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Faculty Employment Status and Student Characteristics as Predictors of Student Success in Modularized Developmental Mathematics

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FACULTY EMPLOYMENT STATUS AND STUDENT CHARACTERISTICS AS PREDICTORS OF STUDENT SUCCESS IN MODULARIZED DEVELOPMENTAL MATHEMATICS

by

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ABSTRACT

FACULTY EMPLOYMENT STATUS AND STUDENT CHARACTERISTICS AS PREDICTORS OF STUDENT SUCCESS IN MODULARIZED DEVELOPMENTAL MATHEMATICS

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Approximately two-thirds of incoming community college students are considered academically unprepared for college-level work and lack adequate literacy and mathematical skills needed to learn at the postsecondary level. To address these realities, individual community colleges and state-wide systems have responded by redesigning developmental curricula and course structures into modularized programs that accelerate student progression through developmental sequences. Simultaneously, community colleges are hiring more adjunct faculty to meet the ever-growing demand to educate students in these programs.

Data were collected for a study of the Virginia Community College System 2012 developmental math redesign to primarily examine the effects of adjunct faculty on student success in the modularized developmental math program. Secondary data analysis was conducted utilizing student characteristics. This study posed two research questions and 16 hypotheses. Logistic regression analysis was performed to examine the factors believed to have an impact on student pass rates in total and from grouped developmental pathways individually. Predictor variables used to measure the effect on achieving a passing grade were: faculty employment status, student race/ethnicity, gender, and age and institutional location— rural, urban, and suburban, were examined. This study examined secondary data of 48,765 first-time-in-college students who were enrolled in Virginia community colleges' redesigned developmental math modules beginning in fall 2013, 2014 and 2015. Findings indicate the following: having an adjunct faculty increased the likelihood of students passing all nine modules but especially the earlier modules that make up 1-5; traditional-age students were more likely to be successful overall compared to non-traditional age students; student enrollment in urban and rural community colleges were negatively associated with achieving a passing grade. Black or African-American, Hispanic or Latino and male students had lower pass-rates than White and female students overall and in developmental pathway. Black or African-American students by comparison had considerably lower pass-rates across all developmental modules than their non-Black peers.

DEDICATION

To my husband Les, my children,
Alexandra, Sophia and Malcolm,
and to my parents,
James and Anita Williams,
Without whom none of this would be possible.

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"Progress lies not in enhancing what is, but in advancing toward what will be."

Khalil Gibran

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CHAPTER 1

INTRODUCTION

Community colleges in the United States are enrolling and educating a growing, diverse and often academically unprepared student body (Flow-Delwiche, 2012; National Center for Educational Statistics, 2008). Compared to four-year colleges and universities, community college students are demographically older; more likely to be women, African American and Hispanic. These students are more likely to attend full time due to full-time work schedules and family responsibilities and more likely to be first-generation and come from a low-income household (Bragg, 2001; Cohen & Brawer, 2008; Cohen et al., 2014; 2014; Morest & Bailey, 2006).

Over the past several decades, community colleges expanded their missions to educate the expanding numbers of underprepared students by offering more of what fewer four-year institutions are willing to provide: developmental education (Arendale, 2011; Richardson et al., 1981). As a result, developmental education curriculum has a considerable number of students who are referred upon entering the institution. Developmental education courses consist of reading, English, and mathematics sequences to strengthen core competencies of the least academically prepared and to mitigate pre-college effects (Cohen & Brawer, 2008; Cohen et al., 2014). In mathematics, approximately 59% of students are referred to developmental math and 33% to developmental English or reading (Bailey 2009). Nationally, the most common developmental subject students are referred to is mathematics (Bailey 2009; Bailey et al., 2010; Roksa, 2009); however, only 33% of developmental math students complete their requirements and progress to a college-level math (Bailey et al., 2010). Previous research have found a number of reasons for these poor outcomes among developmental students, including over-placement among students who could be successful in college-level courses (Bailey, Jaggars, & Jenkins, 2015) and long developmental sequences with numerous “exit points” where students “stop-out” or drop-out along the way (Bailey et al, 2015; Daniel, 2000). Implementation of multiple measures to facilitate developmental coursework success and completion are occurring among many community colleges and state-wide systems in order to address these issues.

In particular, modularized developmental sequences have gained momentum in implementation—termed by some as a “redesign” in colleges, districts, and state community college systems (Bickerstaff, Fay, & Trimble, 2016). Modularization in particular, has become an increasingly popular reform measure. Modularization divides the developmental curriculum into modules or single units (often offered at one credit each) that represent discrete math learning outcomes or competencies (Bickerstaff et al., 2016; Edgecombe, Jaggars, Baker, & Bailey, 2013; Hodara et al., 2013). Ideally, with shortened developmental sequences reduces the number of exit points and student progress is accelerated into college-level math.

Though many individual community colleges and state systems are redesigning their developmental curriculum and revamping their diagnostic assessment tools, the number of students placed into a program are still significant. Community colleges are meeting the challenges of educating an ever increasing number of developmental students by hiring more adjunct faculty to teach them (CCSSE, 2014). Adjunct faculty, are considered a cost-saving measure for most institutions within higher education and in particular, community colleges (Ehrenberg, 2012; Jacoby, 2006; Jaeger & Eagan, 2009;

Roueche, Roueche, & Milliron, 1995). However, research has shown these faculties are associated with lower academic quality (Jacoby, 2006; Jaeger & Eagan, 2009), lower student success rates in developmental education (Zientek, Ozel, Fong, & Griffin, 2013), and reduced transfer and graduation rates (Jacoby, 2006; Jaeger & Eagan, 2009). These course and institutional outcomes are not an indictment of adjunct faculty; rather, they reflect a lack of organizational belonging and integration within institutional structure compared to their full-time colleagues. Despite the redesigned developmental curricula, there has been very little investigation on how students perform in modularized courses when their instructor is adjunct or full-time.

Background

Developmental courses are designed to provide useful tools for improving academic success in college-level coursework. These courses are pre-college level and non-transfer; students are "referred" to them based on their performance on a diagnostic placement test. McCabe (2006) argued that developmental education improves access to higher education, particularly for underrepresented populations, many of whom come from racial/ethnic groups. African-Americans and Hispanics have represented a significant proportion of students entering higher education for the first time and most students from these populations attend community college (Wood & Palmer, 2014). Not surprisingly, racial/ethnic groups make up the overwhelming majority of developmental students; however, other population demographics correlate with developmental placement similarly. Students who are female (Bettinger & Long, 2005; Donovan & Wheland, 2008; James, 2007; Stage & Kloosterman, 1995); less affluent (Attewell et al., 2006); first-generation (Crisp & Delgado, 2014); and older (Cohen et al., 2014) tend to be overrepresented in developmental courses.

Among racial/ethnic groups, it is primarily African-American and Hispanic who are referred (Adelman, 2004; Attewell, Lavin, Domina, & Levey, 2006; Bahr, 2010; Bettinger & Long, 2005; Cohen et al., 2014; Crisp & Delgado, 2014). Bailey, Jenkins, and Leinbach (2005) found that 76% of African Americans and 78% of Hispanic students at community colleges nationwide took at least one remedial course compared with 55% of White community college students. They stated:

> the challenge of raising math skills is further compounded by the fact that students who test into remedial math coursework are disproportionately minority and disproportionately first-generation, two characteristics of at-risk students (p. 3).

Bailey and Smith-Morest (2006) found that over half of all first time in college students are placed into developmental courses. Among institutions of higher education, however, high percentages such as these are not equally shared. Parad and Lewis (2003) contend that community colleges are more likely than other two and four year public and private colleges and universities to provide developmental education courses to students. As a result, as Grubb (1999) and Lewis, Farris, and Greene (1996) found, enrollments in developmental education have reached as high as 80% of new college entrants in some community colleges. Cohen and Brawer (2008) and Radford and Horn (2012) suggested that over 60% of community college students are referred to a developmental sequence. Comparably, the National Education Longitudinal Study of 1988 (NELS: 88) observed that more than 60% of first-time community college students are referred to a least one developmental course. In contrast, Bailey et al. (2005) found that only 29% of first time in college students enrolled in four-year institutions are referred. Among the subjects students are most commonly assigned is developmental mathematics. For example, one study from the Community College Research Center of over 250,000 students at 57 Achieving the Dream colleges, found that 59% of entering students required developmental math (Bailey, Jeong, & Cho, 2008).

Referral into developmental courses represents only half of the problem. Attwell, Lavin, Domina, and Levey (2006) reported that only 30% of students pass all of the developmental mathematics courses in which they enroll. Regarding stopping-out, of students who did enroll in a developmental course, 29% of students who are referred to math and 16% of those referred to reading exit their sequences after failing or withdrawing from one of their courses (Bailey, Jeong, & Cho, 2010). In 2012, the U.S. Department of Education reported that among students who started at a two-year college, after a six-year period 51% never completed a college-level math course (Bailey et al., 2010). Low enrollment and high attrition in developmental courses significantly hinders students' ability to complete college and attain a credential. Additionally, a majority of developmental education students do not achieve a credential or transfer to a four-year institution within eight years of starting their coursework at a community college (Parsad & Lewis, 2003; Crisp & Delgado, 2014). Wathington (2013) described how developmental education has been designed to help academically underprepared students, yet at the same time delay progress to a degree or credential. This delay, explained Wathington, can become "paralyzing as most colleges and universities struggle with helping students to progress" (p. 21). However, to mitigate the effects of the multiple realities confronting these students, many community colleges have responded by reforming developmental education programming (Bickerstaff et al., 2016; Edgecombe, Cormier, Bickerstaff, & Barragan, 2013; Hodara, & Jaggars, 2014).

A growing number of community colleges have adopted modularized and thus accelerated models which allow students to complete developmental sequences and enroll in college-level math and English within a shorter time frame. Typical models might include pairing two or more developmental courses into a single one-semester experience (Edgecombe, Cormier, Bickerstaff, & Barragan, 2013). Edgecombe et al. (2013) found that the most common developmental innovations were compression, modularization, and learning communities. Compression shortens the developmental sequence by combining two or more sequential developmental courses into a single semester while modularization divides the developmental curriculum into modules or single units (Edgecombe et al., 2013). These single units represent discrete math learning outcomes or competencies (Bickerstaff et al., 2016; Edgecombe et al., 2013; Hodara et al., 2013). Modularization, in particular, may be required for some degree programs but not others, and students may be allowed to move from one module to the next at their own pace using computer-mediated or faculty-led instruction (Bickerstaff et al., 2016). To facilitate faster or more efficient progress, a college might combine two, three-credit developmental math courses, usually taken across two semesters, into a single six-credit course (Edgecombe et al., 2013; Hodara et al., 2013). The purpose of modularization is to reduce the length of time in a developmental coursework thereby eliminating stop-out or drop-out at certain exit points. Certain modules may be required for some degree programs but not others, and students may be allowed to move from one module to the next at their pace using computer-mediated instruction (Bickerstaff et al., 2016; Edgecombe et al., 2013; Hodara et al., 2013). The teacher-led lecture format is another option for students. However, this instructional approach does not allow for self-pacing.

Several studies were conducted or sponsored by the Virginia Community College System (VCCS) on its developmental programs, diagnostic placement tool and success in its developmental courses. Roksa, Jenkins, Jaggars, Zeidenberg, and Cho, (2009) examined the 2004 cohort made up of 24,140 First-Time-in-College (FTIC) students in Virginia community colleges. Overall, 50% of the cohort enrolled in at least one developmental education course in reading, writing, or math. Developmental enrollment was especially high for mathematics, with 43% of students taking at least one developmental course in that subject. The pass-rates for developmental English courses were 65% and 48% for developmental mathematics, although there was much variation across specific courses.

Virginia's participation with other states in the 2005-2006 *Achieving the Dream: Community College Counts*, as well as study results led to the implementation of the VCCS Developmental Education Task Force. The task force was formed in fall 2008 to develop recommendations that would lead to the following: 1) reduce the overall need for developmental education in Virginia; 2) design developmental education to decrease the time to complete developmental reading, writing, and mathematics requirements for most students to one academic year; and 3) increase the number of developmental education students graduating or transferring in four years to at least one in three students (VCCS, 2009).

Two developmental redesign teams were formed to review developmental outcomes of VCCS students and recommend measures to improve those outcomes. The Developmental Math Redesign Team (DMRT) however, was charged with redesigning developmental instruction, developmental sequences, integrating technology into developmental mathematics education, and designing, with a testing company, a diagnostic tool for Virginia (VCCS, 2010).

Community colleges, as an additional measure, are responding to the increasing numbers of developmental students by hiring more adjunct instructors (Bahr, 2008; Cohen & Brawer, 2008). Employing these faculty members serves the diversified mission of the community college, which includes providing pre-college education (Boylan, 2002).

Research on non-full-time faculty often use “part-time” faculty, “adjunct” faculty, and “contingent” faculty interchangeably (Gappa, 2000). Gappa and Leslie (1993) defined “part-time” faculty as “those individuals who are temporary, non-tenure-track faculty employed less than full-time” (p.3). Roueche, Roueche, and Milliron (1995) defined “part-time” faculty as “those whose employing institutions recognize them legally as less than full-time—that is, part-time faculty are those so recognized by their employing institutions” (p. 25). Researchers may include adjunct faculty under the umbrella term “contingent” faculty; however, two distinct categories of contingent faculty exist; 1) where individuals are employed full-time with fixed-term positions with no tenure opportunities; and 2) part-time appointments limited to single, often renewable, academic terms. Faculty appointments such as these are referred to as “adjuncts” (Curtis & Jacobe, 2006). For this study, the definition provided by Gappa and Leslie (1993) will be used, as it overlaps with the definition formalized by the community college system that is the focus of this study. The term “adjunct” will be employed throughout the current study to differentiate these faculty from full-time faculty.

Adjunct appointments in community colleges constitute a significant majority of those who provide lower-level instruction (Benjamin, 2003; Cohen & Brawer, 2008). Community colleges, by the nature of their missions, offer mostly lower-division, general education, and technical training courses and are more likely to use adjunct faculty (Banachowski, 1996; Spaniel & Scott, 2013). At the same time, there are growing concerns among higher education scholars (Jacoby, 2006; Jaeger & Eagan, 2009; Bettinger & Long, 2005; Ehrenberg & Zhang, 2005) that institutional overreliance on adjunct faculty is detrimental to student success in undergraduate education (Bettinger & Long, 2005; Ehrenberg & Zhang, 2005), students’ subsequent interest in an academic subject (Bettinger & Long, 2010), the likelihood of the students transferring to four-year colleges or completing their associate’s degrees, (Jacoby, 2006; Jaeger & Eagan, 2009) and pass rates in developmental education courses (Fike & Fike, 2007).

The Center for Community College Student Engagement (CCSSE) published a 2014 report which drew data from the Community College Faculty Survey of Student Engagement survey administered from 2009 to 2013. A total of 71,451 faculty members responded to CCFSSE during this period. Findings indicated that 76% of the nation's community college developmental courses are taught by adjunct while only 24% who teach only developmental education are full-time (CCSSE, 2014; Benjamin, 2003; Fike & Fike, 2007). CCSSE (2014) reported that 25% of faculty who teach only developmental education courses have only a bachelor’s degree.

Literature that focuses on faculty teaching developmental courses suggests multiple factors affect the quality of learning experienced by students in developmental education, particularly mathematics. These include highest credential attained by adjunct faculty (CCCSE, 2014; Fike & Fike, 2007), teaching experience, hours devoted to outside employment, and gender and race/ethnicity of the instructor (CCSSE, 2014). Adjunct faculty, due to their increasing numbers, have a considerable effect on the quality of teaching and learning experienced by developmental students, most of whom are low-income, first-generation, African American and Hispanic (McCabe, 2003).

The conceptual model that guides this study is drawn from Jaeger and Eagan (2008). Their model was developed based on the research of Tinto (1993) and other studies that assumes students who are exposed to more instruction from adjunct faculty experience fewer meaningful interactions with those instructors than they would with full-time faculty. According to these researchers, the result would be that students become less integrated into campus academic culture which has an adverse impact on student performance and ultimately success (Jaeger & Eagan, 2008 p.42). Other studies reinforce these findings and further suggest the importance of faculty and student interactions outside the classroom, findings that consistently show that such interactions have a positive, direct effect on bachelors' degree attainment (Pascarella and Terenzini, 2005; Tinto, 1993). Additional studies applying this conceptual model include: faculty-student interactions and positive predictors of student success (Cotten & Wilson, 2006; Nora, Barlow, & Crisp, 2005; Pascarella & Terenzini, 1977, 2005); student negative perception of adjunct faculty stability and security (Baldwin & Chronister, 2001); and over-reliance on part-time faculty undermining successful student integration (Benjamin, 2002).

Tinto (1993) emphasized the critical importance of faculty members in fostering student development and encouraging student persistence in college. Faculty-student interactions, according to Tinto, encourages social integration (Kuh et al. 1994). Tinto (1975) also noted that informal out-of-class contact between faculty and students had been found to promote the persistence of students who are “withdrawal prone,” such as low-income, first-generation college students.

Description of the Problem

Approximately two-thirds of incoming community college students are considered academically underprepared for college-level work and lack adequate literacy and mathematical skills needed to learn at the postsecondary level (Bailey, Jeong, & Cho, 2010; Spann, 2000). To address these realities, individual community colleges and state systems have responded by “redesigning developmental curricula, policies that place students into developmental coursework, as well as course structures to accelerate student progression through developmental sequences” (Bickerstaff et al., 2016).

An additional measure to offset the needs of institutions and their developmental students is to hire more adjunct faculty. Employing these faculty to teach developmental courses allows community colleges to continue its institutional mission while at the same time maintain institutional fiscal solvency in the face of cuts and increased calls for accountability (National Conference of State Legislatures, 2013). Adjunct faculty has become a critical asset to community colleges’ over the last few decades (Banachowski, 1996; Ehrenberg, 2012; Gappa & Leslie, 1997; Meixner, Kruck, & Madden, 2010; Roueche, Roueche, & Milliron, 1996).

Characteristically, these faculty share many of the features of the community college, they are flexible, diverse, both occupationally and demographically, and oriented to meet the needs of students. Adjunct faculty serve in many two-year colleges nationwide, as a primary connection between the college and its students, yet most adjuncts are disconnected socially and academically from their colleges (Spaniel & Scott, 2013). These same faculty, who lack meaningful inclusion in the life of their institutions are, in greater numbers, tasked with teaching more students than are full-time faculty. Students required to take developmental education courses, are most in need of the social and other types of support of which adjunct faculty are incapable of providing due to the lack of additional training and support by their institutions (Edenfield & Duggan, 2010).

Adjuncts spend a greater proportion of their overall time teaching, however, literature finds that these faculty are less accessible to students, have fewer frequent interactions with students, are more transient, and are less socially integrated into the campus culture, suggesting weaker linkages to students, colleges and institutions (Schuetz, 2002; Schuster, 2003; Selfa, Suter, & Myers, 1997; Umbach, 2007). With increased reliance on adjunct faculty to provide half to most of all instruction at community colleges, some studies indicate a negative effect on student persistence and attainment to graduation with a degree or certificate (Eagan & Jaeger, 2008; Jacoby, 2006).

There is a wealth of scholarship on community colleges emphasizing both the importance of adjunct faculty in fulfilling the community college mission (Banachowski, 1996; Datray, Saxon, & Martirosyan, 2014; Green, 2007), as well as challenges to institutional quality (Ehrenberg & Zhang, 2005; Fain, 2014; Gappa & Leslie, 1997; Jacoby, 2006; Jaeger & Eagan, 2009). Studies highlighting the effects of adjuncts on student outcomes as defined as persistence through developmental sequences, courses, transfer, and graduation appear to dominate higher education scholarship (Bettinger & Long, 2010; Ehrenberg, 2012; Ehrenberg & Zhang, 2005; Fike & Fike, 2007; Jacoby, 2006; Jaeger & Eagan, 2009). Concerns over academic standards and access have gained momentum in higher education agendas over the last several decades as more underrepresented students demand greater opportunities through higher education (Baum, 2010; Cohen & Brawer, 2008; Hughes, 2012). Hiring more adjunct faculty to teach developmental students is one measure many community colleges have adopted to facilitate program completion. Modularized developmental sequences are another.

These two issues converge where adjunct faculty teach the majority of traditional as well as modularized developmental math courses nationwide, including Virginia's community colleges. VCCS institutions, in particular have, in some ways, redefined faculty roles in the redesigned developmental math sequences. For both full-time and adjunct faculty, instructional delivery includes two distinct options for course structure. In the first, computer-mediated shell allows students to work individually on their own with instructors overseeing their progress and providing assistance when needed, which is sometimes referred to as "self-paced" (Bickerstaff et al., 2016). The other approach utilizes traditional, instructor-led lectures. Students are required to work at the same pace as the instructor. Although both delivery approaches redefine the role of the instructor, for adjuncts, the redesigned curriculum may reduce any adverse effects on student learning and progress through developmental sequences. These modified roles include reduced or no traditional lecture and increased "learning mediator" within a math lab or classroom where instructors answer students' questions, and students watch video lectures or work through math problems on a computer. Learning management software used in many of these courses may further mitigate any adverse effects having an adjunct instructor might have on developmental student success.

Purpose of the Study

The purpose of this quantitative study was to examine pass-rates of students who had either an adjunct or full-time instructor under the redesigned 2012 developmental mathematics model in Virginia's community colleges. It was unclear since the redesign if (a) students who were taught by adjunct faculty were as successful in their developmental modules as those taught by full-time faculty; (b) if African-American and Hispanic students were as successful in their developmental modules as their non-African-American and non-Hispanic counterparts; (c) if male students were as successful than their female peers; and (d) if traditional-aged students were as successful than their older peers. Furthermore, it was unclear if there were differences in rates of success based on institutional characteristics, specifically the location of the community college. This study utilized fall 2013 to fall 2015 data collected by the Virginia Community College System (VCCS).

Research Questions

The research study was guided by the following research questions:

Research question 1a. What is the relationship between faculty employment status, race/ethnicity, age, gender, and student enrollment in rural, urban, and suburban community colleges on students earning a passing grade (S) in all of the nine developmental mathematics modules overall?

Research question 1b. What is the relationship between faculty employment status, race/ethnicity, age, and gender, and student enrollment in rural, urban, and suburban community colleges on students earning a passing grade (S) in each of the nine developmental mathematics modules respectively?

Significance of the Study

There is a large population of students in the VCCS who enter postsecondary education without adequate preparation for college-level mathematics. Through the use of quantitative research, this study primarily sought to provide a better understanding of the impact of faculty status and secondarily, student characteristics which include institution location on student performance. Addressing common student and institution characteristics provides additional detail on the success measures of the current developmental modules. Furthermore, this study contributes to the growing literature on the impact of adjunct faculty and other key measures of student success in developmental mathematics. Finally, the current study will inform administrative decisions on the significant usage of adjunct faculty over full-time faculty in developmental mathematics courses.

Overview of Methodology

Secondary instructor and student level data from fall 2013 to fall 2015 were collected by the Academic Services and Research Department of the VCCS. The data maintained by the Academic Services and Research Department represents a census of community college students and employees in the State of Virginia. These data include transcripts, demographics, financial aid awards, matriculation records, degree/certificate awards, faculty employment, and institutional-level data, etc.

Data collected for the current study from this period coincided with the full implementation of the redesigned developmental math in the state-wide system. The sample included a total of 48,765 developmental mathematics students who were identified as First-Time-in-College (FTIC) students at 11 Virginia community colleges beginning the fall semester 2013 to fall 2015. The Academic Services and Research Department of the VCCS provided data for the study in three separate Excel files. Each file listed the following information: two Carnegie institution designations to differentiate the size (small, medium, large, and very large two-year) and locale of institution served (public rural-serving large, public urban-serving multi-campus, public suburban-serving single campus); common pseudo-ID numbers for students which were used to merge the three files; the gender, race/ethnicity, and age of each student; term the student enrolled; developmental module the student was enrolled and credit of the module; race/ethnicity and gender of the faculty member who taught the module; and faculty employment status. Students under the age of 17 at the time of enrollment (n=144) were selected out from the sample as they did not fall into either traditionally or non-traditionally aged college student ages. There were no missing data for any student.

The dichotomous independent variables were the following: faculty employment status was coded with 1 to represent adjunct instructors and 0 to represent non-adjunct instructors; traditional-age student was coded with a 1 to represent traditional-age students (17 to 22) and with a 0 to represent non-traditional-age students (23 and older); and student race/ethnicity. The variable student race/ethnicity was derived from the

VCCS dataset using the NCES categories for race/ethnicity. Black or African American was coded with a 1 to represent Black or African American students and 0 for non-African American students. The variable Hispanic or Latino was coded with a 1 to represent a Hispanic or Latino student and with 0 to represent a non-Hispanic or Latino. The variable White was coded with a 1 to represent a White student and 0 will represent a non-White student. The variable "Other" was coded with a 1 to represent a non-White, non-Black, and non-Hispanic student and with a 0 to represent a Black or African American, Hispanic or Latino, or White student; and student gender which was derived from the VCCS dataset, was coded with 1 to represent male students and 0 to represent female students. Finally, the grouping variable Developmental Modules MTE were coded MTE 1, MTE 2 up to MTE 9. These variables were further defined based on developmental pathway: Career-Technical (MTE 1-3 for modules 1-3), Liberal Arts (MTE > 3 and MTE < 6 for modules 4 and 5), and STEM (MTE > 5 for modules 6-9).

Variables, rural, urban, and suburban institutions were examined as well. These variables were coded as rural versus suburban and urban versus suburban with suburban community colleges as the baseline for comparison.

Descriptive statistics were reported for student, faculty, and institutional variables. Frequency tables reported student race/ethnicity, gender, and age and faculty race/ethnicity, gender, and employment status. Student enrollment in rural, urban, and suburban institutions was also reported over the fall 2013 to fall 2015 period.

Logistic regression was used to examine both research questions in order to assess which predictor variables influenced the dependent variable pass-rates in the developmental mathematics modules.

Definition of Terms

Adjunct faculty: The Virginia Community College System (VCCS) defines adjunct faculty as "employed to teach less than a normal faculty load or to teach less than a full session on a semester by semester or summer term basis. The adjunct faculty contract contains no guarantee of continued employment" (VCCS Policy Manual, 2013).

Developmental courses: Known also as "remedial" or basic skills courses. These courses do not typically count toward a degree or certificate and require students to enroll in courses such as English, writing, or mathematics for one to five semesters based on the results of a diagnostic placement exam and the type of developmental course offered at the institution.

Full-time faculty: The VCCS considers full-time faculty as regular nine-month teaching faculty which includes program heads and assistant division chairs. These appointments include the fall and spring semesters of the academic year. Full-time community college faculty teach 15 or more credit hours per semester under a probationary one-year or continuing contract (The VCCS Policy Manual, 2013, p. 1-3).

Math Essentials (MTE): Nine, modularized one-credit, four-week short sessions which enable most students to complete an entire developmental math sequence in one term in Liberal Arts or Career Technical Education pathways (modules 1-5). Additionally, students can complete in one year, a STEM or business administration pathway (modules 1-9) (Virginia Community College System, 2010).

Rural institution: An institution established outside a metropolitan statistical area with a population of less than 500,000 (Carnegie Foundation for the Advancement of Teaching, 2015).

Sequence: The process that begins with initial assessment and referral to remediation and ends with the completion of the highest-level developmental course that in principle completes the preparation for college-level studies. A majority of students do proceed (or fail to proceed) through their sequences in order, and others may enroll in lower level courses than the ones to which they were referred.

Suburban institution: An institution established in a metropolitan statistical area with a population of least 500,000 (Carnegie Foundation for the Advancement of Teaching, 2015).

Urban institution: An institution established in a primary metropolitan statistical area with a population of at least 500,000 (Carnegie Foundation for the Advancement of Teaching Public File, 2015).

Delimitations

The current study involved using developmental students enrolled only in transfer degree and certificate programs. Many C.S.C. and diploma programs do not require college-level mathematics, science or the full array of other college-level courses where developmental math is may be required.

The study utilized secondary data collected by the VCCS. It was assumed that all of the data were reported correctly to the VCCS by the student and faculty.

The current study did not follow students' matriculation into and success within a college-level math. The focus of the study was on student success within the redesigned modules with key faculty, student, and institutional effects influencing pass-rate performance. Since developmental math is the precursor of credit-bearing math and other math-intensive subjects, then it only made sense to examine if the redesign had in fact improved most outcomes within the curriculum.

The analysis period for course enrollments was truncated to 2 years. Approximately half of students who test into developmental math enroll in the module upon placement (Bailey, 2009). Like other students placed in developmental courses, students in the VCCS may likewise delay their first math module beyond the observation period, and if so, these students were not included in the analysis.

Summary

This chapter described the importance of examining pass-rates and progression of developmental mathematics students enrolled in community colleges and the factors that influence their success. The background of the study, description of the problem, purpose of the study, research questions, and significance of the study were presented. Finally, the overview of the methodology followed by definitions of terms used in the study and delimitations were presented. Chapter 2 presents the most current review of the literature covering the conceptual definition of developmental education, history of developmental education in the United States, in the community college as an institution and specifically the state of Virginia. Overall student success in developmental mathematics and success based on student and institutional characteristics, specifically rural, urban, and suburban, are reviewed. Further, the developmental mathematics redesign in the Virginia Community College System and modularized mathematics will be discussed. Literature focusing on the characteristics of adjunct faculty, nature of part-time teaching, adjunct faculty and their effect on student outcomes and adjunct faculty in developmental mathematics are also examined. Finally, the conceptual model drawn from Jaeger and Eagan (2008) on the negative or salutatory effects of faculty-student interaction will be discussed.

CHAPTER 2

REVIEW OF THE LITERATURE

Multiple topics will guide the framework of the current study. Historically there have been a significant number of students who are referred to developmental mathematics. Principally in community colleges, students referred to developmental curricula are less likely to persist to college-level math and attain a degree compared to their peers who test directly into a college-level math course. Developmental students are more likely to come from high-risk categories such as certain racial/ethnic minority groups, lower income, part-time attendance, female and first-generation to attend college. Adjunct faculty—who are increasingly employed by community colleges nationwide, are more likely to teach these high-risk students than their full-time counterparts. These faculties have historically been recognized and used as a key resource by community colleges striving to achieve multiple missions and remain fiscally solvent. Many researchers have asserted that as a consequence of relying heavily on adjunct faculty, vulnerabilities inherent within the position have led to mostly negative student outcomes across curricula, including developmental education.

In 2012, the Virginia Community College System (VCCS) implemented a developmental education redesign that included developmental mathematics. Many of the 23 colleges adopted the VCCS plan of modularized, one-credit hour, four-week courses and a system-wide math placement and diagnostic tool (VCCS, 2012). Similar to community colleges and systems nationwide, adjunct faculty are overwhelmingly more likely to teach developmental education courses including modularized sequences than full-time faculty.

Prior to the redesign, the VCCS focused on developmental education as a whole for four years prior, with the goal of becoming the "premier purveyor of developmental education, in more streamlined and efficient ways, resulting in greater rates of student success" (VCCS, 2009, pp. 4-5). As a result, the objectives of the VCCS to increase student enrollment, persistence, and academic success as measured by credential attainment revolved around the success of developmental students who were at much greater risk of leaving college without obtaining a certificate or degree than their college-ready counterparts (VCCS, 2009). Despite the mostly positive outcomes reported about the redesign, there are few studies that examine the effect of faculty employment status, student demographics and institution location on student outcomes—as defined by a passing grade within these modularized environments.

This study will contribute to the growing literature on the influence of adjunct employment status and student demographics on pass rates in developmental mathematics. This study will broaden the VCCS' research on the outcomes of the 2012 developmental mathematics redesign by examining institution-level characteristics, specifically rural, urban and suburban locations as another factor in student success.

This chapter begins with a review of relevant literature defining developmental education and the history of developmental education in the United States and the community college. Literature on community college institution location will then be examined. The developmental mathematics redesign implemented in 2012 by the Virginia Community College System and the modularized model will also be described. This chapter will further describe research literature on enrollment and student demographic factors such as age, gender, and race/ethnicity and their effects on developmental mathematics success. Further, research on the use of adjunct faculty and their effect on student success in general and in developmental mathematics in particular—especially within community colleges will be reviewed. Finally, the conceptual model used to guide this study will be discussed. The chapter concludes with a drawing together of the literature as it relates specifically to the problems of this study.

Defining Developmental Education

The terms “remedial” and “developmental” are often used to describe an educational curriculum designed for students who are academically unprepared for college-level course work. The purpose of “remediation” or “developmental” is to help under or unprepared students to gain the skills necessary to excel in college-level courses. Developmental course credits courses do not provide college-level credit.

“Remediation,” according to Bettinger and Long (2005) may ideally serve as a tool to integrate students into the college population. Grubb and Associates (1999) as cited in Wolfe (2012) define remediation as “a class or activity intended to meet the needs of students who initially do not have the skills, experience or orientation necessary to perform at a level that the institutions or instructors recognize as ‘regular’ for those students (p. 174). Contemporary literature on developmental education challenges current conceptualizations of remedial education and implies a qualitatively different approach than “developmental” education (Casazza, 1999). Casazza (1999) examined the word “remedial” and explains that its meaning implies a "fixing" or "correction" of a deficit. For this reason, she suggests that it is often associated with a medical model where a diagnosis is made, a “patient” is prescribed a remedy, and follow-up is conducted to see if the patient, or student, has been brought up to speed. If the treatment does not work, it is then repeated (Casazza, 1999).

Shortly after the turn of the 20th century, colleges and universities offered courses labeled, "remedial reading" and "study skills." By 1909, over 350 colleges were offering "how to study" courses for students deemed underprepared and by 1920 and 100 study habits books had been published (Casazza, 1999). Bettinger and Long (2005) explains that the most common view of remediation is narrower and applies it as coursework that is retaken whereas classes that focus on new material are termed “developmental.” Over several decades this narrower remediation view of developmental education had expanded from improving skills in a particular subject like reading or study skills to a more holistic application (Bettinger & Long, 2005; Casazza, 1999). The holistic or comprehensive approach integrates the separate goals of improving content skills and general education skills necessary to be successful in higher education. Developmental education, the preferred term used by those in the field of developmental education, provides this more comprehensive framework.

The current practice of developmental education has its philosophical roots in *The Student Personnel Point of View*, which was published in 1937 (Higbee & Lundell, 2001). This document provides a student development perspective based on developmental education theory, research and practice. Emphasis was placed on educating the student comprehensively (Higbee & Lundell, 2001). This document contributed significantly to the current understanding of developmental education as services that provide more than courses. A complete range of services to students may include counseling, academic advising and tutoring (Higbee & Lundell, 2001). The

National Association of Developmental Education (NADE) differentiates developmental coursework from developmental education and defines developmental coursework as only “one practice that falls under the umbrella term ‘developmental education’" (Casazza, 1999). On the organizational website, the NADE describes developmental education as:

> programs and services that commonly address academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning -strategies, and affective barriers to learning”. Developmental education includes but is not limited to “all forms of learning assistance, such as tutoring, mentoring, and supplemental instruction, personal, academic, and career counseling, academic advisement, and coursework (NADE, n.d.).

While the terms “remedial” and “developmental” education are used interchangeably in the research literature, this study will use “developmental education” to describe current curricula and courses designed for academically underprepared students. The term “remedial” will be referred to in the next section only in previous literature that describes the earlier years of developmental education in the United States.

Developmental Education in the United States

Developmental education is not a recent phenomenon in higher education. Postsecondary institutions throughout the history of the country have provided some form of developmental education and learning assistance programs to meet academic standards of admitted students who had diverse learning needs (Arendale, 2011; Brier, 1984; Casazza & Silverman, 1996). In the 17th century, 10% of Harvard’s student body came from families of artists, seamen, and servants. At the time, the university reserved places for poorer students whose tuition was paid for either through work or additional fees imposed on the wealthier students (Brubacher & Rudy, 1976; Casazza & Silverman, 1996). First appearing in 1636 with the founding of Harvard University, remedial education through private tutoring, was created to teach reading to adults. Specifically, privileged white males profited the most from such services but the before mentioned poorer students benefited as well (Arendale, 2011; Dotzler, 2003). There were no opportunities, however, to select elective remedial courses since the curriculum prescribed the same choices of classical courses for all students to take, no matter their needs for development (Arendale, 2011). Institutions of higher education struggled with the tension between providing an elite education and the lack of preparedness of entering students. Brier (1984) provides an anecdote that Ezra Cornell, the founder of Cornell University, lamented to a professor that so many applicants had such poor reading skills many could not pass the entrance exam. By 1871, Charles Eliot, Harvard's president, was concerned that “freshmen entering Harvard had bad spelling, incorrectness as well as inelegance of expression in writing, (and) ignorance of the simplest rules of punctuation" (Weidner, 1990, p. 4). As a response, the university developed an entrance exam to include written composition. By 1879 50% of the applicants failed this exam and were admitted, "on condition." As a result of these outcomes, the university began to provide additional assistance to prepare the students for college-level classes (Weidner, 1990, p.4). Remedial education among the earliest colleges and universities reflected elitist standards presumed by the European model of education which advocated a fixed curriculum. Reactions against this model of education for all college students began to grow. Over time, this prescribed curriculum model expanded to include proficiency on an arithmetic exam and additional topic areas such as geography, history, and English (Arendale, 2011).

The Morrill Act of 1862 provided for more flexible curricula which allowed for remedial education to become a realistic option for an academically diverse student body. Further, the Act broadened higher education opportunities beyond politically and economically advantaged white males. Arendale (2011) and Dotzler (2003) describe not only how this Act established land-grant institutions designed to offer agricultural and mechanical arts programs but remedial education well. In 1849, the University of Wisconsin created the Department of Preparatory Studies, the first systematic developmental education program in the United States which offered remedial courses in reading, writing, and arithmetic (Arendale, 2011). Similar colleges, according to Cohen and Brawer (2008) were operating their remedial programs to meet diverse student needs. Land-grant institutions, unlike their more selective counterparts, admitted women and returning service members and in rare cases, freed slaves during the late and early 1900s (Dotzler, 2003). These institutions represented an academic step ladder for masses of non-elite Americans since public education was not widespread across the United States. For example, "many of these new public and private colleges admitted students who only had an elementary education" (Ross, 1942 p. 47). Land-grant institutions could not address the needs of most newly freed slaves and other African Americans. Historic Black Colleges and Universities (HBCUs) instituted remedial education as a core element of curriculum given the nearly nonexistent public high schools and racial animosity towards African-Americans (Boylan & White, 1987). Consequently, the HBCU became the primary producers of educated African Americans in the United States (Boylan & White, 1987).

Other colleges created preparatory departments to meet the needs of students who were not ready for college study. These units were proliferating, and as a result, many colleges saw enrollments exceed that of the regular college admissions (Brubacher & Rudy, 1976). Preparatory departments were often considered to be secondary schools within colleges and universities. The departments offered training that often led to a six-year program of pre-college study for underprepared students (Brubacher & Rudy, 1976).

Higher Education policy changed significantly after World War II. In 1947, the President's Commission on Higher Education (hereafter referred to as the Truman Commission) issued a report with the major recommendations that had a long-term impact on higher education. The primary recommendation of the Truman Commission was to increase the college-going rate by double of what it had been in the United States by 1960 (Gilbert & Heller, 2013). The organization recognized that the cost of attending college was a barrier to many students. Gilbert and Heller (2013) observes that one of the critical recommendations by the Truman Commission called for an increase in access to higher education to students regardless of race, sex, or national origin (p. 420). The Commission also recognized that issues of access were inextricably tied to equity: who should have access to college, the capacity of facilities in colleges and universities, as well as the location of the institutions themselves (Gilbert & Heller, 2013). Explicitly defined, the notion of broader based access included different forms of postsecondary education to be available based on capabilities, skills, and career objectives of students. In Gilbert and Heller' (2013) analysis of the Truman Commission, any hope of achieving these recommendations rested on “eliminating racial, financial, religious, and gender-based barriers to access and rapidly expanding higher education to meet the corresponding demand” (p. 420).

The Commissions’ movement to broaden access was the comprehensive application of remedial education model in both four- and public two-year colleges. Having significant numbers of students unprepared for college-level coursework is especially significant in community colleges given their open admissions policies (Bailey, 2010; Cohen et al., 2015). Open admissions policy guarantees that anyone who seeks a college education, no matter how academically unprepared is afforded the opportunity (Bailey & Morest, 2009; Bailey et al., 2015; Cohen et al., 2015; Williams, 2013).

Typically, enrollments of academically unprepared student are high and come with a significant cost. According to a Department of Education 2006 report, 40% of all college students end up taking at least one developmental course—at an estimated cost to the taxpayers ranges from $1 billion (Bailey et al, 2010; U.S. Department of Education, 2006, p. 9) to $6.7 billion (Scott-Clayton, et al., 2012). This indicates a broad range of public subsidization of developmental education. Critics charge funds are wasted on developmental education because taxpayers are paying for non-college level courses twice: once for secondary schools and once again in higher education (Fain, 2011). For example, according to an *Inside Higher Education* article, Ohio spends $130 million a year on remedial education in its public universities. The Ohio Board of Regents argued at the time that money aimed at academic inadequacies should had been addressed in high school (Fain, 2011). Although the monetary cost of developmental education appears large, Breneman (1998) found that nation-wide spending in the United States on remedial courses in a given year was less than one percent of expenditures for public higher education. In most cases the percentage of developmental education costs compared to total college cost remains around one or two percent (Saxon & Boylan, 2001). According to Breneman and Harlow (1998) “remedial education draws political fire far in excess of any reasonable view of its budgetary costs" (p. 20).

Aside from the costs, critics assert that attrition rates of developmental students are higher and the length of time to graduate is longer compared to non-developmental students. Research literature has shown that this outcome appears true (Bailey et al., 2015; Bailey & Morest, 2009; Cohen et al., 2014). Students referred to two or more developmental courses are less likely to complete college than those who need developmental courses in only one area (Bailey et al., 2015). However, those who place in only one developmental subject area, are as likely as anyone else to graduate (Bailey et al., 2015).

Developmental Education and the Community College

The Truman Commission Report mandated a national developmental education initiative, placing primary responsibility within the mission of the junior college (later to be called community college) (Crews & Aragon, 2004, p. 1). President William Rainey Harper of the University of Chicago in 1892 created the idea of the junior college within the University of Chicago where the first two years were the “Academic College” and the final two years were the “University College” (Arendale, 2011).

As the mission of community colleges broadened to include pre-college academic preparation, many four-year institutions were willing to allow community colleges, in close geographic proximity, to provide these programs to academically underprepared students. Richardson, Martens, and Fisk (1981) explained that as four-year institutions began to receive more state and local funding, there was a reduced need to admit high numbers of the academically unprepared. Arendale (2011) noted that historically, as more academically unprepared students enrolled in community colleges, academic preparatory programs at four-year institutions decreased their number. He also explained that lower tuition costs at community colleges attracted the economically disadvantaged, who were often developmental education students, since federal financial aid and scholarship programs were not available. Cohen, Brawer and Kisker (2014) further explained in *The American Community Coll*ege, sixth edition, that during the 1960s significant increases in community college enrollment was due to the expanded proportion of 18 to 24-year olds in the population—baby boomers. More people were in the college-age cohort, and more were going to college (p. 45). Since then, community college growth has been notable with over 7.5 million students in 2010 (p. 45). Cohen et al. (2014) found that growth is attributed to multiple factors including population expansion with older students' attending college, part-time attendance, and notably, high attendance by women, minorities, and less academically prepared students.

Developmental education has become increasingly critical in higher education as more students are unprepared for college-level work while at the same time, career-oriented postsecondary training or education is increasingly needed (Cohen & Brawer, 2008; Jobs for the Future, 2011). The assumption is that by completing developmental coursework in reading, English, and mathematics, students will acquire the skills necessary to succeed in college-level courses and beyond.

Student Outcomes. With over 1,200 community colleges nationwide, these institutions have built their activities around providing access to a wide range of students, many of whom are disproportionately low-income and from underrepresented minority groups (Bailey & Morest, 2006; Williams, 2013). In particular, open-door admissions offer college admission to all students who have earned a high school diploma or GED and wish to attend community college to further their education (Allen, 2012). However, by offering opportunities for all, the least academically prepared often have consistently negative educational outcomes. In a 2007 study using data from fall 1998 to fall 2003 of 1,729 students from a New England community college, Craig and Ward (2007) concluded that the institution was ”more likely to lose students due to open-door admissions policies that exclude few, partly because, of the responsibility of taking on remedial education” (p. 506). Adelman (1996) found that 45% of college students who took a single remedial course earned a bachelor’s degree, while only 24% of students who took three or more remedial courses earned a bachelor’s degree. Hoyt (1999) examined this relationship between remedial education and student attainment in a large urban community college. Longitudinally tracking fall 1993, 1994, and 1995 cohorts, results show a consistently negative relationship between developmental course work and graduation, transfer, and attrition rates. Similar to findings by Adelman (1996), Hoyt (1999) found that as developmental coursework increase, measures of student success, including retention, decrease.

A recent meta-analysis of student success outcomes by Kuh, Kinzie, Buckley, Bridges, and Hayek (2006) showed that once enrolled in community college, a student’s chances for graduating vary widely. For example, data about community college credential attainment indicate that only 52% of students who begin their studies at a community college attain a credential within six to eight years (Kuh et al., 2006). An additional 12% to 13% transfer to a four-year institution (Hoachlander, Sikora, & Horn 2003; Kuh et al., 2006). Moreover, only 35% of first-time and full-time college students who plan to earn a bachelor's degree reach their goal within four years while 56% achieve it within six years (Kuh et al., 2006).

Community college success outcomes consistently show low percentages within these key measures. Persistence to transfer, graduation, and attainment of a bachelor's degree appear partly precipitated by early departures due to referral and placement into developmental courses and outcomes once placed (CCSSE, 2005; Hutton, 2013; Kuh et al., 2006).

Additionally for community colleges, the benefits and costs of developmental education specific to labor market returns are also variable. Hodara and Xu (2016) links wage record data to student-unit record data from North Carolina and Virginia's community college systems and found that for two cohorts of students who attended community college in both states, developmental English credits led to an increase in earnings of $12 to $21 per quarter. In contrast, for both states, developmental math credits have negative impacts on earnings by $18 to $50 per quarter, particularly for those assigned to the lowest level of the developmental math sequence (p. 799).

Developmental Referrals. The United States Department of Education's National Center for Educational Evaluation and Regional Assistance (2015) found "large numbers of college students, especially at community colleges, are required to take and pass at least one developmental course in math, reading, or writing before they are considered ‘college ready’ or academically qualified for college-level coursework” (p. 3). All community colleges offer developmental courses to meet this demand (Cohen et al., 2014). Citing the Education Commission of the States, Cohen et al. (2014) noted the Commissions’ estimation that 58% of students enrolled in community colleges require some remediation (p. 246). Bailey, Jeong, and Cho (2010) found that 59% of 250,000 incoming students at 57 Achieving the Dream community colleges across the country are referred to developmental math and 33% to developmental English or reading. Nationally, the most common developmental subject students are placed in mathematics (Bailey 2009; Bailey et al., 2010; Roksa, 2009). Scott-Clayton and Rodriguez (2012) conducted a study of 100,000 students in six community colleges in a large, urban system and their analysis focused on first-time degree-seeking students who were admitted to one of the community colleges between fall 2001 and fall 2007. Roughly 90% of the students are assigned to developmental coursework in one or more subjects. Findings were similar in Kentucky (Kentucky Developmental Education Task Force, 2007); California (California Community Colleges, 20102); and Virginia (Virginia Community Colleges, 2010).

Academic Preparedness. A lack of academic preparation for college-level courses is a major challenge facing students pursuing a postsecondary degree (U.S. Department of Education, 2015). Research suggests that there are some factors that have contributed to high enrollment in developmental courses: First, high school graduation requirements often do not align with skills and knowledge needed for college-level coursework (Grubb, 2013; Hodara, Jaggars, & Karp, 2012). The U.S. Department of Education (2006) found among high school seniors in 2000 that only 17% were considered proficient in mathematics. Attewell, Lavin, Domina, and Levey (2006) used data from the National Education Longitudinal Study (NELS) and found that among a sample of NELS students tracked from eighth grade in 1988 until 2000, 58% of the students enrolled at community colleges enrolled in a developmental course compared to 31% of students at non-selective four-year colleges, 14% at selective and two percent at highly selective four-year colleges (p. 898). Radford and Horn (2012) found that among students who started college in 2003-2004, 68% of public two-year college students, 39% of public four-year college students, and 32% of private four-year college students took at least one developmental education course. These findings suggest an upward trend in the number of academically unprepared students entering postsecondary institutions.

The second reason for high enrollment may be due to a significant gap in advanced high school course-taking, particularly in math, between African American and White students, Hispanic and White students, and upper and lower-income students (U.S. Department of Education, 2015; Domina & Saldana, 2012). These gaps partially explain high rates of participation in developmental education among low-income, African-American, and Hispanic or traditionally disadvantaged groups once they enter college (Atwell, et. al., 2006; Long, Iatarola, & Conger, 2009). Enrollment in developmental courses, however, was not limited to racial/ethnic minorities and the economically disadvantaged. Atwell, et al., (2006) concluded from their study that large percentages of students who graduate from suburban and rural high schools take remedial coursework in college, as do many students from high-income families (p. 914). They found that 52% of students from families in the lowest quartile socioeconomic status are more likely to be enrolled in one or more developmental courses, yet, nearly 24% of students from the highest quartile SES families are also enrolled in developmental courses (Attewell, et. al., 2006).

Hodara (2015) suggested a third reason for high enrollment in developmental coursework: placement tests (p. 3). Community colleges, in particular, use a variety of diagnostic tests to determine college readiness. Ideally these tools identify students with stronger academic knowledge and skills and suggest placement directly to a credit-level course while students with weaker skills are referred to a developmental course. Bailey, Jaggars, and Jenkins' (2015) analysis of placement tests suggest that students who score just above or just below the cutoff score do not have better long-term outcomes than similar students who went directly into college-level courses. A "clear and obvious" cutoff where students who fall below the cutoff score will fail and those above it will succeed is, according to the researchers a "continuous and shallowly rising function" (p. 122). Placement systems, their findings suggest, lead to higher numbers referred to developmental courses that do not need it and in the end, lower completion rates (Bailey et al., 2015). Additionally, researchers have found the diagnostic assessment provides a limited measure of college readiness because such evaluations cannot adequately measure other skills students may have that lend themselves to college success (Bailey et al., 2015; Cohen et al., 2014; Fay, Bickerstaff, & Hodara, 2013). Fay et al., (2013) examined student preparation for mathematics placement tests and results show that students did not adequately prepare. In fact, the most common reason that students reported not preparing for the assessment was that they "did not know about their college's preparation materials" (p. 3). Sixty-four percent of students in the sample were reportedly unaware of these materials and 80% for those who took the exam on the day they found out about it (Fay et al., 2013, p. 3). The ensuing performance by students was questioned by the researchers as to not be an accurate indication of students' math skill and a contributing factor to high referral in developmental mathematics (p. 4). The researchers reported that many students are unaware of the purpose and consequence of these placement tests, thus not using their full range of skills, including motivation, for optimal performance. The result, over-placement in developmental courses (Fay, Bickerstaff, & Hodara, 2013).

The purpose of developmental education is to increase pre-college skills and knowledge among academically unprepared students in order to achieve competency for college-level work. However, on average few finish their developmental education sequences (Attewell, Lavin, Domina, & Levey, 2006; Bahr, 2010; Cohen et al., 2014).

Developmental Education Redesign in Virginia Community Colleges

In 2012, the Virginia Community College System (VCCS) accomplished a redesign to its developmental math placement systems, course structures, and curricula. The VCCS began to focus on developmental education as a whole four years before the redesign, with the goal of becoming the "premier purveyor of developmental education, in more streamlined and efficient ways, resulting in greater rates of student success" (VCCS, 2009, pp. 4-5). Accordingly, objectives were developed to increase student enrollment, persistence, and academic success as measured by credential attainment (VCCS, 2009). These goals were considered achievable with the increased success of developmental students who are at a higher risk of leaving college without obtaining a credential compared to their college-ready counterparts.

Modularization and Acceleration. Many community colleges have adopted multiple measures to facilitate developmental coursework success and completion. In particular, accelerated and modularized developmental sequences have gained momentum in implementation—termed as a "redesign" in colleges, districts, and state community college systems, including Virginia (Bickerstaff, et al., 2016). Acceleration allows students to complete developmental sequences and enroll in college-level math and English within a shorter time frame (Jaggars, Hodara, Cho, & Xu, 2015). Typical acceleration models might include pairing two or more developmental courses into a single one-semester experience (Edgecombe, Cormier, Bickerstaff, & Barragan, 2013). Edgecombe et al. (2013) found that the most common developmental innovations are: compression (occurring at 17 colleges), modularization (occurring at 16 colleges), and learning communities (occurring at 16 colleges). Modularization in particular, has become a popular reform approach (Bickerstaff et al., 2016). Modularization divides the developmental curriculum into modules or single units (often offered at one credit each) that represent discrete math learning outcomes or competencies (Bickerstaff et al., 2016; Edgecombe, Jaggars, Baker, Bailey, 2013; Hodara et al., 2013). Certain modules may be required for some degree programs but not others, and students may be allowed to move from one module to the next at their pace using computer-mediated or faculty-led instruction (Bickerstaff et al., 2016; Edgecombe et al., 2013; Hodara et al., 2013). The course structure is not altered if the modules are offered within the same semester. Instead of requiring two, three-credit developmental math courses across two semesters, a college might combine them into a single six-credit course within the same semester (Edgecombe et al., 2013; Hodara et al., 2013). The purpose of modularization is to accelerate student progress through developmental courses by changing the traditional sequence structure, and curriculum and offering only the content students need to succeed in college math once enrolled (Edgecombe, 2011; Hodara, 2013**).** Jaggars, Hodara, Cho, and Xu (2015) found that overall, students on accelerated pathways, including modularization, are more likely than similar peers to complete the relevant college-level course within three years.

Bailey et al., (2010) suggested that up to 33% of developmental students do not continue to the next sequence, even if successful in their current sequence, because external factors pull them away from college. By reducing the time required to complete the developmental sequence, accelerated strategies may decrease the likelihood that external factors will draw students away from the sequence before they complete it (Daniel, 2000). Proponents of accelerated and modularized programming assert that greater access to underserved students, particularly race/ethnic minorities, women, and first-generation students is sustainable through these alternative models (Edgecombe et al., 2013; Hodara, 2014).

Prior to the Redesign. Similar to many community colleges nationwide, VCCS colleges had defined pathways to English composition courses through separate reading and writing sequences. Developmental mathematics courses offered a MTH 2 (Arithmetic), MTH 3 (Algebra I) and MTH 4 (Algebra II). These courses were offered in most of the VCCS colleges and to almost all developmental students (Wolfe, 2012). Nevertheless, across individual colleges, there were significant variations in course design, course offerings, and policy (Bickerstaff et al., 2016). Single courses or three-course sequences, for example, in a semester-long format to satisfy developmental requirements were offered (VCCS, 2011). Credit hour requirements also differed significantly “where courses ranged from three to five credit hours each” (p. 17). A typical student referred to arithmetic would be required to take three semesters of developmental math, for a total of nine to 15 credit hours, before progressing to college-level courses (Bickerstaff et al., 2016). Given these variations, however, in developmental mathematics, course offerings in college-level mathematics offered more consistency in structure.

Several studies were conducted or sponsored by the VCCS on its developmental programs, diagnostic placement tool and success in its developmental courses. Roksa, Jenkins, Jaggars, Zeidenberg, and Cho, (2009) examined the 2004 cohort made up of 24,140 First-Time-in-College (FTIC) students in Virginia community colleges. Overall, 50% of the cohort enrolled in at least one developmental education course in reading, writing, or math. Developmental enrollment is exceptionally high for mathematics, with 43% of students taking at least one developmental course in that subject. Pass-rates for developmental English courses were 65% and 48% for developmental mathematics, although there was much variation across specific courses. Roksa et al., (2009) reported that students who started at lower levels of developmental coursework did poorly. “They had less favorable educational outcomes than either students who started at higher levels of developmental instruction or those who did not take developmental courses” (p. 2).

The VCCS (2011) conducted a similar study on its fall 2006 FTIC cohort. Of the 23,542 students, 14% were considered college-ready based on their placement scores and 24% did not attempt the diagnostic. In 2008-09, enrollment in Virginia’s Community Colleges was at a high of over 262,000 students, representing an increase of 30,000 before the last five years (VCCS, 2009). Over 70% of students entering Virginia's community colleges during that time were referred to developmental math (nearly half to three levels below college-level math) and 34% to developmental English (Cohen et al., 2014 p. 246). These findings as well as "an outgrowth of Virginia's participation with other states in the 2005-2006 *Achieving the Dream: Community College Counts* initiative, the VCCS Developmental Education Task Force was formed in fall 2008. Their purpose was to develop recommendations that would result in the following: 1) reduce the overall need for developmental education in the Commonwealth; 2) design developmental education in a way that lessened the time to completion in developmental reading, writing, and mathematics requirements for most students to one academic year; and 3) increase the number of developmental education students graduating or transferring in four years from 25% to at least 33% (VCCS, 2009). Eventually, two developmental redesign teams were formed: the Developmental English Redesign Team and the Developmental Mathematics Redesign Team (DMRT) in 2010 (VCCS, 2010). Both teams were tasked with providing recommendations on what steps the VCCS should take to improve student success and implementing more streamlined and efficient ways of delivery (VCCS, 2010).

The Developmental Math Redesign Team (DMRT), was charged with redesigning developmental instruction, developmental sequences, integrating technology into developmental mathematics education, and designing, with a testing company, a Virginia-based diagnostic tool (VCCS, 2010). Prior to the redesign, incoming students took a commercially developed placement test, which determined their placement in either a college-level or one of several sequentially ordered developmental math courses

(Bickerstaff, Fay & Trimble, 2016). In addition, four system-wide goals of the VCCS' *Achieve 2015* strategic plan for redesigned developmental education instruction were developed, which were: 1) decrease the number of students enrolling in developmental education; 2) increase the number of students completing developmental education requirements within one year; 3) increase the number of students successfully completing college-level math courses; and 4) increase student success in terms of persistence, graduation, and transfer (VCCS, 2014).

An additional recommendation was to design three different pathways dependent on the program of student chosen by students. One path follows the traditional sequence for STEM and Business Administration, the other Liberal Arts and the third, Career Technical Education (CTE) (Virginia Community College System, Critical Point, 2010). Although the selection of units differs among the pathways, the curricular content of each unit remains consistent and allows for easy transitions to other pathways should a student wish to change programs.

Mathematics Redesign. Since the redesign, developmental requirements are consistent across many of the colleges and essential components are integrated throughout the curriculum (Bickerstaff et al., 2016). According to Bickerstaff et al., (2016) the developmental math content was revised to standardized prerequisite policies for college-level math courses. For example, students wanting to take a technical math or liberal arts math are required to take fewer modules (p. 6). Developmental curricula align with curricula where college-level math courses are introduced (Bickerstaff et al., 2016; Virginia Community College System, 2011) and many of the community colleges have organized one-credit hour modules that are four weeks in length (VCCS, 2011). Virginia also has nine modules in its redesigned mathematics. In addition, the new math placement and diagnostic tool, the Virginia Placement Test for Math (VPT-Math), more accurately identify specific modules a student needs to complete, if any, to be eligible for a particular college-level math course was implemented system-wide (VCCS, 2012 p. 1). Besides these changes, course delivery formats have been restructured to offer students both “stand-alone” and “shell” options, “both presenting advantages and drawbacks in terms of student progress, teaching and learning” (Bickerstaff et al., 2016 p. 32). Bickerstaff et al., (2016) describes a stand-alone course as a:

> one-credit course, in which the course number indicates the module. For example, a student enrolled in MTE 020 in Virginia is enrolled in module 2. These courses are primarily offered in four-week terms. Other than the shortened timeframe, stand-alone courses function like other transcripted courses: students who pass the module are awarded a “Satisfactory” on their transcript; students who fail receive a non-passing designation (U or R) and must re-enroll to attempt the course again. Stand-alone courses can be taught using a traditional, lecture-based instructional delivery approach, but some colleges also employ a computer-mediated instructional delivery approach (p. 9).

Advantages of the stand-alone mathematics modules are that teacher-led pacing supports students with weak time management skills and the structure allows for teacher-led, hybrid or computer-mediated approaches (Bickerstaff et al., 2016). Disadvantages, suggested by the researchers are that the stand-alone structure increases exit points—students may exit the sequence not only between semesters but also within a semester; short courses decrease relationship building between instructors and students and scheduling, and registration is burdensome (p. 32). Recent findings from Bickerstaff et al. (2016) suggest that modularized developmental mathematics along with a diagnostic placement test has enabled students to skip modules, which allows for faster progress to college-level math. However, significant numbers of students that test into the module range of 1-5 are not enrolling in college-level math within one year (p. 32). These students may not be progressing to college-level mathematics within a year's time due to increased exit points and the difficulty to make connections across topics and see the math covered in modules as an integrated system (Bickerstaff et al., 2016). Table 1 lists the topics covered by each module.

Demographics of Community College Students

Compared to four-year colleges and universities, community college students tend to be older, more likely women, racially and ethnically diverse, and less likely to attend full-time because they are working and taking care of a family. Students are also more likely to first-generation to attend college and to come from lower-income households (Bragg, 2001; Morest & Bailey, 2006). This significant diversity among the community college student population is due primarily to open access admission and lower tuition cost. Bragg, (2001) reported that the profile of students who attend community colleges, however, is not new. Historically, the student populations of community colleges have been much more diverse than the populations of four-year colleges. Roueche and Roueche (1999) explained that as community college enrollments rose since the 1960s, community college students as a whole became more diverse and more nontraditional than in earlier years.

Table 1

Modularized Developmental Mathematics Curricula

Module	Module Name	Topics Include
MTE 01	Operations with positive fractions	Fraction notation, prime numbers, prime factorization, least common multiple.
MTE 02	Operations with positive decimals and percents	Decimal notation, place value, Addition, subtraction, multiplication, and division of decimals.
MTE 03	Algebra basics	Operations with signed numbers, definition of absolute value, exponents, scientific notation, order of operations, combining like terms.
MTE 04	Linear equations and inequalities in one variable	Solving linear equations by the addition and multiplication principles, solving linear inequalities.
MTE 05	Graphing Linear equations in two variables	Graphing lines using table of values, interpreting bar graphs and line graphs.
MTE 06	Exponents, polynomials, and factoring. Solving equations by factoring.	Simplifying expressions with integer exponents. Introduction to polynomials, addition, subtraction, multiplication, division by monomials.
MTE 07	Rational expressions and equations	Determining values of a variable for which the expression is undefined, simplifying rational expressions, addition, subtraction, multiplication and division of rational expressions.
MTE 08	Rational exponents, radicals, and complex numbers	Rational exponents, simplifying radical expressions, addition, subtraction, multiplication and division.
MTE 09	Quadratic equations, parabolas, and systems of linear equations and inequalities	Solving quadratic equations by the square root method and the quadratic formula. Graphing parabolas, finding the center of a circle by completing the square.

From: Bickerstaff, Fay & Trimble, (2016) and Virginia Community College System, (2010)

Enrollments. Community college enrollments have been increasing for several decades. From 1963 to 2006, enrollment percentages have increased by 741% which is significantly higher than public (197%) and private (170%) four-institution growth (Williams, 2013 p. 28).

The proportion of students attending college had steadily increased through the last century, and the availability of community colleges contributed to this growth. In 2010, 40% of all students beginning their higher education experience began at a two-year public institution (Cohen et. al., 2014). Sixty-one percent of these students were 30 years or older and were more likely to be women (57%) than men (43%) (NCES, 2012). Higher enrollments among women are not surprising given the significant jump in college participation rates of women between 1959 and 2002. College participation among women increased from 39% to 68%, an increase of 29%, while the proportion of men going on to college increased only by about 8%, from 54% to 62% (Mortenson 2003). While these rates reflect participation overall, community colleges benefited significantly (Williams, 2013).

Nontraditional and racial/ethnic minority students have exceptionally high community college enrollments. Cohen et al. (2014) reported that in 1997, community colleges had 38% of the total enrollment in American higher education and were enrolling 46% of minority students (p. 59). By 2010, minority students constituted 42% of all community colleges nationwide (Cohen, et. al., 2014). Disaggregating by racial/ethnic groups nationwide, 16% of all community college students are African American; 18% are Hispanic; 6% are Asian American or Pacific Islander; and 1% are American Indian or Alaska Native (Cohen et. al., 2014). While these enrollments exceed national population statistics for racial and ethnic minority groups, they are explained in part by large concentrations of racial/ethnic minority students residing in states that have expansive community college systems, such as Arizona, California, Florida, and Texas (Bragg, 2011).

Developmental Mathematics Students. More students require developmental math than any other subject (Adelman 2004a; Boylan and Saxon 1999; Parsad & Lewis, 2003). Within the context of the community college, research on the outcomes of taking developmental math is mixed. On the one hand, students who complete their developmental math sequences exhibit attainment comparable to that of students who do not need remediation (Attewall et. al., 2006; Bahr, 2008; Bettinger & Long, 2004). Bahr (2008) analyzed data from 85,894 first-year students enrolled in 107 community colleges and found that long-term academic outcomes of students who remediate successfully with those who achieve college-level math skill without remediation experience comparable results. These findings, according to the researchers, held true across various levels of math skill deficiency (Bahr, 2008). On the other hand, the majority of developmental math students did not complete their sequence(s), attain a credential, or transfer (Bahr, 2008) which may indicate other strong correlates of successful remediation.

The literature on developmental mathematics reports variable success among students who take these courses. Attewell, et al. (2006) and Kozeracki (2002) found the percentage of students who completed a developmental education course to be between 30% and 75%. Bailey, (2009) using longitudinal data from the Achieving the Dream study, found that only 31% of those referred to developmental math finish their sequence.

Additional findings indicate that few students who start three levels below a college-level math course, complete their full sequence within three years—just 16% for math and 22% for reading (Bailey, 2009). Furthermore, students who complete one or more developmental courses may not show up for the subsequent course (Bailey, 2009). For example, Bailey et al. (2005) found that about one-quarter of all students referred to three levels below a college-level course for both math and reading exit between courses. Moreover, when additional developmental coursework is required, the chance of completing the entire sequence of courses decreases significantly (Bailey et al., 2005). Bailey et al., (2005), Bahr (2008), and Attewell et al. (2006) found that 65% to 75% of students enrolled in developmental coursework in both math and English did not complete their developmental program.

Race/Ethnicity. African-American and Hispanic students are more likely to be referred to developmental mathematics than are their White or Asian peers (Hagedorn et al., 1999; Bailey et al., 2005; Bettinger & Long, 2005; Cohen, et al., 2014). Adelman (2004) estimated that 46% of Black students and 51% of Hispanic students enroll in at least one developmental mathematics course. This, in contrast with 31% of White students and 29% of Asian students. Bahr (2010) found that that White students are 60% more likely to pass a developmental mathematics class than Black or Hispanic students. Bailey, Jeong, & Cho, (2010) found that Black or African-American students had significantly lower odds when they were referred to developmental math at two to three or more levels below college-level.

Acevedo-Gil, Santos, Alonso, and Solorzano (2015) examined Latino/a completion and transfer rates to four-year colleges and universities and found that once in community colleges, few complete a college degree, greatly in part due to high participation rates in developmental education. Latino/a students, nevertheless, had greater difficulty advancing through developmental math sequences. Approximately 17% of these students who enrolled in developmental math during fall 2009 completed a transfer-level math course within four years (Acevedo-Gil et al., 2015).

Regarding pre-college-level course performance, Bahr (2010) examined performance on mathematics assessments and found that Black and Hispanic students have the lowest achievement rate among all race/ethnic groups, from kindergarten through twelfth grade. He suggests that these students simply “carry this disadvantage into postsecondary developmental mathematics while White students carry little to no disadvantage even if referred to developmental coursework”. For example, White students in community colleges are consistently more likely to complete their developmental sequences and outperform other race/ethnic groups (Fike & Fike, 2007; Wolfe, 2012). Hagedorn, Siadat, Fogel, Nora, and Pascarella (1999) drew from a sample from the National Center on Postsecondary Learning and Assessment that consisted of first-year college students from 23 colleges and universities in 16 states throughout the country (Hagedorn, et al., 1999). Their findings indicated that Black and Hispanic students are not only overrepresented in developmental mathematics classes but are less likely to be successful throughout their developmental sequences. Similarly, Bailey et al., (2010) and Roksa et al., (2009) found that African-American students, in particular, have lower completion rates in developmental courses in general.

Gender. Previous literature on student outcomes in mathematics shows that men perform better on pre-college mathematical assessments and accordingly are less likely to be referred to developmental math once in college and women are more likely (Bettinger & Long, 2005; James, 2007). Although women are more likely to be referred to developmental coursework, Bailey et al. (2014), Bettinger and Long, (2005), Cho (2011), Fike and Fike (2007) and Roksa et al., (2009), found that in mathematics in particular, they tend to pass at higher rates than their male counterparts and are more likely to complete their full developmental sequence. The National Center for Education Statistics (2003) found among the Achieving the Dream colleges that women were referred at a higher frequency than males—64% of female students compared to 61% of male students (NCES, 2003). However, female students did better in developmental courses and persisted at higher rates than male students. Seventy-four percent of women referred to developmental education persist to the second year, and 61% to the third year (Achieving the Dream Data Notes, 2008; NCES, 2003). In comparison, male students' second-year persistence rate is 69% and third-year persistence is 56% (Achieving the Dream Data Notes, 2008; NCES, 2003).

Age. Age ranges for nontraditional and traditional student groups vary across studies, the typical age range describing traditional students is 18 to 24 years while pursuing an undergraduate degree (Choy, 2002; Horn, 1996; Hoyt, Howell, Touchet, Young, and Wygant, 2010). Nontraditional students are considered 24 or older although non-age variables such as level of employment, race/ethnicity, and financial status are often defined as more accurate measures of a nontraditional student (NCES, 2016). In Virginia, the State Council of Higher Education of Virginia defines nontraditional students as 25 or older at entry (State Council of Higher Education, n.d.).

Notably, students attending community colleges are older than students who attend four-year colleges and universities (Cohen et al., 2014). Non-traditional students enrolled at colleges and universities have consistently been found to succeed at higher rates than their younger peers (Byrd & Mcdonald, 2005; Roksa et al., 2009). Roksa et al. (2009) conducted a study of VCCS developmental student outcomes using 24,140 first-time in college student cohort data starting in fall 2004. They found older students (those who were 25 years or older) are more likely to pass developmental courses than are younger students. They went further to explain that older students are notably less likely to enroll in developmental courses but when they did enroll, they were quite successful (Roksa et al., 2009). Byrd and Macdonald (2005) examined older, first-generation community college students and found that older students are more successful in their college work due to skills they obtained from their life experiences.

Research on student performance outcomes in developmental mathematics based on age however, show results are more positive for traditional-aged students. Seemingly, the majority of literature finds that non-traditional-aged or older students outperform their younger peers whereas others have found the opposite outcome. For instance, Bailey et al. (2010) in their Achieving the Dream study which included some colleges in Virginia, and found that older students tended to have lower odds of passing to a higher developmental level than their younger peers. Similarly, Bettinger and Long (2005) found that younger students are more likely to complete their developmental sequences than are their older peers. Both of these results may suggest that younger students remember mathematical concepts, even at a developmental level because of when they graduated high school—less than two years prior, compared to their older peers.

Adjunct Faculty: Demographics and the Nature of Part-Time Employment

More recent literature on adjunct use among institutions of higher education show that in 2009, 70% of faculty were adjuncts, the highest ratio in history (Cohen et. al., 2014). Likewise, the National Center for Educational Statistics (2011) show that nearly three-fourths of faculty members are employed as adjuncts and the remaining fourth hold full-time faculty positions (NCES, 2012). By 2009, among the 400,000 faculty hired nationwide, adjuncts make up 70% (CCCSE, 2014).

Characteristics. In a 2009 study of adjunct faculty at four-year colleges and community colleges, 500 adjunct faculty members who were currently employed at each type institution were surveyed. Findings showed that adjunct demographics closely align with their full-time counterparts by gender, age, academic background, and racial/ethnic background (American Academic, 2010). Overall, adjunct instructors are an even mix of men (52%) and women (48%) within all institutions of higher education. However, women make up the majority (54%) of adjunct instructors at community colleges while men make up the majority (56%) at four-year institutions (American Academic, 2010). With respect to race/ethnicity, national statistics indicate the vast majority of faculty to be White, even at a time when more students are coming from diverse racial/ethnic backgrounds (Jeffcoat & Piland, 2012). Most adjunct faculty in the American Academic study were non-Hispanic Whites (84%), with the remainder being African American (4%), Hispanic (3%), Asian (2%), and Other (3%) (American Academic, 2010). In addition, the survey found 83% of adjunct faculty have either a master’s degree (57%) or a Ph.D./professional degree (26%) (American Academic, 2010). Approximately 13% had only a four-year degree. Thirty-three percent of adjuncts who taught at four-year institutions are more likely to have a Ph.D. compared to those who taught at a community college (16%) (p. 8). Table 2 lists adjunct characteristics, institution type, and employment status.

A comprehensive five-year study of contingent faculty—which includes what is termed, adjunct faculty, was conducted. The *Contingent Commitments: Bringing Part-Time Faculty into Focus* (2014) report, data were drawn from the Community College Faculty Survey of Student Engagement (CCFSSE), and responses from 2009 to 2013 of a total of 71,451 were gathered. The survey elicited instructors' perceptions about student experiences as well as reports about their teaching practices and use of professional time. In addition, 32 focus groups were conducted with adjunct faculty, full-time faculty, administrators, and staff at community colleges across the country (CCSSE, 2014). Similar to the American Academic study (2010) the CCSSE (2014) study found that community college adjunct faculty are more likely to hold a master's degree (67%) than a Ph.D. (11%). Thirteen percent hold a bachelor's degree. Like the previous study, adjunct faculty teaching at community colleges are more likely to report that the highest degree earned is a bachelor's degree (13% vs. 8% for full-time faculty). Regarding teaching experience, adjuncts fall on both ends of the continuum. Thirty-seven percent of adjunct faculty are more likely than full-timers (13%) to have fewer than five years of teaching experience but on the other end, 39% of these faculty have 10 or more years of teaching experience compared to 65% of full-time faculty (CCSSE, 2014). More than three-quarters of adjunct faculty have a rank of instructor or lecturer, compared with less than half of full-time faculty. Finally, adjunct faculty are more likely to teach only developmental education courses compared to full-time faculty (16% and 5%

respectively) although 66% teach college-level courses only. Table 3 lists the educational characteristics of adjunct faculty.

The percentage of adjunct faculty varies from state to state and by discipline; in general community college adjuncts teach more than one course a semester and approximately 30% teach three or more classes per semester (Berger, Kirshstein, Zhang, & Carter, 2002; Green 2007). Levin, Kater, and Wagoner (2006) explained that faculty members can be divided into five categories: academic; occupational transfer; vocational; developmental; and librarians or counselors.

> A full 47% of both full and adjunct community college faculty members work in academic areas, including humanities, science, and social sciences. Another 40% work in occupational areas from which students frequently transfer: business, computing, and nursing. A much smaller eight percent work in vocational areas such as industrial arts, drafting, and child care. Four percent work in developmental or remedial education and four percent report themselves as librarians or counselors (p. 68).

Nature of Adjunct Teaching

Citing Wickrun and Stanley (2000), Hutto (2013) identified the lack of institutional support as a weakness in the adjunct faculty system and suggests it as a form of institutional control. Unsupportive teaching and administrative support environments are evidenced in key ways: low salaries, no health benefits, lack of office space, phones, orientations, syllabi, guidance and methodological advice from full-time faculty (Hutto, 2013; Jaeger & Eagan, 2008; Wickrun & Stanley, 2000). Low salaries and lack of office space are themes repeated in several studies about adjunct instructors in community colleges, although four-year institutions have similar environments (Jaeger & Eagan, 2008; Schuetz, 2002; Umbach, 2007; Wickrun & Stanley, 2000; Ansparger, 2014).

Table 2

Demographic Characteristics of Adjunct Faculty, Institution Type and Employment

Demographic Characteristics	P
Racial/Ethnic Demographics	
Whites, non-Hispanic	84
African Americans	4
Hispanics	3
Asians	2
Age	
Age 18 to 44	33
Age 45-54	31
Age 55 or over	36
Gender	
Men	52
Women	48
Type of Institution	
Public two-year institution	41
Public four-year institution	33
Private four-year institution	26
Employment	
One part-time teaching job	34
Multiple teaching jobs	28
Have non-teaching jobs	38

Source: American Academic, 2010

Table 2

Educational Characteristics of Adjunct Faculty: Highest Degree Held, Years of Teaching Experience and Percentage Developmental Education Courses Taught

Educational Characteristics	P
Highest Degree Held	
Doctoral degree	11
Professional degree*	3
Master's degree	67
Bachelor's degree	13
Associate degree	3
Other	2
Years of Teaching Experience	
30 years or more	6
10-29 years	33
5-9 years	26
1-4 years	28
First year	9
Faculty Rank	
Full professor	7
Associate professor	4
Assistant professor	3
Instructor	73
Lecturer	5
Other	9
Developmental Education Courses	
Developmental courses only	76
Developmental and college-level courses	24

Source: Center for Community College Student Engagement (CCCSE), 2014
Note: n = 23,347
Note. *MD, DDS, JD, and DVM

Ansparger (2014) describes how it is not uncommon for adjunct faculty to learn which, if any, classes they are teaching just weeks or days before a semester begins. Their access to professional development, administrative, and technology support and accommodations for meeting with students typically is limited, unclear, or inconsistent. Moreover, these instructors have infrequent opportunities to interact with other faculty about pedagogy and are rarely included in meaningful discussions about the kinds of changes needed to improve student learning, educational progress, and student success outcomes (Jaeger & Eagan, 2008; Schuetz, 2002; Umbach, 2007). Schuetz, (2002) examined differences in "faculty behaviors that help students learn" and found that adjunct faculty are "twice as likely to report spending no time with students" (p. 42). Numerous studies examining the effects of faculty-student interactions on student performance and engagement, reveal the importance of faculty interaction outside the classroom as critical to student learning and persistence (Astin, 1993; Pascarella & Terenzini, 1998; Tinto, 1993; Tinto & Russo, 1994). Furthermore Schuetz (2002) and Krier and Staples (1993) found that these faculty are monitored through a variety of means such as attendance/sign-in sheets, periodic classroom evaluations by supervisors, and course evaluations by students. He suggested administrative methods such as these can contribute to a sense of isolation adjunct faculty.

Colleges depend on adjunct faculty to educate more than half of their students, yet they do not fully embrace these faculty members. Because of this disconnect, teaching part-time can have consequences that can negatively affect student engagement and learning.

Student Outcomes. Until recently, there were few studies providing reliable evidence on the impact of faculty status on student outcomes (Tinto, 2006). More recently, research that focuses on the relationship between student exposure to adjuncts and their effect on various student outcomes such as retention, graduation, and transfer and grade inflation at community colleges have become more prevalent. Burgess and Samuels (1999), examined the impact of full-time versus adjunct instruction on student performance and persistence in selected sequential courses. Data analyses of a large, urban multi-campus community college district, indicated that students whose first course was taught by full-time faculty are better prepared for their second, subsequent course than are students whose first course was taught by an adjunct instructor. In a qualitative study conducted by Pannapacker (2000), it was concluded that the usage of adjunct faculty had a negative impact on students. Using a combination of personal interviews and observations conducted at six colleges over a 14 year period, he identified 10 ways that dependence on adjunct instructors harms students. These 10 ways are: faculty inaccessibility, inadequate advising, incoherent curricula, declining faculty expertise, impaired academic freedom, lowered academic standards, grade inflation, lowered value of degree, student cynicism, and costs to students and their families (p. 35). Calcagno et al., (2008) and Jaeger and Eagan (2009) used data from the National Education Longitudinal Study of 1988 (NELS: 88) and the Integrated Postsecondary Education Data System (IPEDS) to examine the effect that institutional dependence on adjunct faculty members had on the graduation rates of students at community colleges. Results showed that there was a significant and negative relationship between the number of adjunct faculty employed at the institution and student degree completion (i.e., certificate or associate's degree) or student success in transferring to a four-year institution. However, at the time, the results did not provide enough evidence that specifically addressed the relationship between adjunct faculty and associate’s degree completion rates (Jaeger & Eagan, 2009). Jacoby (2006) examined whether graduation rates at community colleges nationwide differed as institutions increased their use of adjunct faculty. Jacoby’s study focused on institution-level data only. His conclusion was that increased employment of adjunct faculty at community colleges negatively affect institutional associates’ degree completion rates. Jaeger and Eagan (2009) used hierarchical generalized linear modeling to analyze student and institution-level data from the California community college system to determine how student exposure to adjunct faculty affects the likelihood of earning an associate’s degree. Their findings indicated that students experience a significant yet modest negative effect on the probability of completing an associate's degree. As students' exposure to adjunct faculty increased, students’ likelihood of completing an associate's degree significantly decreased. This effect remained stable across time as students advanced through their academic programs.

Kuh, Laird, and Umbach (2004) studied instructional practices and student engagement data from the National Survey of Student Engagement and the Faculty Survey of Student Engagement. Their examination revealed differences in the instructional methodology of full-time versus adjunct faculty. Findings suggest that adjunct faculty are less likely than full-time faculty to engage in activities and assignments that are academically challenging, and encourage student collaboration and group projects (Kuh, Laird, & Umbach, 2004; Schuetz, 2002).

Grading. Along with pedagogical differences between full-time and adjunct faculty, differences in grading exist as well. Grade inflation, is defined in many ways but the prevalent explanation is that it is as an increase in grade point average without an associated increase in overall student ability. Kezim, Pariseau, and Quinn (2005) found an upward trend over the past two decades, correlating with increased usage of adjunct faculty. They examined the grading practices of full-time tenured, full-time non-tenured and adjunct faculty in a small business school in the Northeast. Adjunct faculty grades were consistently higher than those of full-time faculty, suggesting that grade inflation intensifies with the increased use of adjunct faculty. Caruth and Caruth (2013) postulated the reasons for higher student grades on the part of adjunct faculty which included: fear of student evaluations, avoidance of bad relations with students, below average teaching skills, lack of experience, a lack of clearly stated objectives, and job security (p. 108). Consistent with this finding, Sonner (2000) in a study comparing average class grades given by adjunct and full-time instructors over a two-year period at a public university, found that adjuncts give higher grades. However, grade inflation, has been found to be not as prevalent at community colleges and less-selective universities (Jaschick, 2016; Oppenheimer, 2014). In a study conducted by Rojstaczer and Healy (2016) on grade inflation in community colleges, it was found that grades dropped on average by .04 points from 2002 to 2012 compared to four-year institutions. They speculated that although community colleges hire significantly more adjunct faculty, that the lower sense of entitlement, higher lack of academic preparedness, and part-time status has led to less pressure to award higher grades.

Not all studies on the effects of adjunct faculty on student outcomes are negative. However, a considerable amount of literature focuses on institution-level outcomes such as retention, persistence, transfer and graduation and many of those studies examine four-year institutions. For example, Figlio, Schapiro and Soter (2013) in a National Bureau of Economic Research study of eight cohorts of freshmen who entered Northwestern University from fall 2001 through fall 2008, found that new students learn more when their instructors are adjuncts than tenure-track professors. These results “held for all subjects, regardless of grading standards or the qualifications of the students the subjects attracted” (p. 15).

Researchers also recognize some limitations of institution-level assessment of faculty status and student outcomes have analyzed student performance at the course-level. Leslie and Gappa (1995) asserted that adjuncts may positively affect student outcomes by fostering interest in a subject compared to a full-time faculty member because they bring “real world” applications to the classroom. Bettinger and Long (2010) examined the effects of instructor type by matching individual student course outcomes to particular instructors. However, their focus was on three outcomes related to course-taking patterns such as whether any additional courses are taken in the subject, not pass-rates in a particular course (p. 4). This finding did not include developmental courses but did highlight how taking an initial course in a given department from an adjunct instructor might lead to beneficial outcomes for students (Bettinger & Long, 2010). Their findings suggests that taking a class from an adjunct often increases the number of subsequent courses that a student takes in a given subject and might also increase the likelihood that the student majors in the subject (p. 14). Further analysis suggests that “adjunct instructors are especially effective in fields that are more directly tied to a specific profession, like education and engineering, although they also had relative positive effects in the sciences” (Bettinger & Long, 2010, p. 14). Again, while the study does not include developmental courses, similar results might suggest to community college students that having an adjunct instructor at the outset of their developmental education might lead to better results. Specific to community colleges, Rossol-Allison and Beyers, (2011) used regression analysis to determine the long-term student success of fall 2005 cohort of incoming first-time, degree-seeking undergraduates (n = 1,466) at a large two-year suburban community college in the Midwest (p. 9). Student demographic, enrollment and grade data along with faculty type/status were collected from the student census file and semester end of term data. Results show that unlike Jacoby’s (2006) findings, faculty status does not have a significant impact on student grades. Particularly, “students who are mostly taught by adjunct faculty are just as likely to pass a course, graduate or transfer as their peers who had a full-time instructor for the majority of their coursework” (p. 10).

Adjunct Faculty and Developmental Mathematics

Adjunct faculty are significantly more likely to teach only developmental education classes than are full-time faculty. Boylan (2002) found that over 60% of the nation's community college developmental courses are taught by an adjunct instructor suggesting that the characteristics of these faculty closely reflect the characteristics of a typical developmental education instructor (CCSSE, 2014). In the 2014 CCSSE report, 76% of faculty who teach only developmental education courses are employed as adjuncts while only 24% of faculty who teach developmental education are employed full-time (p. 9). Similar findings by the American Mathematical Association of Two-Year Colleges (2006) suggest that only 42% of developmental mathematics courses are taught by full-time faculty suggesting that approximately 58% of adjunct faculty teach developmental mathematics courses.

Large percentages of adjunct faculty teach development courses, in general, suggests that adjunct faculty have a significant effect on the quality of teaching and learning experienced by developmental students. For example, the educational background of developmental mathematics faculty varies widely. Developmental mathematics faculty either possess a bachelor’s or a graduate (master’s or Ph.D.) degree. This requirement as a minimum for teaching developmental courses is usually set internally (Cafarella, 2013, p. 28). In Virginia’s community colleges, the minimum requirement for faculty teaching ESL and developmental courses at the instructor level is a bachelor’s degree (Virginia Community College Policy Manual, VCCS-29, 2013). CCSSE (2014) reported that 25% of faculty who teach only developmental education courses have only a bachelor’s degree. In contrast, five percent of these faculty who teach only developmental courses has a Ph.D. as their highest degree (p. 7).

Research on faculty educational attainment and its impact on developmental student outcomes has been mixed. Fike and Fike (2007) examined a sample of 1,318 students enrolled in Intermediate Algebra classes at a community college. Results indicated that faculty education level is correlated with final course grades. In particular, courses taught by faculty members with only a bachelor’s degree achieve lower grades than students taught by faculty with graduate degrees. Fike and Fike (2007) state that “mathematics faculty with advanced degrees may have a better understanding of mathematical principles and concepts and convey this understanding in their instruction" (p. 7). This conclusion, however, contradicts the findings of Gupta, Harris, Carrier, and Caron (2006), who reported that developmental mathematics students who were taught by a faculty member with a bachelor's degree received higher grades than those students taught by faculty members with a graduate degree. However, given these findings, Boylan and Saxon (2005) asserted that developmental mathematics courses should be taught primarily by full-time faculty due to their permanent status at the institution and likelihood of higher educational attainment. They further asserted that because developmental education students are most at risk, they require the best instruction which is assumed to come from full-time faculty.

Community College Location

In 2005, the Carnegie Classification of Institutions of Higher Education developed a new classification system which disaggregated two-year institutions by geographic service area and institutional size (Carnegie Classification of Institutions of Higher Education, 2015). This classification system identifies that community colleges are heavily defined by the population and location they serve by categorizing them as rural-serving, suburban-serving, and urban-serving institutions.

An additive revision was made to the basic classification in 2015. Specifically, the 2015 update includes associate's college categories based on program mix and student mix and size categories (Carnegie Classification of Institutions of Higher Education, 2015). Size, that is the number of enrolled students, is separately calibrated into five categories for two-year colleges. Two-year colleges, which may also include junior colleges, are categorized as very small (< 500), small (500-1,999), medium (2,000-

4,999), large (5,000-9,999) and very large (10,000+) (Carnegie Classification of Institutions of Higher Education, 2015). These classifications allow for differentiation along institutional type and size. Therefore an institution can be defined as an Associates, rural-serving medium sized institution (Carnegie Classification of Institutions of Higher Education, 2015).

Differences between rural, suburban, and urban geographic regions show differences relative to student outcomes and educational attainment among students. For example, urban and suburban institutions have more part-time students than rural institutions. Copeland, Tietjen-Smith, Waller, and Waller (2008) confirmed retention rates for part-time students were lower than their full-time counterparts in community colleges. Even with more part-time students, "community colleges in urban and suburban areas out-perform community colleges in rural areas" (Copeland et al., 2008 p. 2). Community colleges in urban and suburban areas are usually larger institutions that serve more students than those in rural areas.

In a 2000 U.S. Department of Agriculture report, it was found that urban and non-urban (which they defined as suburban and rural) residents differ in key educational characteristics, most importantly educational attainment. The report suggests that the college completion gap was largest between the urban and non-urban areas (Dogbey, 2010). Some reasons given were: relatively low attendance rates among rural students and lack of managerial, technical, and professional employment opportunities. Student performance results from the report suggests that rural students, on average, perform approximately as well as urban students but slightly below suburban students (Dogbey, 2010). This finding contradicts Tietjen-Smith, Waller, Waller, and Copeland' (2007) examination of race/ethnicity and student performance in rural, suburban, and urban community colleges. Tietjen-Smith et al., (2007) found that students in rural community colleges had overall pass rates far below the levels of both urban and suburban community colleges regardless of ethnicity. Pass rates from the suburban community colleges were the highest. As well, the study showed higher variability in pass rates for the urban community colleges than the suburban and rural ones.

Enrollments in rural two-year colleges had mostly White, non-Hispanic students in higher percentages while urban and suburban colleges attracted mostly African-Americans, Hispanics, and other racial/ethnic minorities (Tietjen-Smith et al., 2007). African-American and Hispanic student performance, enrollment status (part-time versus full-time) and retention in the urban community colleges accounted for the higher variability. For example, their findings indicate that African-American and Hispanic students at urban two-year colleges had higher dropout rates among part-time African-American and Hispanic students compared to full-time students of the same race/ethnicity (Tietjen-Smith et al., 2007; Bailey et al., 2009). There is however, little research comparing student performance in developmental curricula in rural, suburban, and urban institutions.

Conceptual Model

This study draws from Jaeger and Eagan' (2008) conceptual model that assumes students who are subject to more instruction from adjunct faculty experience fewer meaningful interactions with those instructors than they would with full-time faculty. As stated by the researchers, the result would be that students become less integrated into campus academic culture which has an adverse impact on student performance and ultimately success (p.42). For example, the Community College Survey of Student Engagement (2007) analyzed five years of engagement data and found that almost half (47%) of students responding to the survey indicated they had never discussed course readings with a faculty member outside of class. Additionally, as few as eight percent reported they had often or very often worked with instructors on activities outside of class (Community College Survey of Student Engagement, 2006; Jaeger & Eagan, 2008 p. 43).

Other studies support these findings and further suggest the importance of faculty and student interactions outside the classroom, findings that consistently show that such interactions has a positive, direct effect on degree attainment (Pascarella and Terenzini, 2005; Tinto, 1993). Additional studies applying this conceptual model include: faculty-student interactions and positive predictors of student success (Cotten & Wilson, 2006; Nora, Barlow, & Crisp, 2005; Pascarella & Terenzini, 1977, 2005); student negative perception of adjunct faculty stability and security (Baldwin & Chronister, 2001); and over-reliance on part-time faculty undermining successful student integration (Benjamin, 2003). Cotten and Wilson (2006) conducted nine focus groups between February and April 2002, with undergraduate students at a medium-sized public research university in the mid-Atlantic region of the United States. Most students in the study reported they had some interaction with faculty. However, "they also indicated that interactions were infrequent, and not a routine part of their academic experience. Several students reported that they had never interacted with a faculty member outside the classroom" (p. 495).

Tinto (1993) emphasized the critical importance of faculty members in fostering student development and encouraging student persistence in college. Faculty-student interactions according to Tinto, encourages social integration (Kuh et al., 1994). Tinto, in earlier research, also asserted that informal out-of-class contact between faculty and students has been found to promote the persistence of students who are “withdrawal prone,” such as low-income, first-generation college students (Tinto, 1975). Astin (1993) reached a similar conclusion. He completed a 25-year longitudinal study, which included a national sample of approximately 500,000 students and 1300 institutions of all types. He found that “student-faculty interaction was significantly correlated with every academic achievement outcome examined, namely: college GPA, degree attainment, graduating with honors, and enrollment in graduate or professional school” (Cuseo, 2008, p. 2).

Jaeger and Eagan (2008) research findings suggested that interactions between faculty and students, particularly outside of the classroom, serves as a positive predictor of academic achievement and overall satisfaction with the college experience (p. 43). Literature that show positive outcomes such as these among students becomes a valuable resource for community colleges who especially rely on adjunct faculty. For example, Polizzi and Ethington (1996) investigated student-faculty interactions at community colleges and found that the extent of these interactions had a positive influence on perceived career preparation growth, particularly for students in trade and industry fields. Student-faculty interactions also appear to have a positive impact on the likelihood of students choosing careers in academic and scientific research (Astin 1993; Pascarella and Terenzini 2005). It is possible that students who have few interactions with adjunct faculty or who have few meaningful connections to these faculty may become dissatisfied with their college experience, may not perform as well academically ” (Jaeger & Eagan, 2008) or may drop-out”.

Summary

This chapter has presented the theoretical and empirical literature on multiple topics concerning developmental education, developmental education in community colleges, demographics of community college students and developmental students. Adjunct faculty and developmental education, Virginia's developmental redesign, institution location and type, differences in developmental student success based on age, gender and race/ethnicity were also described. Finally, a conceptual model drawn from studies on the salutatory effects of faculty-student interactions was discussed. This review has provided literature that underscores the importance and timeliness of analyzing the impact adjunct faculty have on developmental mathematics student success. The next chapter will provide the methodology that will be used to answer the research questions.

CHAPTER 3

METHODOLOGY

This chapter outlines the methodology that will be used in this study, including the context of the study, description of study participants, variables, data collection and analysis procedures.

This study is a quantitative cross-sectional design and will use secondary instructor and First-Time-In-College (FTIC) student level ex post-facto data from fall 2013 to fall 2015, collected by the Academic Services and Research department of the Virginia Community College System (VCCS). This method will be used because it allows for assessment of more variables than is often needed to answer any given research question. Such data also tracks participants longitudinally and has representative samples (Greenhoot & Dowsett, 2012). Data from fall 2013 to fall 2015 coincides with the full implementation of the redesigned developmental math in the VCCS.

The purpose of this study is to examine the contributory effects of faculty employment status (full-time versus adjunct), student race-ethnicity, gender, and age and student enrollment in rural, urban and suburban community colleges on student's pass-rate performance in MTE developmental mathematics modules in Virginia community colleges. Based on the literature, this study will be guided by the following two research questions:

Research Question 1a: What is the relationship between faculty employment status, student race/ethnicity, age, gender, and enrollment in a rural, urban, and suburban community college on students earning a passing course grade (S) in all of the nine developmental mathematics modules overall?

H1. There will be a significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade in all of the developmental mathematics modules overall.

H2. There will be a significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing in all of the developmental mathematics modules overall.

H3. There will be a significant negative relationship between students of Hispanic or Latino race/ethnicity and receiving a non-passing grade in all of the developmental mathematics modules overall.

H4. There will be a significant negative relationship between students who are male and receiving a non-passing grade in all of the developmental mathematics modules overall.

H5. There will be a significant negative relationship between traditional-age and receiving a non-passing grade in all developmental mathematics modules.

H6. There will be a significant negative relationship between enrollment in a rural community college compared to enrollment in a suburban community college and receiving a non-passing grade in all of the developmental mathematics modules overall.

H7. There will be a significant negative relationship between enrollment in an urban community college compared to enrollment in a suburban community college and a non-passing grade in all of the developmental mathematics modules overall.

H8. There will be a significant negative relationship between enrollment in a suburban community college compared to enrollment in a rural and urban community college and a non-passing grade in all of the developmental mathematics modules overall.

Research Question 1b. What is the relationship between faculty employment status, student race/ethnicity, age, and gender and enrollment in a rural, urban and suburban community college on students earning a passing course grade in each of the nine developmental mathematics modules respectively?

H9. There will be a significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade in each of the nine developmental mathematics modules respectively.

H10. There will be a significant negative relationship between students of Black or African race/ethnicity and receiving a non-passing grade in each of the nine developmental mathematics modules respectively.

H11. There will be a significant negative relationship between students of Hispanic or Latino race-ethnicity and receiving a non-passing grade in each of the nine developmental mathematics modules respectively.

H12. There will be a significant negative relationship between students who are male and receiving a non-passing grade in each of the nine developmental mathematics modules respectively.

H13. There will be a significant negative relationship between traditional-age and receiving a non-passing grade in each of the nine developmental mathematics modules.

H14. There will be a significant negative relationship between enrollment in a rural community college compared to enrollment in a suburban community college and receiving a non-passing grade in each of the developmental mathematics modules.

H15. There will be a significant negative relationship between enrollment in an urban community college compared to enrollment in a suburban community college and receiving a non-passing grade in each of the developmental mathematics modules.

H16. There will be a significant negative relationship between student enrollment in a suburban community college compared to enrollment in a rural and urban community college and receiving a non-passing grade in each of the developmental mathematics modules.

Background

This study will be conducted within the Virginia Community College System (VCCS). The VCCS was formed in 1966 for the purposes of establishing "the foundation of a network of community colleges throughout Virginia" (Virginia Community College System Annual Report, 1966-1967). As a result, 23 community colleges were created in Virginia with the same policies, course descriptions, degree programs, and institutional structure (Virginia Community College System, n.d). Each community college offers both college-level and developmental mathematics with the same course objectives that allow comparisons of student-level data independent of the community college that she or he is enrolled (Wolfe, 2012). Currently, the Virginia Community College System provides postsecondary education to an average headcount of 280,000 students each year.

Across the VCCS, the colleges and their students are highly diverse. Northern Virginia Community College is the largest educational institution in Virginia and the second-largest community college in the United States comprising more than 75,000 students (NOVA About Us, 2015). Eastern Shore Community College is one of the nations' smallest, with an approximate enrollment of 990 in 2013 (Commonwealth Data Point, 2013). Therefore, Virginia's community colleges are found in both large suburban and urban centers and more isolated rural communities. Each institution's service region influences the demographic makeup of the college as well as its curricular and programmatic offerings. Furthermore, the diversity found across the system is representative of the composition of student's across the United States. This creates the ability to generalize findings from this study to non-VCCS community colleges (Wolfe, 2012).

Course pass-rates, persistence, and fall-to-fall retention all define academic success and are influenced by a number of institutional, individual, and community wide factors. Institutional size, college policies, services provided by the college, per capita income of the service communities, income, high school grades, motivation towards higher education, and other factors contribute to student persistence and retention (Wolfe, 2012). Data from the VCCS colleges will provide an adequate cross-representation of its students and faculty.

Data Collection

The centralized data collection system of the VCCS allows for the assemblage of data from each of the 23 community colleges. This simplifies and makes more efficient the process of compiling data from all of Virginia's community colleges and conducting research with a statewide sample (Wolfe, 2012). A Request for the Release of VCCS Data form will be submitted by this researcher. All data requested this researcher must be compatible with the mission and goals of the VCCS (VCCS Procedures for Research, 2008). Upon receipt of the data request, the VCCS Research Review Team (RRT) is charged with reviewing and approving or disapproving proposals (VCCS Procedures for Research, 2008). Once the RRT has made its determination, the director of institutional research will notify this researcher via email. If the proposal is accepted, the notification will include: procedures to be followed by the researcher; special conditions or constraints which may apply to the research project; how data will be provided (SAS dataset or flat file); and how data will be destroyed (VCCS Procedures for Research, 2008).

Upon approval, the data will be delivered as an Excel spreadsheet file. Data will be collected for fall 2013 through fall 2015 for FTIC students who began development mathematics modules during the fall 2013 semester. Demographic data collected will include student age, gender, and race/ethnicity, all developmental mathematics modules in which the student had enrolled, and grades for each module in which a student has enrolled. Pseudo-IDs will be given prior to dissemination by the Academic Services and Research department and applied to each student to allow for preservation of confidentiality and compilation of the data on a per-student basis. Students who are 16 years or younger (neither traditional nor nontraditional age) will be selected out from the sample. Only students who began their developmental sequences fall 2013 will be in the sample and therefore, there will be no students included in the sample who did not begin a module.

Faculty data will include employment status (full-time and adjunct) as well as faculty gender and race/ethnicity variables, which will be run for descriptive purposes.

The data that are collected and distributed by the VCCS is reliable and consistent in what the data are supposed to measure, specifically, its statewide measure of student performance. According to the assistant vice chancellor of institutional effectiveness for the VCCS:

> These data come directly from the Student Information System or SIS, where it is verified to the extent possible by students, faculty, college registrars and others. Once we pull data into the official files, we use a series of technological validation checks which are reviewed and cleared by college staff before the data is locked. It's as reliable as any data can be in a system that requires input and intervention from multiple humans (C. Finnegan, personal communication, February 10, 2016).

Independent Variables

The independent and dependent variables inputted SPSS are listed in Table 4.

Faculty Employment Status. The variable Faculty Employment Status will be coded with 1 to represent adjunct instructors and 0 to represent non-adjunct instructors.

Traditional-Age. The variable Traditional-Age student will be coded with a 1 to represent traditionally aged students (17 to 22) and with a 0 to represent non-traditionally aged college students (23 and older).

Student Race/Ethnicity. The variable Student Race/Ethnicity will be derived from the VCCS dataset using the NCES categories for race-ethnicity; therefore, Black or African American will be coded with a 1 to represent Black or African American students and 0 for non-African American students. The variable Hispanic or Latino will be coded with a 1 to represent a Hispanic or Latino student and with 0 to represent a non-Hispanic or Latino. The variable White will be coded with a 1 to represent a White student and 0 will represent a non-White student. The variable "Other" will be coded with a 1 to represent a non-White, non-Black, and non-Hispanic student and with a 0 to represent a Black or African American, Hispanic or Latino, or White student.

Student Gender. The variable Student Gender will be derived from the VCCS dataset and will be coded with 1 to represent male students and 0 to represent female students.

Rural, Urban and Suburban. The variables Student Rural versus Suburban and Student Urban versus Suburban will be derived from the VCCS dataset and will be coded 1 to represent Rural, 2 to represent Urban and 3 to represent Suburban.

Dependent Variables

Pass Rates. The dependent variable Pass-Rates will be derived from the VCCS dataset. Students who pass (S) will be coded as 1. Students who do not pass (U) will be coded as 0.

Table 3

Predictor Variables and SPSS Inputs

Variables	SPSS Input
Faculty Employment Status	Adj_fac
Developmental Modules	DM_MTE
Faculty Gender	Fac_Gen
Faculty Race/Ethnicity	Fac_Re
Pass Rate	Grade_Pass
Traditional Age	Stu_Age
Student Gender	Stu_Gen
Student Race/Ethnicity (for all groups)	Stu_Re
Student Black or African-American	Stu_Black
Student Hispanic or Latino	Stu_Hispanic
Student Other	Stu_Other
Student Rural versus Suburban	Stu_Rural_v_Suburban
Student Urban versus Suburban	Stu_Urban_v_Suburban

Grouping Variables

Developmental Module. The grouping variable, Developmental Module MTE (DM-MTE) will be determined by the developmental modules 1-9 in the full developmental sequence. Each module will be coded as the following; MTE 1, MTE 2, etc. These variables will be further defined and coded based on developmental pathway: Career-Technical (MTE 1-3 for modules 1-3), Liberal Arts (MTE > 3 and MTE < 6 for modules 4 and 5), and STEM (MTE > 5 for modules 6-9).

Subjects

The sample for this study is all FTIC students who enrolled in a Virginia community college MTE math module during the fall 2013, 2014 and 2015 semesters. The VCCS consists of 23 community colleges each of which offers a variety of occupational and college transfer programs, however, only 11 community colleges offered MTE math modules. This sample will provide data on students who enrolled in a developmental mathematics module(s) and progressed through each of their required modules. Data comparing full-time and adjunct faculty who taught each of the developmental mathematics modules at these colleges will also be analyzed.

Data Analysis

This study poses two research questions and 16 hypotheses. The dichotomous variables faculty employment status, traditional-age, gender, race/ethnicity, and developmental modules will be created for each student using the values described in the data collection section. The nominal variables, rural, urban and suburban will also be included.

To answer research questions 1a and 1b in the initial selection of variables, logistic regression analysis will be performed. Influencing factors believed to have an impact on student pass rates in total and from each developmental pathway, will be put in place. Using logistic regression analysis helps determine the significant contributory factors influencing student pass-rates in developmental mathematics modules. Analysis for logistic regression assumes the outcome variable is a dichotomous variable having either a success or failure as the outcome (Maxwell, 2009). A logistic regression model is best when trying to predict membership of only two categorical outcomes (Field, 2013). Logistic regression also yields more accurate predictions of dependent variable probabilities between the observed and predicted probabilities compared to ordinary least squares (OLS) regression **(**Pohlman & Leitner, 2003).

The regression model will use the independent variables: faculty employment status, traditional-age, student race/ethnicity, and student gender and enrollment in rural, urban and suburban community colleges. A preliminary data screen will be performed using frequency tables to examine any missing or implausible values. Descriptive statistics will be generated on race/ethnicity, gender, and age of students enrolled in developmental mathematics courses. Students under the age of 17 years of age will be selected out of the dataset. Descriptive statistics on the race/ethnicity, gender and employment status for all faculty teaching those courses over the same time period will also be conducted. For all analyses, the level of significance will be $p < .05$.

Summary

Chapter 3 provides the methodology that will be used to determine the significant contributory factor(s), faculty employment status, student race-ethnicity, gender and age, and institution-level variables, rural, urban and suburban, that influence the achievement of a passing grade in the VCCS' redesigned developmental mathematics modules. Furthermore, if there are significant differences in passing grades between groups of students based on the same characteristics. Variables, independent, dependent and grouping that will be used in the study, data collection procedures, and subjects have been detailed in the chapter. Finally, logistic regression and chi-square have been presented as the statistical tools that will be used to answer the applicable research question.

Chapters 4 and 5 will present the findings and conclusions respectively. Chapter 4 will present the findings with narratives and tables to explain data obtained from the sample. Chapter 5 will contain a summary of the study along with a discussion of the findings as they relate to previous literature. This chapter will also provide implications of the findings for community college administrators in Virginia as well as other states and will suggest areas for future research.

CHAPTER 4

FINDINGS

The purpose of this study was to examine the relationship of faculty employment status (full-time and adjunct), student race/ethnicity, gender, and age on student performance in the Math Essentials (MTE) developmental mathematics modules in Virginia community colleges. Particular emphasis was placed on the effects of adjunct faculty on developmental math student success through these developmental modules. This study examined secondary data of 48,765 First Time in College (FTIC) students enrolled in 11 Virginia community colleges beginning in fall 2013, 2014 and 2015. Only 11 of the 23 community colleges offered the MTE curriculum in the Virginia Community College System (VCCS) during this period. The dependent variable used in this study was pass-rate. The current study considered "success" in the developmental modules as receiving a passing grade as defined by "S".

The dichotomous independent variables are the following: faculty employment status, which was coded with 1 to represent adjunct instructors and 0 to represent non-adjunct instructors; traditional-age student, which was coded with a 1 to represent traditional-age students (17 to 22) and with a 0 to represent non-traditional-age students (23 and older); and student race/ethnicity. The variable student race/ethnicity was derived from the VCCS dataset using the National Center for Education Statistics (NCES) categories for race/ethnicity. Black or African American was coded with a 1 to represent Black or African American students and 0 for non-Black or African American students. The variable Hispanic or Latino was coded with a 1 to represent a Hispanic or Latino student and with 0 to represent a non-Hispanic or Latino student. The variable White was coded with a 1 to represent a White student and 0 will represent a non-White student. White students represents the baseline for comparison for all other racial/ethnic groups in the study. The variable “Other” was coded with a 1 to represent a non-White, non-Black, and non-Hispanic student and 0 to represent a Black or African American, Hispanic or Latino, or White student; and Student Gender which was derived from the VCCS dataset, was coded with 1 to represent male students and 0 to represent female students. Finally, the grouping variable Developmental Modules MTE were coded MTE 1, MTE 2 up to MTE 9. These variables are further defined based on developmental pathway: Career-Technical (MTE 1-3 for modules 1-3), Liberal Arts (MTE > 3 and MTE < 6 for modules 4 and 5), and STEM (MTE > 5 for modules 6-9).

Nominal variables, rural, urban, and suburban institutions are also included. These variables were coded as rural versus suburban and urban versus suburban with suburban institutions as the baseline for comparison.

Data Screening

There are a total of 48,765 developmental mathematics students who were identified as FTIC students at 11 Virginia community colleges beginning the fall semester 2013 to fall 2015. This total includes students who continued their enrollment each spring semester but does not include students who enrolled during the summer semesters. Data for the study were reported by the Academic Services and Research Department of the VCCS in three separate Excel files. Each file listed the following information: two Carnegie institution designations to differentiate the size, type (small, medium, large, and very large two-year) and location of institution (public rural-serving large, public urban-serving multi-campus, public suburban-serving single campus);

common pseudo-ID numbers for students which were used to merge the three files; the gender, race/ethnicity, and age of each student; term the student enrolled; developmental module the student was enrolled and credit of the module; race/ethnicity and gender of the faculty member who taught the module and faculty employment status. Students under the age of 17 at the time of enrollment (n=144) were selected out from the sample as they did not fall into either traditionally or non-traditionally aged college student ages which were used in this study. There was missing student and faculty race/ethnicity identifiers. Students and faculty who did not identify a race/ethnicity were excluded from the analyses. There was less than one percent of students (n = 284) who did not select a race/ethnicity and less than one percent (n = 119) of faculty did not select a race/ethnicity. Dichotomous variables representing students and adjunct faculty were created in SPSS that represented the following: traditional- age, student Black or African American, student Hispanic or Latino, student White, student “Other”, student male, grade passed, faculty male, and faculty adjunct. Students and faculty who displayed these characteristics were coded with a 1, otherwise, students and faculty not displaying these characteristics were coded 0.

Descriptive Statistics

Students in the sample mostly attended medium community colleges (43%), secondarily very large community colleges (32%) and then large community colleges (24%). One percent of developmental mathematics students attended a small community college. Analysis of the location and number of campuses of each of these institutions revealed that students were enrolled in MTE modules at mostly single campus suburban institutions (33%) and medium sized rural community colleges (30%).

Fourteen percent of students attended an urban multi-campus community college. Descriptive statistics on these variables are provided in Tables 5 and 6.

Table 4

Carnegie Description of Size of Virginia Community Colleges and Enrollment of MTE

Category	*n*	P
Large two-year	11,612	24
Medium two-year	20,832	43
Small two-year	556	1
Very large two-year	15,765	32

Students were predominantly female (59%), traditional college aged (80%), and White (51%). Black or African American students made up 32% of the students enrolled in the modules. Descriptive statistics on these variables are provided in Table 7.

A majority of faculty members were female (66%) and White (77%). Black or African American faculty made up 17% of the faculty pool. Adjunct faculty were the majority of instructors who taught developmental math (59%). Descriptive statistics on these variables are provided in Table 8.

Enrollment data in MTE modules indicate the majority of students enrolled in MTE 1 (26%) with decreasing enrollment with each subsequent module to MTE 9 (2%). Sixty-six percent of FTIC students passed (S) the developmental modules from fall 2013 to fall 2015. Thirty-one percent received did not pass (U) and three percent withdrew over the same period of time. Descriptive statistics on enrollment in the developmental modules and pass-rates are provided in Tables 9 and 10.

Table 5

Carnegie Basic Description of Locations of Virginia Community Colleges and Enrollment of MTE Students

Category	*n*	P
Rural-serving large	6,446	13
Rural-serving medium	14,386	30
Rural-serving small	556	1
Suburban-serving multi-campus	4,183	9
Suburban-serving single Campus	16,244	33
Urban-serving multi-campus	6,950	14

Two cross-tabulations were created to show the number of students enrolled in the requisite modules leading to a Career-Technical (MTE 1-3), Liberal Arts (MTE 4-5) or STEM (MTE 6-9) credit-bearing mathematics course at the different institutions. Race/ethnicity of students enrolled in each pathway is also included. Analysis of data in Table 11 indicate that the majority of students were enrolled in modules 1-3 which make up the Career-Technical pathway regardless of the location of the institution. Students enrolled on the Liberal Arts and STEM pathways (4-5 and 6-9 respectively) had similar enrollments with some variability based on the location of the community college. Twenty-nine percent of rural students were on the Liberal Arts track. Data of STEM modules show that 27% of urban students were enrolled on this track. The descriptive statistics for student enrollment based on location are provided in Table 11.

Table 6

Descriptive Statistics for Student Sample Demographic Information

Variable	Categories	*n*	P
Gender	Male	20,005	41
	Female	28,760	59
Age	17-22	39,213	80
	23 and older	9,408	19
Race-Ethnicity	White	25,073	51
	Black or African American	15,706	32
	Hispanic or Latino	3,816	8
	Asian	994	2
	American Indian or Alaska Native	313	.6
	Native Hawaiian or Other Pacific Islander	163	.3

Note. Students who did not specify a race/ethnicity or who selected more than one race/ethnicity are not included in table.

Table 7

Descriptive Statistics for Faculty Sample Demographic Information

Variable	Categories	*n*	P
Gender	Male	16,442	34
	Female	32,323	66
Race-Ethnicity	White	37,744	77
	Black or African American	8,433	17
	Hispanic or Latino	302	.6
	Asian	2,065	4
	American Indian or Alaska Native	92	.2
Faculty Employment Status	Full-time	19,805	41
	Adjunct	28,960	59

Note. Faculty who did not specify a race/ethnicity or who selected more than one race/ethnicity are not included in table.

Table 12 shows the race/ethnicity of students who enrolled in each of the developmental tracks. Black or African-American students made up the majority of students enrolled in the Career-Technical modules (65%), then Hispanic (55%) and lastly American Indian or Alaska Native (54%) respectively. White students made up the majority enrolled in Liberal Arts modules (29%) and Asian students made up the majority who enrolled in the STEM track (31%). Thirteen percent of Black or African-American students took the STEM modules.

Table 8

Descriptive Statistics for Enrollment into MTE Modules

Variable	Categories	*n*	P
Developmental Modules	MTE 01	12,616	26
	MTE 02	6,383	13
	MTE 03	7,869	16
	MTE 04	6,647	14
	MTE 05	6,025	12
	MTE 06	4,138	9
	MTE 07	2,501	5
	MTE 08	1,689	4
	MTE 09	897	2

Note: Summer semesters were excluded from the data.

Table 9

Descriptive Statistics for FTIC Student Course Grades for fall 2013 to fall 2015

Variable	Categories	*n*	P
Pass Rate	S	32,114	66
	U	15,221	31
	W	1,430	3

Note: Summer semesters were excluded from the data.

Table 10

Student Enrollment in MTE Modules in Rural, Suburban and Urban Institutions

Variable	MTE Group					
	Career-Technical		Liberal Arts		STEM	
	n	P	*n*	P	*n*	P
Rural	12,028	56	6,102	29	3,258	15
Suburban	11,210	55	5,156	25	4,061	20
Urban	3,630	52	1,414	20	1,906	27

Predictive Models

To answer the questions on whether the predictor variables faculty employment status, student race/ethnicity, gender, age, and enrollment at a rural, suburban, or urban community college influences students' pass-rate performance in all, as well as in each developmental math module, logistic regressions were performed to identify to what extent these variables account for success.

Research Question 1a: Effect of Predictor Variables on Pass-Rates in All Nine Modules

A binary logistic regression was performed with the dependent variable pass-rate in all nine MTE modules and predictor variables faculty employment status, student enrollment in a rural versus suburban community college and an urban versus suburban community college, student race/ethnicity Black, Hispanic, and "Other", student gender and student age. Students identified as Asian, American Indian or Alaska Native and Native Hawaiian have been combined into the category "Other" for all of the following binary regression analyses. Students identified as White represents the baseline group that the other race/ethnic groups are compared. Analyzing the results of the Wald statistic on the interaction variables indicate that students who were male (p =.000), traditional-age (p =.000), African American or Black (p =.000) Hispanic or Latino (p =.007), “Other” (p =.03), attended rural institutions (p =.000) or an urban community college (p =.000) contributed significantly to pass-rates in all nine developmental modules.

Table 11

Student Enrollment in MTE Modules Based on Race/Ethnicity

Category	Variable	MTE Group					
Student Race/Ethnicity		Career-Technical		Liberal Arts		STEM	
		n	P	*n*	P	*n*	P
	White	12,537	50	7,166	29	5,370	21
	Black or African American	10,202	65	3,472	22	2,032	13
	Hispanic or Latino	2,097	55	981	26	738	19
	Asian	465	47	220	22	309	31
	American Indian or Alaska Native	169	54	84	27	60	19
	Native Hawaiian or Other Pacific-Islander	66	41	35	22	62	38

Note. Students whose race/ethnicity is unknown or who selected more than one race-ethnicity are not included.

Adjunct faculty (*p* =.000) also contributed significantly to pass rates in all nine MTE modules. Table 13 presents the regression coefficients (*B*), the Wald statistics, significance levels, adjusted odds ratios [Exp (*B*)], and 95% confidence intervals (CI) for the adjusted odds ratio for the logistic regression pass-rates in all nine modules. To determine the level to which the model fits the data, the Nagelkerke pseudo *R* square statistic was used. The model which includes the predictor variables accounts for three percent of the variation in pass-rates of VCCS students, which can be explained by the eight predictor variables.

To examine the effect the predictor variables have on the outcome variable, the adjusted odds ratio was utilized. Field (2013) explains that if the [Exp (*B*)] or adjusted odds ratio value is greater than one, then it indicates that as the predictor increases, the odds of the outcome occurring increases. Conversely, a value less than one indicates as the predictor increases, the odds of the outcome occurring decreases (p. 784). Table 13 shows the adjusted odds ratio for each predictor variable in the logistic regression model for pass-rates in all developmental modules. Results indicate the following:

Male Student Success. The odds of male students passing all of the MTE modules are 28% less likely than female students.

Traditional-Age Student Success. The odds of traditional aged (17-22) students passing all of the developmental modules are one percent more likely than non-traditional aged (> 23) students.

Black or African-American Student Success. The odds of Black or African-American students passing all of the modules are 40% less likely than White students.

Hispanic or Latino Student Success. The odds of Hispanic or Latino students passing all of the modules are 10% less likely than White students.

"Other" Race/Ethnic Student Success. The odds of "Other" race/ethnic groups passing all nine modules are 8% less likely than White students.

Rural Community College Success. The odds of students who attend a rural community college are 11% less likely to pass all nine developmental modules than students who attend a suburban community college.

Urban Community College Success. The odds of students who attend an urban community college passing all MTE modules are 19% less likely than students who attend a suburban community college.

Adjunct Faculty. The odds of passing all nine modules are 17% more likely if a student has an adjunct versus a full-time instructor.

Summary of the Hypotheses. Research question 1a is comprised of eight hypotheses that state there is a significant negative relationship between the predictor variables faculty employment status, student race/ethnicity, gender, age, and enrollment in a rural, urban, or suburban community college and receiving a non-passing grade in all nine developmental modules. The following hypotheses were or were not supported by the data:

Hypothesis 1 was not supported. It states that there is a significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade in all developmental mathematics modules overall. Hypothesis 2 was supported. It states that there is a significant negative relationship between students who are Black or African-American and receiving a non-passing grade in all nine modules. Hypothesis 3 was supported. It states that there is a significant negative relationship between students who are Hispanic or Latino and receiving a non-passing grade in all nine developmental modules. Hypothesis 4 was supported. It states that there is a significant negative relationship between students who are male and receiving a non-passing grade in all nine developmental modules. Hypothesis 5 was not supported. It states that there is a significant negative relationship between students who are traditional-age and receiving a non-passing grade in all nine developmental modules. Hypothesis 6 was supported. The hypothesis states that there is a significant negative relationship between student enrollment in a rural community college and receiving a non-passing grade in all of the developmental modules. Hypothesis 7 was supported. It states that there is a significant negative relationship between enrollment in an urban community college and receiving a non-passing grade in all of the developmental modules. Hypothesis 8 was not supported. The hypothesis states that there is a significant negative relationship between enrollment in a suburban community college and receiving a non-passing grade in all nine of the developmental modules compared to enrollment in a rural and urban community college. Table 14 lists the hypotheses that were and were not supported by the data.

Research Question 1b: Effect of Predictor Variables on Pass-Rates in Each Developmental Mathematics Module

A binary logistic regression was performed to determine the relationship between faculty employment status, student enrollment in a rural versus suburban community college and an urban versus suburban community college, student age, student Black or African American, Hispanic and “Other” and student gender on earning a passing grade in each of the nine developmental mathematics modules respectively. In this analysis, modules are grouped according to the required modules needed to matriculate into a credit-bearing mathematics course: developmental modules 1-3 (MTE < 4), 4 and 5 (MTE > 3 and MTE < 6) and modules 6-9 (MTE > 6). Tables 15, 17 and 19 present the regression coefficients (*B*), the Wald statistics, significance levels, adjusted odds ratios [Exp (*B*)], and 95% confidence intervals (CI) for the adjusted odds ratio for the logistic regression pass-rates in each of the developmental models.

Table 12

Predictors of Pass-Rates in All Nine Developmental Mathematics Modules

Variable	*B*	Wald	Exp(*B*)	95% CI for Exp (*B*)	
				Lower	Upper
Student Gender	-.329***	283.871	.720	.693	.748
Student Age	.008***	23.870	1.01	1.01	1.01
Student Black or African American	-.510***	516.609	.601	.575	.628
Student Hispanic or Latino	-.102**	7.226	.903	.893	.973
Student Other	-.080*	4.816	.923	.859	.991
Student Rural v Suburban	-.115***	26.995	.892	.854	.931
Student Urban v Suburban	-.209***	50.929	.811	.766	.859
Faculty Adjunct	.160***	65.385	1.17	1.13	1.22
Constant	.809***	388.887	2.24		

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

Table 13

Hypotheses Supported and Not Supported by Data Results for All Nine Developmental Modules

Hypotheses	Supported	Not Supported
H1. Significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade.		X
H2. Significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade.	X	
H3. Significant negative relationship between students of Hispanic or Latino race/ethnicity and receiving a non-passing grade.	X	
H4. Significant negative relationship between students who are male and receiving a non-passing grade.	X	
H5. Significant negative relationship between students who are traditional-age and receiving a non-passing grade.		X
H6. Significant negative relationship between enrollment in a rural community college compared to enrollment in a suburban community college and receiving a non-passing grade.	X	
H7. Significant negative relationship between enrollment in an urban community college compared to enrollment in a suburban community college and receiving a non-passing grade.	X	
H8. Significant negative relationship between enrollment in a suburban community college compared to enrollment in a rural and urban community college and receiving a non-passing grade		X

In order to determine the level to which the model fits the data, the Nagelkerke pseudo *R* square statistic was used for each of the developmental pathways. The model for modules 1-3 which includes the predictor variables accounts for four percent of the variation in pass-rates of VCCS students, which can be explained by the eight predictor variables. The model for modules 4 and 5, which includes the predictor variables, accounts for two percent of the variation in pass-rates of VCCS students, which can be explained by all eight predictor variables. Finally, the model for modules 6-9, which includes the predictor variables, accounts for four percent of the variation in pass-rates of VCCS students.

Modules 1-3. Analyzing the results of the Wald statistic on the interaction variables indicate that students who were male (p =.000), African American or Black (p =.000) Hispanic or Latino (p =.002), "Other" (p =.02), attended rural versus suburban community college (p =.000) or an urban versus suburban community college (p =.000) contributed significantly to pass rates in developmental modules 1-3. Adjunct faculty (p=.000) also contributed significantly to pass rates in this module grouping. Table 15 lists the predictors of pass-rates for modules 1-3. The adjusted odds ratio for each predictor variable for passing modules 1-3 indicates the following:

Male Student Success. The odds of male students passing modules 1-3 are 25% less likely than female students.

Black or African-American Student Success. Students who are Black or African-American are 48% less likely to pass modules 1-3 than White students.

Hispanic or Latino Student Success. The odds of Hispanic students passing modules 1-3 are 15% less likely than White students to pass modules 1-3.

"Other" Race-Ethnic Student Success. The odds of students identified as "Other" passing modules 1-3 are 12% less likely than White students.

Rural Community College Student Success. Students who attend a rural community college are 16% less likely to pass modules 1-3 than students who attend a suburban community college.

Urban Community College Student Success. Students who attend an urban community college are 14% less likely to pass modules 1-3 than students who attend a suburban institution.

Adjunct Faculty. The odds of passing modules 1-3 are 22% more likely if a student has an adjunct versus a full-time instructor.

Summary of the Hypotheses. Research question 1b is comprised of eight hypotheses that state there is a significant negative relationship between the predictor variables faculty employment status, student race/ethnicity, gender, age, and enrollment in a rural, urban or suburban institution and receiving a non-passing grade in each of the nine developmental modules. In this case, each of the developmental modules were grouped by developmental pathway to a credit-bearing mathematics course. Data supporting or not supporting each hypothesis will be described by the pathway (1-3, 4 and 5, and 6-9). The following hypotheses were or were not supported by the data for modules 1-3.

Hypothesis 9 was not supported by the data. It states that there is a significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade in each developmental mathematics module respectively. Hypothesis 10 was supported. The hypothesis states there is a significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade in each developmental mathematics module respectively. Hypothesis 11 was supported.

The hypothesis states there is a significant negative relationship between students who are Hispanic or Latino and receiving a non-passing grade in each developmental module respectively. Hypothesis 12 was supported. It states there is a significant negative relationship between students who are male and receiving a non-passing grade in each developmental module respectively. Hypothesis 13 was not supported. The hypothesis states there is a significant negative relationship between students who are traditional-age and receiving a non-passing grade in each of the nine developmental modules respectively. Hypothesis 14 was supported. The hypothesis states there is a significant negative relationship between enrollment in a rural community college and receiving a non-passing grade in each of the developmental mathematics modules respectively compared to enrollment in a suburban community college. Hypothesis 15 was supported. It states that there is a significant negative relationship between enrollment in an urban community college and receiving non-passing grade in each of the developmental modules respectively compared to enrollment in a suburban community college. Hypothesis 16 was not supported. The hypothesis states that there is a significant negative relationship between enrollment in a suburban community college and receiving a non-passing grade in each of the developmental modules respectively compared to enrollment in a rural or urban community college. Table 16 lists the hypotheses that were and were not supported by the data.

Table 14

Predictors of Pass-Rates in Developmental Mathematics Modules 1-3

Variable	*B*	Wald	Exp(*B*)	95% CI for Exp (*B*)	
				Lower	Upper
Student Gender	-.289***	114.426	.749	.710	.790
Student Age	.002	1.040	1.00	.998	1.00
Student Black or African American	-.652***	450.175	.521	.490	.553
Student Hispanic or Latino	-.164**	9.749	.848	.765	.941
Student Other	-.129*	5.750	.879	790	.977
Student Rural v Suburban	-.171***	31.549	.843	.794	.894
Student Urban v Suburban	-.147***	12.991	.863-	.797	.935
Faculty Adjunct	.199***	53.665	1.22	1.15	1.28
Constant	1.07***	393.394	2.91		

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

Table 15

Hypotheses Supported and Not Supported by Data Results for Modules 1-3

Hypotheses	Supported	Not Supported
H9. Significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade.		X
H10. Significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade.	X	
H11. Significant negative relationship between students of Hispanic or Latino race/ethnicity and receiving a non-passing grade.	X	
H12. Significant negative relationship between students who are male and receiving a non-passing grade.	X	
H13. Significant negative relationship between students who are traditional-age and receiving a non-passing grade.		X
H14. Significant negative relationship between enrollment in a rural community college compared to enrollment in a suburban community college and receiving a non-passing grade.	X	
H15. Significant negative relationship between enrollment in an urban community college compared to enrollment in a suburban community college and receiving a non-passing grade.	X	
H16. Significant negative relationship between enrollment in a suburban community college compared to enrollment in a rural and urban community college and receiving a non-passing grade		X

Note: H13 showed no effect on the dependent variable passing grades.

Modules 4 and 5. The results of the Wald test on pass-rates in modules 4 and 5 indicates that students who are Hispanic (p = .649) and enrolled in an urban community college (p = .636) had no effect on pass rates in modules 4 and 5. Students who are male (p = .000), traditional-age (p = .000), Black or African-American (p = .000), and enrolled in a rural community college (p = .023) contributed significantly to pass-rates in this module pathway. Adjunct faculty (p = .000) also contributed significantly to pass-rates in modules 4 and 5. Table 17 lists the regression results for modules 4 and 5. The adjusted odds ratio for each predictor variable that demonstrated significance in the logistic regression model for pass-rate in these modules indicates the following:

Male Student Success. The odds of male students passing modules 4 and 5 are 28% less likely than female students.

Traditional-Age Student Success. The odds of traditional-age students (17-22) passing modules 4 and 5 are one percent more likely than non-traditional age students (>23).

Black or African-American Student Success. Students who are Black or African-American are 39% less likely to pass modules 4 and 5 than White students.

"Other" Race/Ethnic Student Success. The odds of students identified as "Other" are 13% less likely to pass MTE modules 4 and 5 than White students.

Rural Community College Student Success. The odds of passing modules 4 and 5 for students who attend a rural community college are nine percent less likely than students who attend a suburban community college.

Adjunct Faculty. The odds of passing modules 1-3 are 12% more likely if a student has an adjunct versus a full-time instructor.

Table 16

Predictors of Pass-Rates in Developmental Mathematics Modules 4 and 5

Variable	*B*	Wald	Exp(*B*)	95% CI for Exp (*B*)	
				Lower	Upper
Student Gender	-.332***	78.447	.717	.666	.772
Student Age	.010**	9.880	1.01	1.00	1.01
Student Black or African American	-.495***	124.05	.610	.559	.665
Student Hispanic or Latino	-.033	.207	.967	.839	1.11
Student Other	-.141*	4.102	.868	.758	.995
Student Rural v Suburban	-.095*	5.192	.909	.837	.987
Student Urban v Suburban	.030	.224	1.03	.910	1.16
Faculty Adjunct	.116**	9.244	1.12	1.04	1.21
Constant	.567**	47.091	1.76		

Note. *$p < .05$. **$p < .01$. ***$p < .001$

Summary of the Hypotheses. Research question 1b is comprised of eight hypotheses that state there is a significant negative relationship between the independent variables faculty employment status, student race/ethnicity, gender, age, and enrollment in a rural, urban or suburban institution and receiving a non-passing grade in each of the nine developmental modules. In this case, data supporting or not supporting each hypothesis will be described for modules 4 and 5.

Hypothesis 9 was not supported by the data. It states that there is a significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade in each developmental mathematics module respectively. Hypothesis 10 was supported. The hypothesis states there is a significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade in each developmental mathematics module respectively. Hypothesis 11 was not supported as there was no effect on the dependent variable. The hypothesis states there is a significant negative relationship between students who are Hispanic or Latino and receiving a non-passing grade in each developmental module respectively. Hypothesis 12 was supported. It states there is a significant negative relationship between students who are male and receiving a non-passing grade in each developmental module respectively. Hypothesis 13 was not supported. The hypothesis states there is a significant negative relationship between students who are traditional-age and receiving a non-passing grade in each of the nine developmental modules respectively. Hypothesis 14 was supported. The hypothesis states there is a significant negative relationship between enrollment in a rural community college and receiving a non-passing grade in each of the developmental mathematics modules respectively compared to enrollment in a suburban community college. Hypothesis 15 was not supported as there was no effect on the dependent variable. It states that there is a significant negative relationship between enrollment in an urban community college and receiving non-passing grade in each of the developmental modules respectively compared to enrollment in a suburban community college. Hypothesis 16 was not supported. The hypothesis states that there is a significant negative relationship between enrollment in a suburban community college and receiving a non-passing grade in each of the developmental modules respectively compared to enrollment in a rural or urban community college. Table 18 lists the hypotheses that were and were not supported by the data.

Table 17

Hypotheses Supported and Not Supported by Data Results for Modules 4 and 5

Hypotheses	Supported	Not Supported
H9. Significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade.		X
H10. Significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade.	X	
H11. Significant negative relationship between students of Hispanic or Latino race/ethnicity and receiving a non-passing grade.		X
H12. Significant negative relationship between students who are male and receiving a non-passing grade.	X	
H13. Significant negative relationship between students who are traditional-age and receiving a non-passing grade.		X
H14. Significant negative relationship between enrollment in a rural community college compared to enrollment in a suburban community college and receiving a non-passing grade.	X	
H15. Significant negative relationship between enrollment in an urban community college compared to enrollment in a suburban community college and receiving a non-passing grade.		X
H16. Significant negative relationship between enrollment in a suburban community college compared to enrollment in a rural and urban community college and receiving a non-passing grade		X

Note: H11, H13 and H15 show no effect on the dependent variable passing grades.

Modules 6-9. Examining the results of the Wald test on the outcome variable pass rates in modules 6-9 indicates that the predictor variables male (*p* =.000), traditional-age (*p* =.000), Black or African-American (*p* = .000), and enrollment in an urban community college (*p* = .000) contributed significantly to pass developmental modules 6-9. Students who are Hispanic or Latino (*p* = .106), "Other" (*p* = .449) and who attend a rural institution (*p* = .535) there is no effect on pass rates in modules 6-9. Adjunct faculty (*p* =.067) also do not have an effect on pass rates in the same pathway. Table 19 lists the regression results for modules 6-9. The adjusted odds ratio for each predictor variable in the logistic regression model that demonstrated significance for passing course grades in modules 6-9 indicates the following:

Male Student Success. The odds of male students passing modules 6-9 are 34% less likely than female students.

Traditional-Age Student Success. The odds of traditional-age students (17-23) passing modules 6-9 are three percent more likely than non-traditional aged students (> 23).

Black or African-American Student Success. Students who are Black or African American are 24% less likely to pass modules 6-9 than White students.

Urban Community College Student Success. The odds of students passing modules 6-9 who attend in an urban community college -

are 40% less likely than students who attend suburban community colleges.

Summary of the Hypotheses. Research question 1b is comprised of eight hypotheses that state there is a significant negative relationship between the independent variables faculty employment status, student race/ethnicity, gender, age, and enrollment in a rural, urban or suburban institution and not passing each of the nine developmental modules. In this case, data supporting or not supporting each hypothesis will be described for modules 6-9.

Hypothesis 9 was not supported by the data as there is no effect on the dependent variable. It states that there is a significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade in each developmental mathematics module respectively. Hypothesis 10 was supported. The hypothesis states there is a significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade in each developmental mathematics module respectively. Hypothesis 11 was not supported as there was no effect on the dependent variable. The hypothesis states there is a significant negative relationship between students who are Hispanic or Latino and receiving a non-passing grade in each developmental module respectively. Hypothesis 12 was supported. It states there is a significant negative relationship between students who are male and receiving a non-passing grade in each developmental module respectively. Hypothesis 13 was not supported. The hypothesis states there is a significant negative relationship between students who are traditional-age and receiving a non-passing grade in each of the nine developmental modules respectively. Hypothesis 14 was not supported as there is no effect on the dependent variable. The hypothesis states there is a significant negative relationship between enrollment in a rural community college and receiving a non-passing grade in each of the developmental mathematics modules respectively compared to enrollment in a suburban community college. Hypothesis 15 was supported. It states that there is a significant negative relationship between enrollment in an urban community college and receiving non-passing grade in each of the developmental modules respectively compared to enrollment in a suburban community college. Hypothesis 16 was not supported. The hypothesis states that there is a significant negative relationship between enrollment in a suburban community college and receiving a non-passing grade in each of the developmental modules respectively compared to enrollment in a rural or urban community college. Table 20 lists the hypotheses that were and were not supported by the data.

Table 18

Predictors of Pass-Rates in Developmental Mathematics Modules 6-9

Variable	*B*	Wald	Exp(*B*)	95% CI for Exp(*B*)	
				Lower	Upper
Student Gender	-.409***	83.083	.664	.608	.725
Student Age	.034***	42.140	1.03	1.02	1.04
Student Black or African American	-.280***	25.633	.756	.678	.842
Student Hispanic or Latino	-.135	2.606	.874	.742	1.02
Student Other	.055	.574	1.06	.916	1.21
Student Rural v Suburban	-.033	.384	.968	.873	1.07
Student Urban v Suburban	-.515***	76.334	.598	.533	.671
Faculty Adjunct	.083	3.359	1.087	.994	1.18
Constant	.321**	7.500	1.378		

Note. $*p < .05$. $**p < .01$. $***p < .001$

Table 19

Hypotheses Supported and Not Supported by Data Results for Modules 6-9

Hypotheses	Supported	Not Supported
H9. Significant negative relationship between students taught by adjunct faculty and receiving a non-passing grade.		X
H10. Significant negative relationship between students of Black or African-American race/ethnicity and receiving a non-passing grade.	X	
H11. Significant negative relationship between students of Hispanic or Latino race/ethnicity and receiving a non-passing grade.		X
H12. Significant negative relationship between students who are male and receiving a non-passing grade.	X	
H13. Significant negative relationship between students who are traditional-age and receiving a non-passing grade.		X
H14. Significant negative relationship between enrollment in a rural community college compared to enrollment in a suburban community college and receiving a non-passing grade.		X
H15. Significant negative relationship between enrollment in an urban community college compared to enrollment in a suburban community college and receiving a non-passing grade.	X	
H16. Significant negative relationship between enrollment in a suburban community college compared to enrollment in a rural and urban community college and receiving a non-passing grade		X

Note: H9, H11 and H14 show no effect on the dependent variable, passing grades.

Summary

The results for this study were introduced in this chapter to primarily show the effect of faculty employment status, particularly adjunct status, on student pass-rates in the MTE developmental math modules. This study also investigated other predictive variables such as student race/ethnicity, gender, and age as well as institution type—rural, urban and suburban community colleges of which students were enrolled. Descriptive statistics for the sample were analyzed and reported along with results from logistic regression models to answer each of the research questions. The findings in this chapter identified each of the significant variables and adjusted odds ratios identified each predictor variables' contribution on the outcome variable, pass-rates in all and in each developmental module. Chapter 5 will provide a summary of the study along with a discussion of the findings as they relate to previous literature. This chapter will also discuss further implications of these findings and will suggest areas for future research.

CHAPTER 5

DISCUSSION

This chapter summarizes the major findings from this study of several predictor variables' contribution and effect on student pass-rates in the redesigned developmental math program by the VCCS in 2012. The primary focus of this study was to examine the effects of faculty employment status, with emphasis on adjunct faculty, and student performance in all and each MTE developmental math module. The predictor variables student race/ethnicity, gender, age, and enrollment in a rural, urban and suburban community college were also examined for their effects on student pass rates. This study utilized secondary data collected by the Academic Services and Research Department of the Virginia Community College System. This study was guided by three research questions:

Research question 1a. What is the relationship between faculty employment status, student race/ethnicity, age, gender, and student enrollment in a rural, urban and suburban community colleges on students earning a passing course grade in all of the nine developmental mathematics modules overall?

Research question1b. What is the relationship between faculty employment status, student race/ethnicity, age, and gender and student enrollment in a rural, urban and suburban community college on students earning a passing course grade in each of the nine developmental mathematics modules respectively?

Summary of Results

Research question 1a (predictors of pass-rate in all nine modules) indicate that all eight predictor variables, student gender, age, student Black or African American, student

Hispanic or Latino, student “Other”, student rural versus suburban, student urban versus suburban and adjunct faculty contributed significantly to student performance in all mathematics modules.

Research question 1b (predictors of pass-rate in each of the nine modules) encompasses findings for module groups 1-3, 4 and 5, and 6-9. Findings for modules 1-3 indicate that seven predictor variables, student gender, student Black or African American, student Hispanic or Latino, student “Other”, student enrollment in a rural community college, student enrollment in an urban community college and adjunct faculty contributed significantly to student performance in modules 1-3. Student age had no significant effect on pass rate performance.

Findings for modules 4 and 5 show that six predictor variables, excluding Hispanic or Latino and student enrollment in an urban community college contributed significantly to pass rates. The six predictor variables that contributed to student pass-rates are: student gender, age, Black or African-American, student “Other”, student enrollment in a rural community college, and adjunct faculty status.

Findings for modules 6-9 indicate that four predictor variables, student gender, age, student Black or African American, and student enrollment in an urban community college contributed significantly to pass rates in modules 6-9.

There were a total of 48,765 developmental mathematics students enrolled in MTE modules who were identified as First Time in College (FTIC) students at 11 Virginia community colleges beginning the fall semester 2013 to fall 2015. This total includes students who continued their enrollment each spring semester but does not include students who enrolled during the summer semesters.

Data for this study were reported by the Academic Services and Research Department of the VCCS in three separate Excel files. Each file listed the following information: two Carnegie institution designations to differentiate the size (small, medium, large, and very large two-year) and locale of institution served (public rural-serving large, public urban-serving multi-campus, public suburban-serving single campus); common pseudo-ID numbers for students which were used to merge the three files; the gender, race/ethnicity and age of each student; term the student enrolled; developmental module the student was enrolled and credit of the module; race/ethnicity and gender of the faculty member who taught the module; and faculty employment status.

Students under the age of 17 at the time of enrollment (n=144) were selected out from the sample as they did not fall into either traditionally or non-traditionally aged college student ages which were used in this study. There were no missing data for any student. Dichotomous variables representing students and adjunct faculty were created in SPSS that represented the following: traditional age, student Black or African American, student Hispanic or Latino, student White, student "Other", student_male, grade passed, faculty male, and faculty adjunct. Students and faculty who displayed these characteristics were coded with a 1; otherwise, students and faculty not displaying these characteristics were coded 0.

Discussion of the Research Findings

This section provides a discussion of the results used to address the three research questions and hypotheses posed in this study. The discussion will include how findings compare to previous research, implications for stakeholders and researchers; the limitations of the study; and recommendations for future research.

Research Question 1a. Using logistic regression analysis, the first research question of the current study attempted to determine if there was a relationship between faculty employment status, student characteristics and institution type and pass-rates in all nine modules. The overall model accounted for three percent of the variance in student pass-rates and eight variables had a *p* value less than .01.

Supported Hypotheses for All Nine Developmental Modules

This current study found that gender is a significant predictor of pass- rates in all nine modules. Male students were 28% less likely to pass modules 1-9 compared to their female peers. This finding is consistent with research on gendered performance in developmental mathematics, specifically that of female students, although more likely to be referred to developmental mathematics, are more likely to pass developmental math compared to males (Bailey et al., 2010; Bettinger & Long, 2005; Cho, 2011; Fike & Fike, 2007; Roksa, 2009).

Findings from the current study indicate that Black or African American students are 40% less likely to pass all nine modules compared to their White peers. Hispanic or Latino students in comparison, are 10% less likely to pass all nine modules compared to White students taking the same modules.

Results from this current study are consistent with prior research literature on student performance in developmental math which has found that generally, non-White students are less successful than their White peers (Acevedo-Gil et al., 2015; Bailey et al., 2010; Bettinger et al., 2005; Cohen et al., 2014; Fike & Fike, 2007; Palmer & Wood; 2014; Roksa et al., 2009). Black or African American students have consistently been found to have less success in developmental courses and are less likely to matriculate to college-level courses. These findings are also consistent with research that show Hispanic or Latino students have similar difficulties as African-American students advancing through developmental math sequences (Acevedo-Gil et al., 2015).

Findings from the current study are partially consistent with previous research that found differences in developmental pass-rates based on the location of the institution. This study did find that that rural and urban community college students were less likely to pass all nine modules compared to students enrolled in suburban community colleges. Rural students are 11% less likely to pass all nine modules compared to suburban students and urban students are 19% less likely to pass all nine compared to students attending suburban colleges. These results however, may be related to socioeconomic status of students (rural and urban) and race/ethnicity (urban with a mostly Black or African-American student body) than location. Where these findings are consistent with prior literature, students enrolled in rural and urban community colleges had overall pass-rates below suburban community colleges (Tietjen-Smith et al., 2007). Pass-rates in urban community colleges are found to be more variable than rural and suburban community colleges due to higher enrollments of African-American and Hispanic students (Tietjen-Smith et al., 2007). However, findings from the current student are not consistent with this conclusion given the large number of Black or African-American students enrolled in Virginia's suburban community colleges.

Inconsistencies with Tietjen-Smith et al., (2007) research lie with rural student pass-rates relative to urban students. Tietjen-Smith et al., (2007) found in their study in rural community colleges had overall pass-rates far below the levels of both urban and suburban community colleges regardless of ethnicity. In this current study, students enrolled in urban community colleges had lower pass-rates than rural students. Findings from this current study may be more consistent with Bailey et al., (2010) which found that urban community colleges tend to serve high proportions of African-American and economically disadvantaged students and as a consequence, these students have lower odds of passing to a higher level of remediation than their peers at colleges serving low proportions of these populations, generally rural and suburban community colleges. This current study did not examine progression to higher levels of remediation by students regardless of race/ethnicity, however, higher non-pass rates by Black or African-American students compared to their non-Black counterparts ensures lack of progression to upper modules.

Unsupported Hypotheses for All Nine Developmental Modules

The primary focus of this study was to measure the effect of adjunct faculty on student success in the VCCS 2012 redesigned developmental mathematics curriculum, hypothesizing that there was an inverse relationship between adjunct faculty and student pass-rates. This study found that there was no relationship between having an adjunct faculty member in developmental mathematics and receiving a non-passing grade in all nine modules. Additionally, the odds of a passing all nine modules are 17% more likely if a student had an adjunct instead of a full-time instructor.

Initially, student pass-rates and number and status of faculty teaching math modules, descriptive statistics were used. As indicated in Table 8, 59% of faculty who taught developmental mathematics from fall 2013 to fall 2015 were adjunct faculty, indicating the majority of students had at least one adjunct instructor during that time. Findings in Table 10, show that 66% of students received an S in the modules.

The current finding is inconsistent with prior research showing adjunct faculty have an adverse effect on various student success measures including success in and progression through developmental mathematics (Calcagno et al., 2008; Fike & Fike, 2007; Jacoby, 2006; Jaeger & Eagan, 2007, 2008; Pannapacker, 2000). Results from this investigation are more consistent with research that suggests adjunct status does not have a significant, negative impact on student grades (Gupta et al., 2006; Rossol-Allison & Beyers, 2011). This finding also suggests that adjunct faculty are more likely to give higher grades across all nine modules than their full-time counterparts. If so, the current study may demonstrate consistency with previous research on grade inflation among adjunct faculty due to the tenuous nature of part-time teaching (Caruth & Caruth, 2013; Kezim et al., 2005; Sonner, 2000).

This current study found that traditional-aged is a significant predictor of student pass-rates. A traditional-aged student was 1% more likely to pass all nine modules than a non-traditional student. This finding is consistent with previous research that suggest younger students tended to have higher odds of passing to a higher developmental level than their older peers (Bailey et al., 2010) and that younger students are more likely to complete their developmental sequences (Bettinger & Long, 2005). However while significant, a one percent likelihood of passing all nine modules compared to non-traditional-aged students may suggest, more than anything, that the age cut-off decided by this researcher between traditional-aged and non-traditional-aged students may or may not have been precise enough.

Current findings are consistent with research showing that students enrolled in suburban community colleges had higher rates of success and overall pass-rates compared to rural and urban students (Dogbey, 2010; USDA, 2000). However, most literature on institution type have not investigated outcomes among referred developmental students. Therefore, it is difficult to extrapolate from current literature any similarities with findings from this current study except for course-level success among developmental math students enrolled at a suburban community college compared to their rural and urban counterparts.

Research question 1b. Research question 1b of the current study attempted to determine if there was a relationship between faculty employment status, student characteristics and institution type and pass-rates in each of the developmental math modules. In order to accurately examine the results for this research question, the modules were grouped as developmental pathways accordingly: modules 1-3 (Career-Technical), modules 4 and 5 (Liberal Arts) and modules 6-9 (STEM).

The overall model for modules 1-3 accounted for four percent of the variance in student pass-rates and five of the eight variables had a p value less than .001. The overall model for modules 4 and 5 accounted for two percent of the variance in student pass-rates and two of the eight variables had a p value less than .001. Finally, the overall model for modules 6-9 accounted for four percent of the variance in student pass-rates and four of the eight variables had a p value less than .001.

Discussion of the results that support hypotheses described in Chapter 4 are presented first and hypotheses that were not supported are discussed second.

Supported Hypotheses in Each of the Developmental Modules

This current study found that gender is a significant predictor of pass-rates in each of the developmental pathways. It was found that male students are 25% less likely to pass modules 1-3, 28% less likely to pass modules 4 and 5 and 34% less likely to pass modules 6-9 than their female counterparts.

Results of this study are consistent with the 2004 First-Time-in-College (FTIC) VCCS developmental mathematics cohort (Roksa, 2009) and other research that showed that women were consistently more likely to pass developmental math courses compared to their male counterparts (Bailey et al., 2010; Bettinger & Long, 2005; Cho, 2011; Fike & Fike, 2007).

The current study found that student race/ethnicity is a significant predictor of pass-rates in each developmental pathway, however, groups vary in their outcomes. Black or African American students are 48% less likely to pass modules 1-3, 39% less likely to pass modules 4 and 5, and 24% less likely to pass modules 6-9 compared to White students. Hispanic or Latino students are 15% less likely to pass modules 1-3 compared to their White peers. However, there is no effect of being Hispanic or Latino on pass-rates in modules 4 and 5 and 6-9. This finding may be consistent with research on Latino student developmental course-taking and its adverse effects on completion and transfer rates to four-year colleges and universities (Acevedo-Gil, et al., 2015). Once in community college, few Latino students complete a college degree, in large part due to high participation rates in developmental education. Moreover, these students had great difficulty advancing through developmental math sequences (Acevedo-Gil et al., 2015).

Results from this current study show that students enrolled in a rural community college are 16% less likely to pass modules 1-3 and 9% less likely to pass modules 4 and 5 compared to their suburban counterparts. There is no effect on pass-rates in modules 6-9 and the predictor variable rural community college.

Students enrolled in an urban institution are 16% less likely to pass modules 1-3 and 40% less likely to pass modules 6-9 compared to students enrolled in a suburban institution. There is no relationship on pass-rates in modules 4 and 5 and the predictor variable urban community college. This study is partially consistent with the previous studies mentioned in the last section on institution location characteristics. Compared to suburban community colleges, rural and urban pass-rates in developmental mathematics are lower. However when comparing rural to urban community colleges, both have similar pass-rates in modules 1-5 unlike Highs' findings of lower pass-rates among rural community colleges (1998). This may suggest that socioeconomic status and institutional resources may play a significant part in student performance for both types of institutions. This may not however, fully explain the significantly high non-pass rates of urban students enrolled in modules 6-9.

According to Bailey et al., (2010) urban community colleges tend to serve high proportions of Black and economically disadvantaged students and as a consequence, these students have lower odds of passing to a higher level of remediation than their peers at colleges serving low proportions of these populations, generally rural and suburban community colleges. Analysis of colleges in the current data however, indicate that the majority of Black or African-American students attend suburban community colleges and secondarily, urban. As well, Black or African-American students were 24% less likely to pass modules 6-9. Race/ethnicity does not fully explain this phenomena. The results are inconsistent with Bailey et al., (2010) and points to other factors influencing developmental success such as fewer resources compared to suburban institutions. Students who attend institutions with fewer resources are less likely to master content at the lower levels sufficiently enough to be successful at the higher levels, particularly among Black students.

Unsupported Hypotheses in Each of the Developmental Modules

Findings from the predictor variables that do not support the hypotheses across the developmental pathways, modules 1-3, 4 and 5 and 6-9 are discussed.

Although adjunct faculty is a significant predictor of pass-rate performance, findings from each of the developmental pathways do not support the hypotheses. In modules 1-3 and 4 and 5, adjunct faculty is a significant predictor of pass-rate performance. However, in modules 6-9, adjunct faculty have no effect on student pass-rates; therefore the null is true. In modules 1-3, this current study found that students who have an adjunct instructor are 22% more likely to pass these modules than if they had a full-time instructor. For modules 4 and 5, results from this study show that students who have an adjunct instructor are 12% more likely to pass these modules than if they had a full-time instructor. As mentioned under research question 1a, this finding is inconsistent with prior research showing the negative effects of adjunct on various student outcomes (Calcagno et al., 2008; Fike & Fike, 2007; Jacoby, 2006; Jaeger & Eagan, 2007, 2008; Pannapacker, 2000) and consistent with research that suggests adjunct status does not have a significant, negative impact on student grades (Gupta et al., 2006; Rossol-Allison & Beyers, 2011).

Findings from the current study are consistent with research showing that students enrolled in suburban community colleges had higher rates of success and overall pass-rates compared to rural and urban students in modules 1-3 (Dogbey, 2010). However, for modules 4 and 5 and 6-9, results are mixed. Suburban students had higher pass-rates than rural students in modules 4 and 5 but there was no effect for urban students. Therefore, for urban students enrolled in modules 4 and 5, the null hypothesis is true. For modules 6-9, urban students had lower pass-rates than their suburban counterparts but there was no effect for rural students. Similarly, for rural students enrolled in modules 6-9, the null is true. As mentioned under research question 1a it is difficult to extrapolate from current literature any similarities with findings from this current study except for course-level success among developmental math students enrolled at a suburban community college compared to their rural and urban counterparts.

This study also found that there was no relationship between traditional-age and pass-rates in modules 1-3. However, for modules 4 and 5, traditional-age students were one percent more likely to pass compared to their non-traditional counterparts. Finally, traditional- age students were also three percent more likely to pass modules 6-9 compared to their non-traditional peers. This result supports Bailey et al. (2010) findings that showed that older students tend to have lower odds of passing to a higher developmental level than their younger peers.

Limitations of the Study

There are several limitations to this study. First, faculty characteristics in the data were limited where highest degree earned for adjunct and full-time faculty was not included in the dataset. Highest degree attained would have provided an opportunity for more precise analysis of instructor effects on pass-rates in each developmental pathway. For example, as mentioned in Chapter 2, 25% of faculty who teach only developmental education courses have only a bachelor's degree (CCSSE, 2014) and in the VCCS, the minimum requirement for faculty teaching developmental courses is a bachelor's degree

(Virginia Community College Policy Manual, VCCS-29, 2013). Having credential data of faculty who taught developmental mathematics during the study timeframe could possibly explain the different pass-rates for students in the lower modules 1-3 and 4 and 5 and the higher percentage of passing grades given by adjunct compared to full-time faculty.

Second, large-scale, quantitative data of system-wide effects on developmental mathematics students, inhibits nuanced examinations of the effects on student outcomes. Adding qualitative approaches to the study such as focus groups or interviews with a small sample of adjunct faculty would have provided an additional layer of richer data. Qualitative measures specifically to assess instructor commitment, perceptions of faculty-student interactions, and perceived effects on student success since the modularized redesign could have provided data to compare these current findings and provide more meaningful examination.

Third, progression from one module to the next could not be provided in the dataset nor was it possible in all cases to know which developmental pathway a student had chosen. A student's progression toward a higher level of remediation is predicated on the student's success in the previous level; however, for this study, even if a student were successful, a student could still exit the sequence or change to a program with less required math. Since both the sequence and progression were unknown, students were artificially placed into developmental pathways by the researcher. These measures could not adequately assess student math course-taking intentions or academic ambitions. In essence, the data provided represents a discrete snap-shot.

Fourth, this study employed Jaeger and Eagan' (2008) conceptual model. In this model, there is no consideration of environmental factors external to the community colleges which may mitigate or intensify student-faculty interactions and thus student performance in the classroom. Examples include loss of employment, family obligations, or lack of transportation having a negative effect on achieving a passing grade in the developmental modules. These challenges may disproportionately impact community college students. However, these external factors were not investigated and were beyond the scope of this study.

Fifth, additional institutional and student characteristics that have been shown to affect progression to higher-level remediation and ultimately progression into a college-level math course is not accounted for in this study. For example, financial aid lowers tuition costs and reduces barriers to progression and completion. However, larger numbers of students receiving financial aid may indicate a lower income, which can depress student success in all courses including developmental math. These data did not comprise any other institution-level data other than size and location and only location is including in this analysis. Student characteristics such as the type of degree programs selected—if selected, or part-time status also affect college course taking behavior. Within the scope of this study, the effect of these outcomes is somewhat uncertain and may also impact what conclusions are drawn from the data.

Implications for Further Research

A major implication derived from this study is the need for additional research. The primary finding of this study contradicts the preponderance of literature that suggests adjunct faculty have an adverse effect on student success in four and two-year institutions. Researchers consistently describe adjunct faculty as comprised of individuals who are disconnected and alienated, unavailable to colleagues and students, and lack organizational commitment all of which lead to poorer outcomes for students (Ansparger, 2014; Bettinger & Long, 2010; Burgess and Samuels, 1999; Calcagno et al., 2008; Jacoby, 2006; Jaeger & Eagan, 2009; Kuh, et al., 2004; Pannapacker, 2000; Roueche et al., 1995; Schuetz, 2002; Umbach, 2007; Wickrun & Stanley, 2000). All of the characteristics described by these researchers are inherent in institutional culture; however, these characteristics do not appear to have influenced student success—as indicated by the higher pass-rates in the redesigned developmental math program. Nevertheless, the effects of Virginia's community colleges practice of hiring adjunct faculty to teach developmental math may still have negative effects, particularly for African-American, Hispanic and male students and students striving to progress to higher levels of developmental math within the current or future developmental structure. Findings in this current study for these groups suggest that the most at-risk students, males, Black or African-American and Hispanic or Latino students may benefit more from the modularized program compared to the previous developmental math structure, however, they may not benefit as well academically as their female, non-Black and non-Hispanic peers from this current employee structure.

While the majority of non-White students had high pass-rates overall, African-American students in particular had lower pass-rates compared to their non-Black peers across all nine modules. Researchers find that minority students generally have lower odds of progressing to higher levels of remediation compared to their peers at rural and suburban community colleges (Bailey et al., 2010). This of course, leads to less African-

American as well as Hispanic representation in higher-level math and associated STEM fields (Wood & Palmer, 2014). Furthermore, Black or African-American students in Virginia’s community colleges, mostly attend suburban community colleges, but their numbers are substantial in urban institutions as well.

Compared to rural institutions, suburban and urban community colleges tend to have more resources devoted to facilitating student success; however, rural community colleges in comparison to urban ones, generally have higher overall pass-rates. The current study found that overall pass-rates were higher among rural students in comparison to those enrolled in urban community colleges but lower pass-rates compared to suburban community colleges. By itself, this may suggest that higher full-time enrollment among rural students, more than student racial/ethnic demographics, increases student success in course grades and persistence to transfer and graduation (Bailey et al., 2010; Cohen et al., 2014). The need for additional research that includes a broader array of student, faculty and institutional characteristics to yield additional insight into factors associated with student outcomes, particularly those who are most at-risk is strongly encouraged. Additionally, research on developmental resources available to each of the institutions may be warranted. Students at institutions with fewer resources are less likely to master content at the lower levels sufficiently enough to be successful at the higher levels.

Implications for Practice

The Virginia Community College System set out to improve developmental math student outcomes for all students needing foundational knowledge and skills building in mathematics. The findings of the current study show that the majority of students enrolled in MTE modules from fall 2013 to fall 2015 passed their modules. Descriptive statistics indicate that 66% of students received an S or Satisfactory. This is no small matter and further supports the VCCS' objective of increasing the number of students who successfully complete their developmental sequences.

The current study also set out to investigate whether faculty employment status, particularly adjunct status, had a negative effect on student performance in the redesigned developmental modules. In fact, the opposite was true. Students who had an adjunct instructor had an increased likelihood of passing all nine modules. This result was more pronounced among the earlier modules where students generally have the most difficulty (Bickerstaff, et al., 2016). Moreover, adjunct faculty make up a significant majority of instructors who teach developmental math in the VCCS. Fifty-nine percent to be exact. These faculty gave 67% of passing grades compared to full-time faculty who awarded 63% of passing grades in the modules. These findings suggest that having mostly adjunct instructors teach developmental math may prove more academically beneficial to students overall than having a full-time instructor. Yet, not all students experienced the same level of success within the modularized structure. This may or may not be due to the predominance of adjunct instructors in these developmental courses. However, what is known is that Black or African-American and male students had lower pass-rates across all nine modules compared their White and female counterparts. Hispanic or Latino students, to a lesser degree, had lower pass-rates in the earlier modules compared to their White peers as well. Being White and female were predictive of consistent developmental math success in the 2012 redesigned modules. What is also known is that results from descriptive analysis found that not only were the majority of modules taught by these instructors, the majority of these instructors were White and female. While findings suggest that having an adjunct instructor in these courses may not prove detrimental to student success, the lack of diversity among the faculty may be a barrier for some students. With this in mind, the colleges within the VCCS should strongly consider diversifying the make-up of its developmental math faculty. Increased racial/ethnic and gender diversity among adjunct developmental math ranks may benefit these students to the point where they achieve academic parity with their White and female peers.

With the racial and gender disparity in pass-rates among Black, Hispanic and male developmental math students, the VCCS should consider a system-wide implementation of programs designed to increase minority and male success. Programs such as Minority Male Community Collaborative (M2C3), Black and Hispanic Male Initiative Program, Man UP and similar programs provide social, academic and sometimes financial support to minority male community college students. The overwhelming majority of African-American and Hispanic males who are in higher education are either enrolled in community college or started at a community college (Wood & Palmer, 2014). More importantly, males of color in community colleges compared to those in four-year institutions, differ greatly with respect to demographic characteristics (e.g., marital status, children), academic and social integration, and institutional context (Wood & Palmer, 2014). Flowers' (2006) research on Black males in community colleges found that these students experience lower levels of academic and social integration than their peers enrolled in four-year institutions. Initiatives or partnerships designed to strengthen minority and male student success are often designed to assist faculty and administrators to understand how organizational culture, climate and racial identity affect the college experience for these students. Broad based measures specific to these groups may facilitate academic progression through developmental and college-level courses on par with White students.

Finally, and as mentioned previously, the current study found that four percent more adjunct faculty gave passing grades than their full-time peers overall. While the difference in pass-rates between full-time and adjunct instructors was small, results consistently showed that students were more likely to receive a passing grade with an adjunct versus a full-time instructor. However small the effect, this is something that the VCCS may want to investigate, specifically in terms of possible instructor and course-level differences that may exist within the institutions. According to Bickerstaff et al, (2016) and the Virginia Community College System (2010), Virginia published a standardized curriculum guide that describes each module; outlines learning outcomes and course competencies; and a suggested four-week timeline, assessment items and teaching tips. The guide also outlined a number of policies and recommendations related to assessment, calculator usage and most importantly, grading. Virginia also set the passing benchmark as a score of 75% on the module’s final assessment which implies a uniformity in grade-giving across the state regardless of employment status. Findings from this study show uneven module effects between faculty groups. These effects could be due to grade inflation—even with increased standardization, given the research on adjunct status and the propensity towards grade inflation due to working conditions (Caruth & Caruth, 2013; Kezim, et al., 2005; Sonner, 2000). However, other factors may also explain higher pass-rates such as: students are receiving a more coherent and simpler explanation of mathematics content from adjuncts compared to full-time instructors and thus have more positive outcomes (Figlio, et al., 2013; Leslie & Gappa,1995); faculty status has no significant negative impact on course grades (Rossol-Allison & Beyers, 2011); and finally, the modularized curriculum with its increased standardization of curriculum, delivery, and assessment—although not perfect, may in fact, mitigate the adverse effects of having an adjunct instructor teach a developmental course. A final consideration on what contributes to the differences between adjunct and full-time developmental math instructor pass-rates may be instructional delivery. These differences may lie between teacher-led and computer-mediated modules. In fact, Bickerstaff et al., (2016) found that students in computer-mediated modules, where students self-pace, "struggled to manage their time and make progress through the modules" (p. 25). Students in different modules are in the same class and "students with questions during class oftentimes waited extended periods for one-on-one assistance from their instructor" (Bickerstaff et al., 2016 p. 28). Faculty reported, that they "felt they could not use whole-class instruction and students perceived that their instructors were rushed in one-on-one interactions with them" (Bickerstaff et al., 2016 pp. 28-29). Analysis of instructional delivery was beyond the scope of this study and therefore could not be accounted for in the analyses. Therefore, the VCCS should consider investigating which type of module adjunct faculty are more likely to teach compared to full-time faculty. If adjunct faculty are more likely to be given a teacher-led versus a computer-mediated module, then it is possible that pass-rates will be higher. In addition, the VCCS should further investigate pass-rates, grading, and instructional differences between these two faculty groups to ensure there is consistency among faculty in all of the community colleges that offer Math Essentials.

Conclusion

The purpose of this study was to examine the relationship of faculty employment status (full-time and adjunct), student race-ethnicity, gender, age and enrollment in a rural, suburban, and urban community college on student's pass-rate performance in the 2012 MTE developmental mathematics modules.

First, adjunct faculty increased the likelihood of students passing all nine modules and was particularly effective in the early modules. Second, some student characteristics were consistently predictive of passing the developmental modules such as: being traditional-age, female, White, and enrolled in a suburban community college. Other student characteristics were consistently predictive of not passing these modules: being Black or African-American and male. Hispanic or Latino pass-rates were lower in the earlier modules and lower pass-rates among students in rural and urban community colleges differed depending on which modules they were enrolled.

The findings from this study are unique in part because multiple factors were considered in the examination on what predicts student success within the VCCS' redesigned developmental math. The findings presented in the current study may help inform future researchers and community college practitioners.

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TEACHING EXPERIENCE

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AWARDS AND GRANTS

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- Recipient of the J. Sargeant Reynolds President’s Award for Teaching Excellence for Part-time Faculty (2003 - 2004)

RESEARCH EXPERIENCE

- Leonda Williams Keniston, Julie Honnold, Amy S. Hubbard (2002). *The Dayton Multiracial Dialogues: Expanding the Circle of Contact through Dialogue.* Evaluation report for the City of Dayton, Human Relations Council, 2002.

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RESEARCH PRESENTATIONS

- Hubbard, A., Keniston L., Honnold, J., (1999). *Cross-Cultural Conflict Meditation on Interracial Dialogue: Prospects for Genuine Change.* Paper presented at a refereed roundtable discussion at the American Sociological Association conference in Chicago, IL.

- Keniston, L. (1999). *Religion as a Medium for Cross-Racial Friendship Formation: A Study of the Baha'i's of the State of Virginia and Washington, D.C.,* Paper presented at a refereed roundtable discussion of the American Sociological Association conference in Chicago, IL.