollment status. This result is not well aligned with the literature, likely due to the uniqueness of Florida's reform which allows students to opt out of developmental course enrollment. It is well documented within the literature that Black, Hispanic, low-income, and part-time enrolled students are most likely to need remediation (Complete College America, 2012; Crisp, et al., 2017; Davis & Palmer, 2010; Nix, Jones, Brower, & Hu, 2020; Strayhorn, 2014). Using data from a 2006 first-time-in-college cohort from 33 states, Complete College America (2012) found that 64.7% of low-income students who enrolled at a community college were placed into developmental courses. This percentage was even higher in Florida which reported that 65.2% of low-income students needed remediation (Complete College America, 2012). Houser and An (2015) found that low-income students were four times more likely to enter school with lower skill levels than middle-income families. Similarly, in their analysis of racial disparities in postsecondary mathematics remediation, Bahr (2010) indicated that as high as 62% of Black students and 63% of Hispanic students were assigned to developmental courses, nearly double that of White students (36%). Additionally, in their study using data from the Beginning Postsecondary Student Longitudinal Study, Crisp and Delgado (2014) also found that minority students were disproportionately enrolled in developmental courses. Lastly, data from the National Center for Education Statistics 2004/09 Beginning Postsecondary Students Longitudinal Study indicated that 42% of first-time-in-colleges who first enrolled in 2004 took at least one developmental course prior to 2009 (Wine & Wheeless, 2011).

Because there was not a statistically significant finding for research question two, predicted probability statistics were also reviewed to provide added description about the effect of student characteristics (socioeconomic status, race/ethnicity, and enrollment status) in this study. Predicted probability statistics for research question two indicated that students who received a Pell grant, were non-White, or were enrolled full-time, were less likely than their peers to enroll into a developmental math class. Although the predicted probability statistics results are not generalizable to all Florida community colleges, or to students who may have enrolled before or after the 2014-2017 timeframe of our study, these results were consistent with the literature related to race/ethnicity (Florida Department of Education, 2020; Park et al., 2018).

Park et al. (2018) found that there was a statistically significant decline in the likelihood of Black and Hispanic students enrolling into a developmental math course following the implementation of Senate Bill 1720 (2013). Although developmental education enrollment declined for all race/ethnicity groups, this decline in enrollment was higher for Black (22.88%) and Hispanic (14.79%) students than it was for White (11.78%) students. Similarly, according to the most recent Florida Department of Education (2020) developmental education accountability report, overall developmental education enrollment in Florida have steadily declined from 35,817 students in 2012-13 to 10,294 students in 2019-20. The researcher was unable to locate any examples in the literature which identified socioeconomic status and enrollment status as factors which may impact optional developmental education course enrollment in Florida.

Although the lack of a significant finding for research question two was not well-supported by the literature, it could still be considered a positive result. While disproportionate numbers of low-income, minority, or part-time enrolled students have historically been required to take developmental courses, when given the choice, similar enrollment patterns were not observed for the students in this study. As such, an optional developmental education policy could be a way to allow low-income, minority, or part-time enrolled students to have greater access to the college-level courses that they have often failed to reach after being initially relegated to developmental education courses.

Research question 3 - Mathematics achievement by moderated student characteristics. Results of the third research question indicated that there were no statistically significant differences in the students' mathematics achievement based on socioeconomic status or enrollment status when moderated by race. Because there were not statistically significant findings for research question three, predicted probability statistics were reviewed to provide added description about the effects of the moderated student characteristics (socioeconomic status and enrollment status) in this study. Predicted probability statistics indicated that non-White students who did not receive a Pell grant were least likely to successfully complete their introductory college-level math course when compared to other students. These students also performed the worst in their introductory college-level math course given they were least likely to receive A, B, or C grades, but most likely to receive D, W, or F grades. Although these observations are not generalizable to populations outside of the study sample or students who may enroll in the future, they were partially supported by the literature. The income achievement gap is well documented by prior studies (Houser & An, 2015; Hu et al., 2018; Owens, 2018; Paschall et al., 2018; Rittle-Johnson, Fyfe, Hofer, & Farran, 2017; Schenke, Nguyen, Watts, Samara, & Clements, 2017). The racial achievement gap is also well documented (Bahr, 2010; Davis & Palmer, 2010; Hauert, Moore, & Nottingham, 2021; Kotok, 2017; Olszewski-Kubilius). Additionally, several researchers found a close relationship between socioeconomic status and race (House & An, 2015; Owens, 2018; Paschall et al., 2018; Rothstein, 2015). In a 2018 study conducted by Paschall et al., the researchers found that even when comparing families with the same income, the achievement gap between Black and White families still exists. Within-race differences also existed such that high-income Black and Hispanic performed higher than their low-income Black and Hispanic students, but lower than low-income White students (Paschall et al., 2018).

Although it is not entirely clear why non-White students who did not receive a Pell grant had lower performance in their college-level math course, one potential explanation may be found when considering that Pell grant receipt was not a perfect proxy for socioeconomic status. In this study, students who did not receive a Pell grant were considered to have a higher socioeconomic status than students who did receive a Pell grant. However, because a number of the students included in this group could have actually been low-income students who failed to complete the Free Application for Federal Student Aid (FAFSA), a requirement for receiving the Pell grant, they may have inadvertently been included in the “high” socioeconomic status group for this study. Another potential explanation for why non-White students who did not receive a Pell grant had lower performance in their college-level math course is that it might be an indication of an unintended consequence of Senate Bill 1720. Perhaps underprepared students who chose to opt out of their developmental course placement did so because of the perceived financial savings that could be gained by not enrolling in a non-credit bearing course. If these students opted out of development education despite being academically underprepared for college-level math, that could explain the lower course success and course grades for that student population.

Additional predicted probability statistics indicated that non-White students who enrolled full-time were also less likely to successfully complete their introductory college-level math course when compared to other students. Moreover, these students performed poorly in several grade categories given they were less likely to earn A or B grades, and most likely to earn F grades, when compared to other students. These observations are not well supported by the literature. Regarding the intersection between race/ethnicity and enrollment status, several studies suggested that Black and Hispanic students who attend college part-time are less likely to persist (Crisp & Nora, 2012; Urias & Wood, 2014). Similarly, Bailey, Jeong, and Cho (2010) found that Black students who attend part-time were less likely to complete their developmental course sequence. Although it was not a statistically significant finding, and it is not generalizable to populations outside of the study sample or students who may enroll in the future, the observation that full-time enrolled non-White students in the study were less successful in their college-level math course could be an indication of an unintended consequence of Senate Bill 1720. Perhaps underprepared students who chose to opt out of their developmental placement, overloaded themselves when they also chose to enroll full-time.

Limitations

This study included several limitations. Because of the nonexperimental design, there was lower internal validity and results could only be discussed in terms of correlation rather than causation. This study also had a limitation regarding external validity. Because the data source was a single institution, there may be unknown factors unique to WCCCF which were not addressed in this study. As such, this study had limited generalizability. Additionally, as was alluded to in the prior section, selection bias may have been a limitation in this study. Because students could elect to opt in or out of taking developmental education courses, there may have been less randomization than might otherwise exist and the observed results could be due to pre-existing differences between those who opted in or out of developmental math courses.

Due to the constraints surrounding data availability and the strict inclusion criteria, the study sample size was smaller than may have been ideal. As such, power was another limitation in this study. The use of grades rather than other measures of academic achievement such as pre- and post- diagnostic exams could also be considered a study limitation. Because grade is a gross measure, it does not allow for the more detailed analysis that would be possible with other metrics.

Additionally, the use of Pell grant receipt as a proxy for socioeconomic status was another limitation. Nationally, only 62% of students completed the FAFSA in 2015, and in Florida, this percentage drop down to 52.5% (Florida College Access Network, 2022). As such, there is a greater likelihood that at least some of the students who were included in the non-Pell grant recipient group in this study were in that group because they failed to complete a FAFSA, and not because they had a higher socioeconomic status.

Furthermore, because the researcher did not follow the students longitudinally, analysis of long-term outcomes was not possible. Lastly, although pre-collegiate factors such as high school mathematics course enrollment and high school GPA were identified in the literature as variables which could impact mathematics achievement (Scott-Clayton et al., 2014; Woods, Park, Hu, & Jones, 2018), because this information was not accessible, the potential impact of these factors was not addressed in this study and may have confounded the results.

Implications for Policy and Practice

Because there were no statistically significant findings in this study, it would be premature to make recommendations for policy or practice based on the results of this study. As such, while the predicted probability statistics which were reviewed in this study did lend themselves to some potential implications for policy and practice, the implications should be viewed more as recommendations for further exploration, rather than strict suggestions of which policies and practices should be implemented in the future.

Predicted probabilities statistics indicated that students in this study who did enroll in developmental education courses were slightly more likely to pass and earn a higher grade in their college-level math course. As such, it may be beneficial for institutions to investigate whether there is evidence to support an argument for a continued offering of developmental courses. As mentioned previously, because the reform efforts necessitated by Senate Bill 1720 (2013) included redesign of developmental course offerings and modalities, institutions should also determine whether reform of their developmental course offerings could support enhanced success. Such redesign effort may include offering compressed and corequisite courses which shorten or eliminate the time students would spend remediating if they opted into developmental course enrollment.

Additionally, although predicted probability statistics indicated that more Black and Hispanic students chose to enroll directly into college-level courses, there could still be some achievement gaps which need to be addressed. In the most recent study by Hu et al. (2021), 6 out of 7 institutions that were included in the study indicated that Black students were performing lower than their non-Black peers and that this group had been less than optimally impacted by the developmental reform efforts. To address this concern, institutions should determine whether there is a need to design targeted supports for this student population. Specific consideration should also be given toward whether there may be a benefit to providing supports for students who are enrolling full-time. Proper instruction on time management and other noncognitive success skills, which would have traditionally been obtained during developmental education courses, could be embedded into other segments of the student experience so that all students can benefit.

Continued and enhanced academic advisement will also be integral to the continued success of students. Advisors can help provide students with recommendations and support so that students are making informed decisions regarding their mathematics course enrollment. Furthermore, the use of multiple measures to help students determine the most appropriate starting point for their math coursework is highly recommended. Florida is currently in the rule development stages of a recently passed legislative change, Senate Bill 366 (2021), which would establish statewide multiple methods for assessing the communication and computation skills of students.

One facet of this study which was not addressed in much detail, but which does have implications for policy and practice is related to math pathways. Although most of the other literature surrounding the results of Senate Bill 1720 (2013) were focused on student enrollment in either MAT 1033 or an aggregate of all gateway math course options, this study was unique in that it singled out MGF1106 and MGF 1107 courses. These courses are liberal arts math courses and are designed for students who do not need to complete algebra-based math courses for their selected field of study. Because math can be a barrier for many students, institutions should consider exposing students to the mathematics content which is most applicable to their academic and career goals. The Florida Department of Education will also be initiating rule development proceedings related to the development of new mathematics pathways in the Summer of 2022 (Florida Student Success Center, 2019).

Recommendations for Further Research

Although there have been various studies conducted regarding the impacts of Senate Bill 1720 (2013), there are several recommendations which should be considered for future research. Chief among these is the investigation of the long-term outcomes of this reform. Although this study was not targeted toward the investigation of all the impacts of Senate Bill 1720 (2013), research studies which analyze the long-term outcomes of this legislation could provide deeper insight into its full impacts. Additionally, because prior research on the effects of developmental education have found that some students who take developmental education courses often achieve positive short-term outcomes, these short-term gains may not necessarily translate to positive long-term outcomes. As such, now that it has been eight years since Senate Bill 1720 was enacted, metrics such as credit accumulation, persistence, degree completion, and transfer should be fully explored to best ensure that various student populations are not just enjoying short-term gains because of the reform. Additionally, with legislation regarding both alternative placement methods and math pathways on the horizon, studies which specifically investigate how students have performed in light of various alternative placement metrics (i.e. – high school GPA, dual enrollment experience, accelerated credit completion, advanced math enrollment, etc.) or when enrolling in non-algebraic math courses (liberal arts math, statistics, etc.) would be of particular value.

In order to address some of the study limitations mentioned earlier in this chapter, future researchers should investigate whether the patterns observed with the 2014-2017 sample in this study would be replicable with other students. Future research should also seek to include data from as many locations as possible. Additional measures of academic achievement should also be included to allow for greater depth of analysis. A better proxy for socioeconomic status should be examined as well. Likewise other measures of student success or support should also be explored including financial aid eligibility (based on academic performance) and usage patterns for student support resources such as academic advising and tutoring.

Lastly, as it relates to student characteristics, future studies should continue to add to the literature related to student achievement as predicted by socioeconomic status or enrollment status. Additional student characteristics which also warrant investigation are first generation status, age, and veteran status.

Conclusion

Florida's developmental reform efforts have received national attention and despite initial concerns about the impact of this legislation, results of recent studies have indicated that students fared better than expected. However, these results do not support the complete removal of developmental education, but rather, the intentional redesign of developmental education course offerings and the targeted infusion of additional student supports. Despite the seemingly positive short-term results that have been observed in response to institutional changes mandated by the enactment of Senate Bill 1720 (2013), full investigation of the long-term effect of this policy modification, especially as it pertains to vulnerable student populations, should be conducted.

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APPENDIX

HUMAN SUBJECTS REVIEW EXEMPT STATUS LETTER

OLD DOMINION UNIVERSITY

OFFICE OF THE VICE PRESIDENT FOR RESEARCH

aalac INTERNATIONAL PROUDLY, AN AAALAC ACCREDITED PROGRAM

Physical Address
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Office of Research
1 Old Dominion University
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Phone(757) 683-3460
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DATE:	September 28, 2018
TO:	Linda Bol
FROM:	Old Dominion University Education Human Subjects Review Committee
PROJECT TITLE:	[1307223-1] The Relationship Between Optional Developmental Education Enrollment and the Mathematics Achievement of Black Community College Students in Florida
REFERENCE #:	
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	September 28, 2018
REVIEW CATEGORY:	Exemption category # *6.4*

Thank you for your submission of New Project materials for this project. The Old Dominion University Education Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Laura Chezan at (757) 683-7055 or lchezan@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Education Human Subjects Review Committee's records.

VITA

ANDREA LISA LEE
Old Dominion University
Darden College of Education, 120 Education Building
Department of Educational Foundations and Leadership
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Education

- Ph.D., 2022, Community College Leadership, Old Dominion University
- M.Ed., 2012, Student Personnel Administration in Higher Education, University of North Carolina at Greensboro
- B.B.A., 2011, Finance and International Business, Florida International University

Professional Experience

July 2019-Present	Director, Academic Advisement and Career Centers Santa Fe College, Gainesville, FL
October 2018-July 2018	Interim Director, Academic Advisement and Career Centers Santa Fe College, Gainesville, FL
July 2018-September 2018	Coordinator, Academic Pathways and Completion Santa Fe College, Gainesville, FL
February 2018-July 2018	Academic Student Success Advisor State College of Florida, Bradenton, FL
August 2015-April 2020	Adjunct Faculty, Career Planning State College of Florida, Bradenton, FL
February 2015-February 2018	Student Development Advisor State College of Florida, Bradenton, FL
January 2013-February 2015	Student Success Specialist Seminole State College of Florida, Sanford, FL

Selected Presentations and Publications

Lee, A. L. (2021, October). Fostering better images. *Santa Fe College Emerging Leaders Presentation*. Zoom.

Lee, A. L. (2020, October). Thriving instead of just surviving during the transition to online services. *Pensacola State College Professional Development Day*. Zoom.

Lee, A. L. (2020, May). Thriving instead of just surviving during the transition to online advising. *Association of Florida Colleges Administration Commission Webinar.* Zoom.

Lee, A. L. (2017, February). Fostering better images. *YMCA Achievers Career Expo*, University of South Florida, Sarasota-Manatee, Sarasota, FL.

Lee, A. L. & Harris, C. (2015, October). Nontraditional students. *Southern Association for College Student Affairs Conference*, Jacksonville, FL.

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