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Predictors of Community College Students’ Academic Success in the Corequisite Model

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PREDICTORS OF COMMUNITY COLLEGE STUDENTS' ACADEMIC SUCCESS IN THE COREQUISITE MODEL

by

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(Under the Direction of Steven Tolman)

ABSTRACT

The purpose of this quantitative study is to determine predictors of community college student academic success in the corequisite model. Academic success will be defined dichotomously on a pass or fail basis. The population in this study included 1,933 students that enrolled in at least one corequisite English and/or mathematics course at the college between the fall semester of 2015 and summer semester of 2018. The predictors to be examined are a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, high school GPA, placement test scores, academic major, time spent receiving academic tutoring in college's tutoring center; and corequisite course faculty employment status. Logistic regression analysis identified four strong predictors of student academic success in corequisite English courses: (1) being female, (2) high school GPA, and (3) number of attempts in corequisite English courses. Also, logistic regression analysis identified seven strong predictors: (1) sex, (2) age, (3) high school GPA, (4) student Pell Grant recipient status, (5) student first-generation college student status, (6) standardized writing placement test score, and (7) corequisite course faculty employment status. The strongest predictor in both logistic regression analyses was high school GPA.

INDEX WORDS: Developmental education, Corequisite model, Remediation, Community college students, Logistic regression, Mathematics, English, Gateway courses, Predictors

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DEDICATION

I dedicate this dissertation to my family—past, present, and future.

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CHAPTER 1: INTRODUCTION

College developmental education (DE), also called remedial/basic skills education or learning support, is a combination of courses and academic support services designed to address students' academic deficiencies in English (reading and writing) and mathematics to prepare them for college-level courses (Bettinger, Boatman, & Long, 2013; Snyder, de Brey, & Dillow, 2019; University System of Georgia, 2016). More than one million students enroll in DE each year and these students are often minority and/or economically disadvantaged (Chen, 2016; Complete College America [CCA], 2016). Additionally, 69% of U.S. degree-granting public institutions offer DE (Snyder et al., 2019). Despite DE's availability and the number of students it serves each year, students who do not complete their DE course requirements are less likely to earn college-level credits in these subjects (Chen, 2016).

National reform efforts have been aimed at improving academic outcomes including the implementation of the corequisite model (CCA, 2016). The corequisite model pairs an introductory college-level mathematics and/or English course, with a DE course designed to provide additional academic support (California Acceleration Project, n.d.). Several states have passed legislation and policy aimed at increasing the utilization of the corequisite model at their public institutions. For instance, the Tennessee Board of Regents implemented the corequisite model within its community colleges (CCs) and universities in 2015 (Denley, 2016). Additionally, Texas recently passed a state law mandating 100% of its public colleges and universities offer DE via the corequisite model by the 2020-2021 academic year (H.B. 2223, 2017). Similarly, beginning with the fall semester of 2018, the University System of Georgia (USG) implemented corequisite model as its only form of DE (USG, 2018a).

Background

The origins of DE in the U.S. can be traced back to the founding of the earliest institutions such as Harvard University and Princeton University. During that time most college textbooks were written in Latin (Boylan, 1988; Parker, Sterk Barrett, & Bustillos, 2014). However, many of the students attending those institutions did not come from families that had the means to provide preparation in Latin. Therefore, higher education institutions offered courses in Latin prior to students' enrollment in college-level courses. The University of Wisconsin created the first formal DE program in 1849 (Boylan, 1988; Parker, Sterk Barrett, & Bustillos, 2014). The availability of DE increased as student enrollment grew through the Morrill Land Grant Acts, The Serviceman's Readjustment Act of 1944, also known as the G.I. Bill, and the expansion of CCs (Cohen, Kisker, & Brawer, 2014; Parker, Sterk Barrett, & Bustillos, 2014). The use of DE has persisted over the years and was offered at most degree-granting institutions in 2016-2017 (Snyder et al., 2019).

Students often enter DE because of their placement test scores. The two most commonly used placement tests are College Board's ACCUPLACER and American College Testing's (ACT) COMPASS (Wilson, 2012). Over 11 million ACCUPLACER tests were administered in 2016 (College Board, 2017) and approximately two million COMPASS tests were administered each from 2012 to 2014 (Adams, 2015). These placement tests determine if students are academically prepared for introductory English and/or mathematics college courses or if they need academic support and must enroll in English and/or mathematics DE courses (Hughes & Scott-Clayton, 2011).

Students that are required to enroll in DE have had limited success earning credits for introductory English and mathematics courses, also called gateway courses. Approximately 20%

of CC students who start in multiple DE course sequences successfully complete gateway English and mathematics courses within two years (CCA, 2016). Thus, new strategies for the implementation of DE have been recommended (Collins, 2013; King, McIntosh, & Bell-Ellwanger, 2017). The corequisite model is one strategy that has gained national attention (Collins, 2013; CCA, 2016; King, McIntosh, & Bell-Ellwanger, 2017). The corequisite model allows students to enroll directly in gateway courses with an additional DE course for subject area academic support. The implementation of the corequisite model in Colorado, Georgia, Indiana, Tennessee, and West Virginia has been successful at increasing the number of students assigned to DE who earn credit for gateway mathematics and English courses (CCA, 2016). Within the University System of Georgia, where this research study will be conducted, a corequisite model pilot study has increased the success rate, defined as earning a final letter grade of C or better, of students assigned to one or more DE courses from 26% in mathematics and 36% in English to 69% and 73%, respectively (Tran, 2016).

There are several predictors that can be combined to provide a more in-depth analysis of student academic outcomes in the corequisite model beyond the presentation of course pass rates. First, high school GPA and placement tests when paired are stronger predictors of gateway course success (Scott-Clayton, Crosta, & Belfield, 2014). Second, larger percentages of minority students, particularly African-American and Hispanic, and Pell Grant recipients are placed into DE (CCA, 2016). Therefore, it is important to consider how a student’s race and Pell Grant recipient status impact their success in the corequisite model. Third, age is another predictor to consider in the success of students in the corequisite model. Snyder et al. (2019) found approximately 61% of the first-year undergraduate students who took DE classes were between the age of 15 and 23. Fourth, another predictor to consider in student success in the corequisite model is a student's sex. 55% of female and 47% of male CC students enroll in DE mathematics and approximately 33% of both male and female CC students enroll in DE English (CCA, 2017). This is an important predictor to consider in determining whether a gender gap exists between students enrolled in corequisite courses. Fifth, there is uncertainty with respect to the type of impact (i.e. positive, negative, or null) that being a first-generation college student has on DE academic outcomes (Chen, 2016; Houston & Xu, 2016). Sixth, students who enroll in appropriate mathematics DE courses for their academic major, also known as mathematics pathways, earn gateway mathematic course credits at improved rates (Huang, 2018; Zachry Rutschow & Mayer, 2018). Advocates of mathematics pathways recommend that students who are science, technology, engineering, and mathematics (STEM) majors enroll in gateway mathematics courses that lead to calculus (Zachry Rutschow & Mayer, 2018). Whereas, students whose academic majors are in humanities or social sciences should enroll in gateway mathematics courses in quantitative reasoning or statistics. Finally, institutional resources such as faculty employment status and academic tutoring are positively associated with student academic success (Datray, Saxon, & Martirosyan, 2014; Laskey & Hetzel, 2011).

Statement of the Problem

DE has become an integral component of the American higher education system at CCs. However, there have been recent efforts to eliminate and/or reduce the number of DE courses because assignment to DE based solely on their placement test scores is an unreliable practice. Additionally, students assigned to DE that do not complete their assigned DE course sequences are less likely to earn postsecondary credentials. These reform efforts have included states passing laws impacting DE at public institutions, institutions using metrics in addition to placement test scores for DE placement, and the reduction of multiple DE course sequences.

The USG has fully participated in many of these efforts. The results from the USG's Fall 2015 roll-out of corequisite English and mathematics courses indicated that students enrolled in corequisite courses had similar academic outcomes to their peers who were not required to enroll in DE. During the Fall 2018 semester, all USG institutions began offering DE courses exclusively via the corequisite model. However, this is problematic as it is not known which predictors are most associated with student academic success in the corequisite model. Thus, the ability of institutions to create and strengthen their DE academic support systems and processes for improved student outcomes is limited.

Purpose Statement

The purpose of this quantitative study was to determine predictors of CC student academic success in the corequisite model. Academic success was defined dichotomously on a pass or fail basis. The predictors examined were a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, high school GPA, placement test scores, academic major, time spent receiving academic tutoring in college's tutoring center; and corequisite course faculty employment status. These predictors were examined collectively with the aim of providing a broader investigation of student academic success in corequisite courses. These predictors could be used to aid institutions in the development of interventions designed to improve student academic success in the corequisite model.

Research Question

This quantitative study sought to answer the following question regarding students enrolled in the corequisite model at a small, public, rural two-year college in Georgia; What are the best predictors of student academic success in the corequisite model: a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, placement test scores, high school GPA, academic major, corequisite course faculty employment status, or time spent receiving academic tutoring?

Methods

This study sought to determine best predictors of CC student academic success in the corequisite model using archival student data. Specifically, this study used a quantitative research design as relationships between variables were investigated. Creswell (2009) noted that a quantitative research design is appropriate when the research is concerned with "…[T]he identification of factors that influence an outcome" (p. 18). Additionally, as the dependent variable in the research question was dichotomous, logistic regression was used for data analysis (Lomax, 2007; Menard, 2010). Following data analysis, the results were reported in both text and tabular format and descriptive statistics for the population were provided.

The setting for this study was a small, rural, public two-year state college with three campus locations that offers associate and limited baccalaureate degrees. The population was 1,933 students who enrolled in corequisite English and/or mathematics courses at the college during the fall semester of 2015 through the spring semester of 2018. The dependent variable was the dichotomous corequisite course outcome, i.e. pass/fail. The independent variables in this study included a student's sex, race, age, Pell Grant recipient status, first-generation student status, high school GPA, placement tests scores, academic major, corequisite course faculty employment status, and student hours spent receiving academic tutoring. As this study was *ex post facto* in nature, a dichotomous dependent variable was selected as opposed to student course letter grades. Course letter grades would be an appropriate independent variable if an experimental or quasi-experimental design was used and the research question focused on the impact of pedagogical or course-specific grading practices that were used across multiple sections.

For this study, the researcher acquired Institutional Review Board (IRB) approval and a letter of cooperation from the research location and Georgia Southern University. Following IRB approval, three de-identified datasets containing archival student data from the Fall 2015 to Summer 2018 semesters, inclusive, were provided to the researcher for data analysis as Microsoft Excel spreadsheets. The first dataset included student utilization of the institutional tutoring center. The second dataset included the following information for students: sex, race, age, Pell Grant recipient status, first-generation college student status, high school grade point average, placement test scores (i.e. reading, writing, and mathematics), academic major, corequisite course faculty employment status, and outcome in corequisite mathematics courses. The third dataset included the following information for students: sex, race, age, Pell Grant recipient status, first-generation college student status, high school grade point average, placement test scores (i.e. reading, writing, and mathematics), academic major, corequisite course faculty employment status, and outcome in corequisite English. Additionally, Microsoft Excel's Pivot Table tool was used to determine cases where students had multiple attempts of the same course, the number of attempts was recorded and added to the datasets. These datasets include only the variables located in Tables A-1, A-2, and A-3 in the Appendix and were merged into one Microsoft Excel workbook. Following data extraction and data merging in Microsoft Excel, the final datasets included only variables in Tables A-4 and A-5 of the Appendix. Finally, the data were imported into the Statistical Package for the Social Sciences (SPSS) version 25 for statistical analysis.

Significance of the Study

This study was significant at both the institutional and USG levels. The institution involved in this study can use the findings to better inform its practices. First, the institution will be able to identify predictors that are most important to the success of its students enrolled in corequisite courses. Thus, the institution can improve the academic outcomes of students in the corequisite model by strengthening its current academic support structures and creating new programs designed to mitigate factors that negatively impact student academic success in corequisite courses. Additionally, the methodology used in this study can be used by the institution to investigate similar predictors of student academic success in other courses. At the USG level, this study will provide a methodology that can be replicated to evaluate the impact of the corequisite model policy within each of its institutional categories. For instance, the USG can use its extensive dataset to identify which predictors best determine success in corequisite courses.

Finally, as the corequisite model continues to be implemented on a national scale, it is important that practitioners and policymakers do not focus solely on course pass rates. Although, course pass rates are important they do not provide practitioners with the details needed to develop interventions for students who are academically unsuccessful in corequisite courses. This study adds to the current literature by identifying predictors that are associated with students' academic success in the corequisite model. This is important because institutions have a responsibility to provide student support structures for the corequisite model.

Definition of Terms

Academic Success*: A*cademic success will be defined dichotomously on a pass or fail basis.

Students who earned a final letter grade of A, B, or C will be coded as passing and all other letter grades will be considering failing.

Academic Preparation*:* Academic preparation will refer to a student's high school grade point average, and placement test scores.

Access to Higher Education: Access to higher education refers to the ability of an individual to enroll at a postsecondary institution.

Community College: A public higher education degree-granting undergraduate institution with an open admissions policy. A community college is sometimes referred to as a junior college or two-year college.

Corequisite Model: A gateway mathematics and/or English paired with an additional DE course for subject area academic support.

Developmental Education *(DE)*: Courses or services provided for helping underprepared college students attain their academic goals (Boylan, 2002, p.3).

DE Course: A college non-credit bearing academic courses in English, mathematics, or reading. The course is numbered below the 1000 level. In this study these courses include ENGL 0999, MATH 0997, and MATH 0999.

DE Student: A student required to enroll in a DE course.

DE Program: A combination of DE courses and an institution's DE course placement policy, corequisite course faculty employment status, academic advising, and academic tutoring.

Faculty Status: The employment status of a faculty member. Full-time faculty (FT) are employed with an institution for a full academic year. Part-time faculty (PT) are employed with an institution on a semester-to-semester basis based on the staffing needs of the institution.

First-Generation Student Status: A student whose parent(s) has not earned a postsecondary credential.

Gateway Course: An introductory college-level mathematics or English course.

STEM Major: An academic major that places an emphasis on science, technology, engineering, and mathematics. This would additionally include business/business education majors.

Non-STEM Major: All majors that are not classified as STEM majors.

Student Demographics*:* A student's self-reported race and sex, Pell Grant recipient status, and first-generation college student status.

Chapter Summary

DE is a combination of courses or services designed to help underprepared college students. DE continues to be a major component of the American CC sector. However, all students who are required to enroll in DE do not achieve the same type of academic outcomes. Therefore, administrators, faculty, and staff of CCs must continually conduct program research to ensure that their DE programs are yielding positive student academic outcomes.

The purpose of this quantitative study was to determine predictors of CC student academic success in the corequisite model. This study sought to determine the best predictors of student academic success in the corequisite model at a two-year CC in Georgia: a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, high school GPA, placement test scores, academic major, time spent receiving academic tutoring, or corequisite course faculty employment status. This study was significant because the results add to the literature on factors associated with student academic success in the corequisite model. Specifically, it can aid leaders at the institution involved in this study to develop policies, procedures, and practices to improve the academic outcomes of students enrolled in corequisite courses.

CHAPTER 2: REVIEW OF THE LITERATURE

For more than a decade there has been extensive research conducted on the pros and cons of collegiate DE as it relates to placement testing, instructional practices, course outcomes, and reform efforts (Bahr, 2012; Clotfelter, Ladd, Muschkin, and Vigdor, 2015; Scott-Clayton & Rodriguez, 2015; Xu, 2016). This review of the literature is focused on predictors of student academic success as it relates to corequisite courses taught at CCs. It is not a comprehensive examination of all predictors of student academic success in corequisite courses, components and outcomes associated with DE, or CCs. However, it has been designed to provide the reader an overview of predictors related to student academic success in the corequisite model at CCs as it relates to the data analyzed in this study.

A review of the literature was conducted for recent peer-reviewed articles published from 2012 to present using the online electronic database systems available through Georgia Southern University's library. The library's Discover search engine was used to simultaneously search multiple databases including Academic Search Complete, Advanced Placement Source, Complementary Index, Educational Research Information Clearinghouse (ERIC), Education Full Text (H.W. Wilson), Omi Full Text Mega (H.W. Wilson), and Professional Development Collection. The keywords and phrases used in these searches included "developmental education," "corequisite," "remedial education," "outcomes," "graduation," "completion," "English," "math," "writing," "placement testing," "college," "students," "university." Boolean operators were applied to search phrases to further filter the search results. Additionally, a search was conducted using ProQuest's Dissertation and Theses database. Finally, Google Scholar© was utilized to find the popularity of a source that appeared commonly in multiple articles' reference sections. It was also used to search for other works that might have been relevant to this literature review.

Organization of the Literature Review

This chapter provides a review of the literature on predictors of student academic success in the corequisite model. The literature review begins with brief overviews of CCs and DE to provide context to the students and environment where the study was conducted. Next, the theoretical framework of this study will be discussed. Finally, each predictor examined in this study as it related to student academic success in the corequisite model will be discussed. In this review of the literature CCs are limited to public degree-granting undergraduate institutions that have open admission policies.

Community Colleges

The development of American CCs is a hallmark of our democracy (Mellow & Heelan, 2014). Most CCs are "open admission" which means these institutions accept any student who has earned at least a high school diploma or its equivalent. Therefore, the primary mission of each CC is to provide its community with access to postsecondary options (Cohen et al., 2014; Vaughn, 2006). Indeed, this mission of providing postsecondary options within a local context presents CCs with unique challenges and opportunities in serving their local communities. With that in mind, the following discussion will provide an overview of the history, students, faculty, finances and governance, and typical academic programming of CCs. Finally, this section will close with a description of Georgia CCs.

History

The initial concept of an American CC was proposed during the middle to late nineteenth century (Brubacher & Rudy, 1996). Three mechanisms can be considered with respect to the creation of American CCs: (1) preparation for the baccalaureate degree, (2) social and industrial demands of society, and (3) economic necessity of students for a local higher education option. First, CCs initially served as a bridge between secondary schools and the senior and junior years of a baccalaureate degree program (Brubacher & Rudy, 1996). Shortly thereafter, in 1901, Joliet Junior College in Illinois became the first public CC in the United States (Beach, 2011; Cohen et al., 2014; Vaughn, 2006). Following the establishment of Joliet Junior College, the number of CCs grew to 1,200 by 1970 (Beach, 2011; Cohen et al., 2014; Vaughn, 2006). There were several catalysts that led to this growth: (1) G.I. Bill which extended higher education opportunities to veterans, (2) the Truman Commission's advocacy for CCs, (3) the higher education demands of Baby Boomers, and (4) the economic, political and social demands for a local higher education option (Levin & Kater, 2018; Mellow & Heelan,2015; Vaughn, 2006).

Students

Approximately six million students enrolled at 1,029 CCs in the United States during the fall semester of 2017 (NCES, 2019), see Table 1. These students accounted for 49.5% of all undergraduate students attending US public degree-granting institutions. Although nearly half of all undergraduate students attend CCs, it should be noted that most of these students attended on a part-time basis (NCES, 2019), see Table 1. The literature provides several reasons for the enrollment of part-time students including family obligations, course flexibility, and full-time employment status (Mellow & Heelan, 2015; Malcom-Piqueux, 2018).

Table 1

Fall 2017 Undergraduate Student Demographics at US Public Degree-Granting Enrollment

	Community Colleges	%	4-year Institutions	%	Total	%
Full-time	2,394,281	42.6%	4,909,660	85.5%	7,303,941	64.3%
Part-time	3,228,847	57.4%	831,463	14.5%	4,060,310	35.7%

Women	3,164,127	56.3%	3,093,657	53.9%	6,257,784	55.1%
Men	2,459,001	43.7%	2,647,466	46.1%	5,106,467	44.9%
American Indian or Alaska Native	52,050	0.9%	30,230	0.5%	82,280	0.7%
Asian	326,192	5.8%	439,110	7.6%	765,302	6.7%
Black or African American	780,152	13.9%	617,999	10.8%	1,398,151	12.3%
Hispanic	1,466,888	26.1%	911,342	15.9%	2,378,230	20.9%
Native Hawaiian or Other Pacific Islander	16,833	0.3%	10,273	0.2%	27,106	0.2%
White	2,502,814	44.5%	3,129,991	54.5%	5,632,805	49.6%
Two or more races	198,598	3.5%	227,238	4.0%	425,836	3.7%
Race/ethnicity unknown	175,384	3.1%	116,953	2.0%	292,337	2.6%
Nonresident alien	104,217	1.9%	257,987	4.5%	362,204	3.2%
Total	5,623,128	100.0%	5,741,123	100.0%	11,364,251	100.0%

Faculty

Cohen, Kisker, and Brawer (2014) noted that the highest academic degree earned by CC faculty members differs based on the mission of each individual institution. Each academic program within a CC may have different faculty credentialing standards for faculty. For example, a CC that offers an adult education program may require faculty members to hold at least a bachelor’s degree. However, the CC may require faculty in a nursing program to have at least a master’s degree. Again, this flexibility in faculty credentialing allows CCs full their institutional missions.

Moreover, faculty employment status at CCs varies by institutional mission and academic program. Some CCs may elect to employ faculty on a part-time basis or full-time basis based on academic program (Cohen et al., 2014; Vaughn, 2006). Furthermore, CC may award faculty tenure and rank just like their colleagues at other institutions (Vaughn, 2006). In some situations, CC faculty may have the ability to join labor unions that protect their interests.

Governance and Finances

CC have governance structures like those of other institutions. Mellow and Heelan (2015) noted that governance is primarily concerned with decision-making and authority. Thus, governance is about power. Therefore, governance at CCs is a political process within a local context and must be navigated effectively for CCs to exercise their unique missions. CCs are like other institutions in that they have both external and internal governance structures. This means that CCs typically have one or more external governing bodies (Mellow & Heelan, 2015; Vaughn, 2006). The major governing body of CCs is typically the state governing board charged which setting policies, establishing procedures, and providing oversight and state funding. Additionally, most CCs have boards of trustees that include local community members that leverage the expertise of individual members to promote the mission of the CC. Furthermore, CCs voluntarily participation in the accreditation process at institutional and programmatic levels has an impact on institutional governance processes (Cohen et al., 2014; Kater & Kisker, 2018). Moreover, many CCs have internal governing structures based on the concept of shared governance (Mellow & Heelan, 2015). Shared governance allows all institutional stakeholders to participate in the decision-making process by establishing policies and procedures that provide clarity, transparency, and access to institutional stakeholders (Mellow & Heelan, 2015; Vaughn, 2006).

CCs are primarily funded from state and/or local sources (Cohen et al., 2014). These allocations are often formula-based and dependent on full-time student equivalency (Palmer & Romano, 2018). However, state and local support for CCs just like other public higher education institutions has declined primarily because (1) decreased revenue of states and local municipalities, (2) lack of public confidence in the effectiveness of higher education, and (3) changing perceptions of higher education as a private good versus a public good (Mellow & Heelan, 2015; Palmer & Romano, 2018). Therefore, CCs like other public higher education institutions have relied more heavily on increases in tuition and fees (Palmer & Romano, 2018).

Nonetheless, CCs have remained a relatively affordable option for students despite an increased dependence on tuition and fees (Palmer & Romano, 2018).

Academics

The unique missions of CCs often lead to the implementation of multifaceted academic programs. These academic programs can be classified as community education, developmental education, and collegiate education (Cohen et al., 2014; Vaughn, 2006). It should be noted that all CCs do not provide the same types of academic programs as each CC operates within a unique local context and responds to varying community needs. Nonetheless, an overview of each of these academic programs is discussed below.

Community education. CC's unique missions allow these institutions to offer continuing education programs of various duration on a wide range of topics (Vaughn, 2006). Programs could range from non-credit bearing courses such as Quickbooks to the basics of photography. Additionally, CCs may offer programs designed to meet the short-term needs of employers who need employees with certified skills. CCs often partner with industry to provide the necessary training so that employers have a pipeline to employees who are "work ready" at the completion of a training program (Cohen et al., 2014). Moreover, some CCs may offer adult education to prepare students to take the general educational development (GED) tests or learn English as a Second Language (ESL) (Montero-Hernandez & Cerven, 2018). This training is often provided to students free of charge. After students pass their GED tests, they gain access to postsecondary options. Finally, some CCs have created partnerships with local high schools to provide opportunities to high school students to earn both technical training and transfer credit while still enrolled in high school (Cohen et al., 2014). Students who enroll in technical courses often can enter industry almost immediately following high school graduation depending on the requirements of their selected technical program.

Developmental education. DE at CCs provide students with coursework and academic support to assist them in being successful in their program of study (Perin, 2018). Specifically, DE provides students with the requisite skills for a certificate, diploma, associate degree, or bachelor's degree program (Cohen, et al., 2014; Perin, 2018; Vaughn, 2006). It should be noted that DE is not to be confused with Adult Education (ADE) as ADE is often designed to help students earn a secondary credential and DE is designed to prepare students for college-level courses (Perin, 2018). The need for DE courses at CCs cannot be understated as 99% of CCs offered DE courses during the 2017-2018 academic year (NCES, 2019). In fact, Chen (2016) found that 68% of two-year college students enrolled in at least one DE course. Chen used data from the most recent Beginning Postsecondary Students Longitudinal Study, BPS: 04/09. Chen's results are summarized in Table 2.

Table 2

Two-Year Students Enrolled in Developmental Education Courses

	Percentage	Average number DE courses taken
2- year Public	68.0%	2.9
Men	64.6%	2.9
Women	70.7%	3.0
Black or African American	78.3%	3.5
Asian	68.1%	3.5
Hispanic or Latino	74.9%	4.0
White	63.6%	2.4
All other races	71.4%	3.1
Age – 18 or younger	69.1%	2.8
19	69.6%	3.0
20-23	73.3%	3.0
24 or older	62.1%	3.0

These data indicate that two-year public institutions provide access to diverse student populations. However, many minority students are placed at a disadvantage because they enroll in more DE courses. Additionally, the data show that age is not a contributing factor in assignment to DE courses. In fact, it shows that relatively recent high school graduates or general educational development (GED® Testing Service, n.d.) recipients are required to enroll in the same number of DE courses as their older peers.

Collegiate education. CCs offer multiple postsecondary credentials. The credentials can include certificate and diploma programs that typically take less than two years to complete (Cohen et al., 2014). Additionally, students can decide to earn associate degrees by completing a typical two-year program of study. These programs can include fields such as liberal arts, health professions, business management, protection services, and visual and performing arts (Vaughn, 2006). Moreover, CCs can have articulation agreements with partner institutions that allow for relatively seamless transfer into baccalaureate degree programs (Bailey et al., 2015). Nonetheless, CCs experience a tremendous amount of internal and external pressure as it relates to student program completion rates (Levin, Kater, & López Damián, 2018). However, the common metrics used to measure success are often counterintuitive to the institutional missions of CCs and the type of students that they serve (American Association of Community Colleges, 2018).

Community Colleges in Georgia

CCs within the state of Georgia operate primarily within two higher education systems: The Technical College System of Georgia (TCSG) and the University System of Georgia (USG). There are currently 22 institutions, see Table 3, within the TCSG with a primary focus on providing community education, DE, and collegiate education. Additionally, the TCSG has partnered with the Georgia Department of Education to open 43 College and Career Academies with plans to open four new College and Career Academies in the near future to continue to serve more than 200,000 students (TCSG, 2018) These College and Career Academies are charter schools with partnerships between local businesses, schools, and technical colleges to provide training to students that lead to a postsecondary certificate upon graduation from high school (Georgia College & Career Academies, n.d.).

Within the USG there are nine CCs, see Table 3 (NCES, 2019). These institutions provide students with opportunities to earn associate's and limited bachelor's degrees (Lee, 2017). Many of the programs offered at these institutions are in the liberal arts and prepare students for continued study at a four-year institution. Similar, to their TCSG counterparts the USG institutions offer courses to high school students through dual enrollment programs (USG, 2016). These courses allow students to earn postsecondary course credits while still enrolled in high school. Moreover, there is some overlap in functionality between CCs in the TCSG and USG with respect to DE and preparation of students for transfer to four-year degree programs. Both systems offer DE via the corequisite model and have seen modest success with its implementation (Southern Regional Education Board, 2017). Additionally, institutions within both systems often sign articulation agreements to provide students with seamless transfer between institutions (Southeastern Technical College, n.d.).

Georgia has one independent CC without oversight from the TCSG or USG, Georgia Military College (GMC). GMC was formerly a member institution of the USG, but in the 1920s that membership was ceased through legislative action (GMC, n.d.). Today, GMC operates 14 campus sites throughout the state of Georgia and online (GMC, 2018). However, GMC offers similar academic programs to those provided within the USG.

Table 3

Fall 2017 Undergraduate Enrollment at Georgia Community Colleges

Institution	Location	Enrollment
Technical College System of Georgia		
Albany Technical College	Albany, GA	2,697
Athens Technical College	Athens, GA	3,808
Atlanta Technical College	Atlanta, GA	3,874
Augusta Technical College	Augusta, GA	4,162
Central Georgia Technical College	Warner Robins, GA	6,574
Chattahoochee Technical College	Marietta, GA	8,532
Coastal Pines Technical College	Waycross, GA	1,570
Columbus Technical College	Columbus, GA	2,656
Georgia Northwestern Technical College	Rome, GA	3,889
Georgia Piedmont Technical College	Clarkston, GA	3,138
Gwinnett Technical College	Lawrenceville, GA	7,091
Lanier Technical College	Oakwood, GA	3,031
North Georgia Technical College	Clarkesville, GA	2,236
Oconee Fall Line Technical College	Sandersville, GA	1,100
Ogeechee Technical College	Statesboro, GA	1,685
Savannah Technical College	Savannah, GA	3,469
South Georgia Technical College	Americus, GA	1,509
Southeastern Technical College	Vidalia, GA	1,255
Southern Crescent Technical College	Griffin, GA	3,900
Southern Regional Technical College	Thomasville, GA	2,457
West Georgia Technical College	Waco, GA	5,167
Wiregrass Georgia Technical College	Valdosta, GA	2,405
University System of Georgia		
Albany State University	Albany, GA	5,761
Atlanta Metropolitan State College	Atlanta, GA	2,238
Bainbridge State College	Bainbridge, GA	1,315
Dalton State College	Dalton, GA	4,756
East Georgia State College	Swainsboro, GA	2,596
Georgia Gwinnett College	Lawrenceville, GA	11,584
Georgia Highlands College	Rome, GA	5,715
South Georgia State College	Douglas, GA	2,150
Georgia Military College	Milledgeville, GA	5,947
Total Enrollment		**118,267**

An Overview of Developmental Education

Boylan (2002) defined developmental education (DE), also called remedial or learning support, as "courses or services provided for helping underprepared college students attain their academic goals" (p. 4). Bettinger et al. (2013) purported that DE courses provide an opportunity to remove barriers to college entry for prospective students. In this study, DE courses will include only college courses in English and/or reading, or mathematics designed to prepare students for a college degree program. Additionally, in this study, academic advising and academic tutoring will be included as components of DE.

DE can be traced back to the earliest days of higher education in America. During this period institutions such as Harvard, for both economic and academic reasons, had to provide supplemental instruction for underprepared students within an academic setting that was predicated on students' mastery of Latin (Parker, Sterk Barrett, & Bustillos, 2014). However, many of these students came from families that did not have the means to provide this training (Parker, Sterk Barrett, & Bustillos, 2014). Furthermore, as higher education opportunities were extended to more citizens through the growth of CCs, the primary responsibility of providing DE shifted to CCs from four-year universities (Cohen et al., 2014; Parker, Sterk Barrett, & Bustillos, 2014).

Currently, most DE programs include three main components (1) placement testing, (2) academic instruction, (3) academic support. Institutions vary in how they integrate these components. Some institutions centralize these components in a department and systematically deliver a DE program (Boylan, 2002). However, other institutions deliver each component separately through multiple departments without the coordination of a comprehensive DE program. Each one of these three components of a DE program along with a discussion of the corequisite model will be discussed below.

Placement Testing

Most students enter DE courses because of their placement test scores (Bettinger et al., 2013). Placement test scores have been used prevalently for admission by institutions (Wilson, 2012). However, there have been issues with the assignment of students to DE based solely on placement test scores. Placement test scores have been shown to be imprecise in determining the success of students in DE courses (Clotfelter et al., 2015; Scott-Clayton et al., 2014; Xu, 2016). Moreover, the Massachusetts Board of Higher Education [MBHE] (2016) recently allowed Massachusetts high school graduates to use their high school GPAs as an alternative to the ACCUPLACER for placement into DE mathematics at Massachusetts CCs and select University of Massachusetts campuses and state universities. Collectively, these studies have shown that placement test scores should not be used independently of other metrics. However, when placement test scores are used in combination with other metrics, such as high school GPA, interviews, and/or portfolios, students are more likely to be placed in appropriate DE or introductory college-level courses (Scott-Clayton & Rodriguez, 2015; Texas Higher Education Coordinating Board, 2014).

Academic Instruction

Following the assignment of students to DE courses based on placement test scores, they often enroll in DE courses taught by part-time faculty. Ginder, Kelly-Reid, and Mann (2017) found that 68.1% of instructional staff at two-year public institutions and administrative offices in the Fall of 2015 had part-time status. This disproportion use of part-time faculty members could be attributed to several factors: first, many CCs offer courses that must be taught by faculty with specialized industrial experience and the number of students in a program may be relatively small (Cohen et al., 2014). Second, many CCs rely on part-time faculty for economic reasons (Beach, 2011). Likewise, Shulman et al. (2017) reported an alarming trend in the academy: since 1975 the percentage of full-time tenured, tenure-track faculty, and graduate students has declined from 65.6% to 43.3% in 2015. The trend in the American higher education system has moved towards a heavy reliance on part-time or non-tenure track adjunct faculty for undergraduate instruction. Shulman et al. (2017) noted an increase in part-time and full-time non-tenure track faculty from 34.3 percent in 1975 to 56.7 percent in 2015.

Academic Support

Academic support services include academic advising and academic tutoring. As mentioned earlier in this chapter, these services fall within the definition of DE. Thus, DE services extend to most, if not all, college students. Indeed, O'Banion (2012) states "the purpose of academic advising is to help students select a program of study to meet life and vocational needs" (p.43). Academic advising is an important component of the educational process and that quality academic advisement is a necessary precursor to academic instruction. Additionally, when faculty members are involved in the advising process, they provide students with an enriched experience because of their knowledge of the field. For example, Williamson, Goosen, and Gonzalez (2014) discussed one college's efforts to engage faculty as advisors in its educational planning process. Williamson et al. found that students who attended at least one advising session had cumulative success rates, defined as earning grades of A, B, or C, of 70.4% versus 30.4% for students who did not receive any advisement. Williamson's et al. results indicated that having positive, purposeful interactions with faculty can have a positive impact on students.

Additionally, academic tutoring is a component of DE (Boylan, 2002). As such it provides a means for students to gain additional academic support for their courses. Academic tutoring is often provided to students via professional or peer tutors through a variety of media. More importantly, despite the modality of tutoring services, tutoring must provide students with opportunities to mitigate deficiencies in their learning and become academically successful. Berkopes and Abshire (2016) found positive benefits for students who utilized academic tutoring centers. Additionally, tutoring has been found to have positive effects on GPA, student retention, and final letter grades (Laskey & Hetzel, 2011; Vick, Robles-Piña, Martirosyan, & Kite, 2015.)

The Corequisite Model

The academic success of students initially placed in DE is the primary measure that students and their families, college faculty and administrators, state legislators, and external organizations use to determine the effectiveness of DE. These stakeholders are interested in how students perform in DE and subsequent college-level English and mathematics courses. The ability of students to earn credits in introductory English and mathematics significantly improves their probability of earning a postsecondary credential (Denley, 2017). The corequisite model, as it is popularly known, was first introduced in 2007 at Community College of Baltimore County as the Accelerated Learning Program (ALP) (Adams, Gerhart, Miller, & Roberts, 2009). The ALP allowed students who would have placed in the highest DE course based on their ACCUPLACER exam scores to voluntarily enroll directly into a three-hour gateway English course with an additional course taught by the same instructor for another three hours. Thus, students meet with the same instructor for approximately six hours each week for a full semester. It is important to note that each ALP English section was limited to 20 students (8 students assigned to DE and 12 non-DE students). Adams et al. (2009) found that 142 out of 224 students (63%) who enrolled in the ALP program from fall 2007 through spring 2009 passed the gateway English course. Whereas 294 out of 762 (39%) students who took the traditional DE course sequence passed the gateway English course.

National expansion of the corequisite model. The ALP gained national attention in 2010 when the Community College Research Center (CCRC) completed a study to analyze the effectiveness of the ALP program. During 2010, Jenkins, Speroni, Belfield, Jaggars, and Edgecombe (2010) of CCRC analyzed the results of CCBC's ALP program. Jenkins et al. (2010) used two sets of DE students to conduct the study. Students who enrolled in the ALP for the first-time were the treatment group (*n* = 104). Students who enrolled in the highest level of DE writing were in the control group (*n* = 2,070). Results from the analysis of data of the gateway English course showed that the ALP group's pass rate of 74.0% versus 37.7% for the control group was statistically significant one year after completion of the required DE course.

Subsequently, Cho, Kopko, Jenkins, and Jaggars (2012) conducted a follow-up study of Jenkins' et al. (2010) initial ALP analysis. The ALP treatment group included 592 students and the control group included 5,545 students who enrolled at CCBC from the fall 2007 through fall 2010. The ALP students' gateway English course pass rate was 73.65% versus 68.79% for non-ALP students one year after completion of the required DE course. Thus, these results corroborated the finding of Jenkins et al. (2010). It should be noted that by the end of the fall 2011 the ALP versus non-ALP gateway pass rates were 74.66% versus 73.14%.

Additionally, the effectiveness of the corequisite model has been studied in Louisiana (Campbell & Cintron, 2018). In Louisiana, 264 students at five CCs enrolled into pilot corequisite mathematics courses. These students were within two points of the CC's minimum

ACT scores to enroll directly into gateway courses without DE. These students were compared to two additional groups: the first group included students that had the required scores, but did not enroll in the corequisite mathematics courses, but instead completed a traditional DE mathematics course sequence; the second group included students who did not have the requisite scores and completed a traditional DE course mathematics sequence. Campbell and Cintron found no statistically significant difference between the success rates of the corequisite (67.80%), corequisite eligible (68.34%), and corequisite ineligible groups (66.02%). Results from the study did show that students who met the required test score requirements could be successful without enrolling in a multiple DE course sequence. However, the results are limited because of the study's relatively small sample size and no demographic information was provided about the students involved. Thus, the results are not generalizable to similar CC students.

Furthermore, Tennessee fully implemented the corequisite model at its public institutions during the fall semester of 2015 (Denley, 2016). The results for both corequisite English and mathematics were promising at Tennessee CCs although only descriptive statistics were provided. Following full implementation of the corequisite model, mathematics course success rates improved from 12.3% with multiple course DE sequences during the 2012-2013 academic year to 54.8% with the corequisite model. Likewise, in corequisite English courses success rates improved from 30.9% with multiple course DE sequences during 2012-2013 to 61.8% with the corequisite model. Indeed, the corequisite model has been showed to be effective in Tennessee, yet without student demographic information available it is difficult to determine what factors contributed to this drastic improvement in course success rates.

Based on the literature on DE course outcomes, the impact of placement test scores on students placed in DE, studies related to the ALP by Jenkins et al. (2010) and Cho et al. (2012) states and national organizations advocated for and took legislative action to reform DE courses. These reform efforts included allowing students to enroll directly into gateway courses or through the corequisite model (Cal. Ed. Code §78213; CCA, 2014; Collins, 2013; H.B. 2223, 2017; USG, 2018a; Venezia & Hughes, 2013). However, Goudas and Boylan (2012) leveled criticism at what was perceived as an attempt to eliminate DE. Goudas and Boylan's primary criticism was that CCA, whose organizational mission is to increase graduation rates, used its platform and media presence to advocate states, policymakers, and institutions "… to do away with any and all remedial courses that occur before college-level courses and implement corequisites for every student who places into remediation" (p.8). Moreover, Goudas and Boylan argued that the corequisite model had not led to increased graduation rates and doubled the cost of traditional DE.

Nonetheless, since that time Goudas (2018) has noted that the corequisite model as originally implemented in the ALP "… does appear to correlate with an improvement in gatekeeper pass rates and subsequent retention over stand-alone remediation when properly implemented" (p.24). Additionally, Boylan, Brown, and Anthony (2017) mildly acknowledge the efficacy of the corequisite model with respect to gateway course success but lament that the associated costs and long-term outcomes (i.e. graduation rates) have not improved. Moreover, DE practitioners are opposed to making wholesale decisions for all students assigned to DE courses because it is "easy, cheap, and fast" (Goudas, 2018, p.25). In contrast, organizations and policymakers have made decisions based primarily on the premise that increases in gateway course success rates for more students, including those assigned to DE, courses will lead to more students earning academic credentials, but that has yet to be determined as most policies for the scaling of the corequisite model are fairly recent (CCA, 2014; Collins, 2013; H.B. 2223, 2017; USG, 2018a; Venezia & Hughes, 2013).

Theoretical Framework

As mentioned in the previous section, CCBC used institutional data to revise its writing program via the ALP. Most importantly, the purpose of the ALP was to "… improve the success rates of our basic writing students" (Adams et al., 2009). CCBC offered several explanations for the success of the ALP program including (1) mainstreaming, (2) cohort learning with the same students and instructor for both courses, (3) small class sizes, (4) contextual learning, (5) allowing students to enter the gateway course faster, (6) combining students in DE with students who do not require DE, (7) integration of time management, and (8) an awareness by faculty of student's life situations (e.g. work schedules). Thus, Adams et al. (2009) implemented an institutional specific assessment process to improve student outcomes.

Similarly, higher education institutions can use Astin's Input-Environment-Outcome (I-E-O) model to determine the impact their environments have on student outcomes (Astin & Antonio, 2012). Astin initially developed the I-E-O model during the 1960s based on a series of studies related to the production of Ph.D. students based on the undergraduate institution that these students attended (Astin & Antonio, 2012). Studies prior to Astin's work found that the institutional resources, for example student-to-faculty ratio, and number of faculty members holding Ph.Ds, determined whether undergraduate students pursued Ph.Ds. Thus, these early studies focused on the environment provided by institutions. However, Astin found that student characteristics were more important than the environmental factors provided by institutions in determining whether undergraduates would pursue Ph.Ds (Astin & Antonio, 2012).

Furthermore, Astin's I-E-O model combined prior studies on environmental factors related to student outcomes with his work on student inputs to create a framework for higher education institutions to assess their environment as it relates to student outcomes (Astin & Antonio, 2012). Astin posits that outcomes are always based on inputs. However, Astin notes that there is no single input that determines an outcome. Finally, Astin notes that environments are always mediators between inputs and outcomes.

Examples of Astin's I-E-O Model within Higher Education

As an example of the use of Astin's I-E-O model within higher education, Fink (2014) used Astin's I-E-O model to analyze college students' scores on Keye's Mental Health Continuum score. Fink used data from the National Study of Living-Learning Programs (NSLLP) instrument to determine predictors of student mental health within a higher education setting. Fink used student demographics—gender, race, sexual orientation, parents' education and income, precollege measures—volunteerism, academic success, science courses, English course, and high school GPA as *Inputs*. The *Environmental Factors* included student ranking of college climate, social and academic interactions, a student's personal engagement within the college, and intermediate outcomes—professional confidence, college success confidence, academic skill confidence, degree of emotional consequences related to the use of alcohol, sense of belonging, and sense of civic engagement. Fink found that both student inputs and environmental factors excluding students' personal engagement on campus were statistically significant predictors of students' Keye's Mental Health scores based on the application of Astin's I-E-O model.

Another recent example of the use of Astin's I-E-O model is from the work of Sesate, Milem, and Bryan (2017) who used it to predict medical students' scores on the first test of the

United States Medical Licensing Exam (USMLE). Sesate et al. used several blocks of variables as *Inputs* including student demographics and medical school admission metrics (e.g. MCAT, GPA, STEM Major, etc.) and the *Environmental Factors* were students' first-year of medical school block and second-year of medical school block scores. Sesate et al. found that environment factors were better predictors of student success on the first test of the USMLE based on the application of Astin's I-E-O model.

Use of Astin's I-E-O Model in This Study

As this study focused on identifying predictors of student academic outcomes in the corequisite model, it was appropriate to apply Astin's I-E-O model, see Figure 2.1 as a theoretical framework. Astin's I-E-O model provided a means of investigating relationships between variables where *Inputs* and *Environment* served as blocks of independent variables and *Outcome* was the dependent variable.

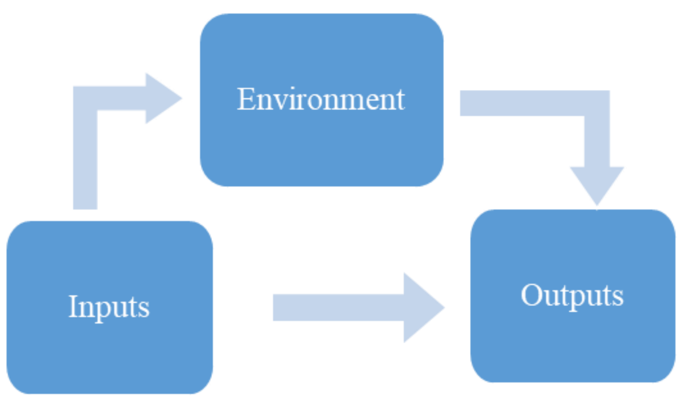

Figure 1: *Astin's Inputs-Environment-Outcome (I-E-O) Model.*

The *Inputs* in the I-E-O model refer to those qualities that students bring to their respective environment. In this study the *Inputs* were a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, high school GPA, placement test scores, and academic major. It should be noted that in this study students' high school GPA calculations will only include 17 units of the University System of Georgia's

Required High School Curriculum (USG, 2018b). These units include four units of each of the following (1) English, (2) mathematics, and (3) science; three units of social studies, and two units of the same foreign language, American Sign Language, or computer science (USG, 2018b).

The *Environment* in the I-E-O model refers to what institutions contribute to the development of student *Inputs*. In this study the *Environment* were corequisite model faculty employment status and student utilization of the college's academic tutoring center. Finally, *Outcome* in the I-E-O model refers to the ideal event that practitioners would like to occur. In this study, the *Outcome* investigated was whether a student passed or failed a corequisite course.

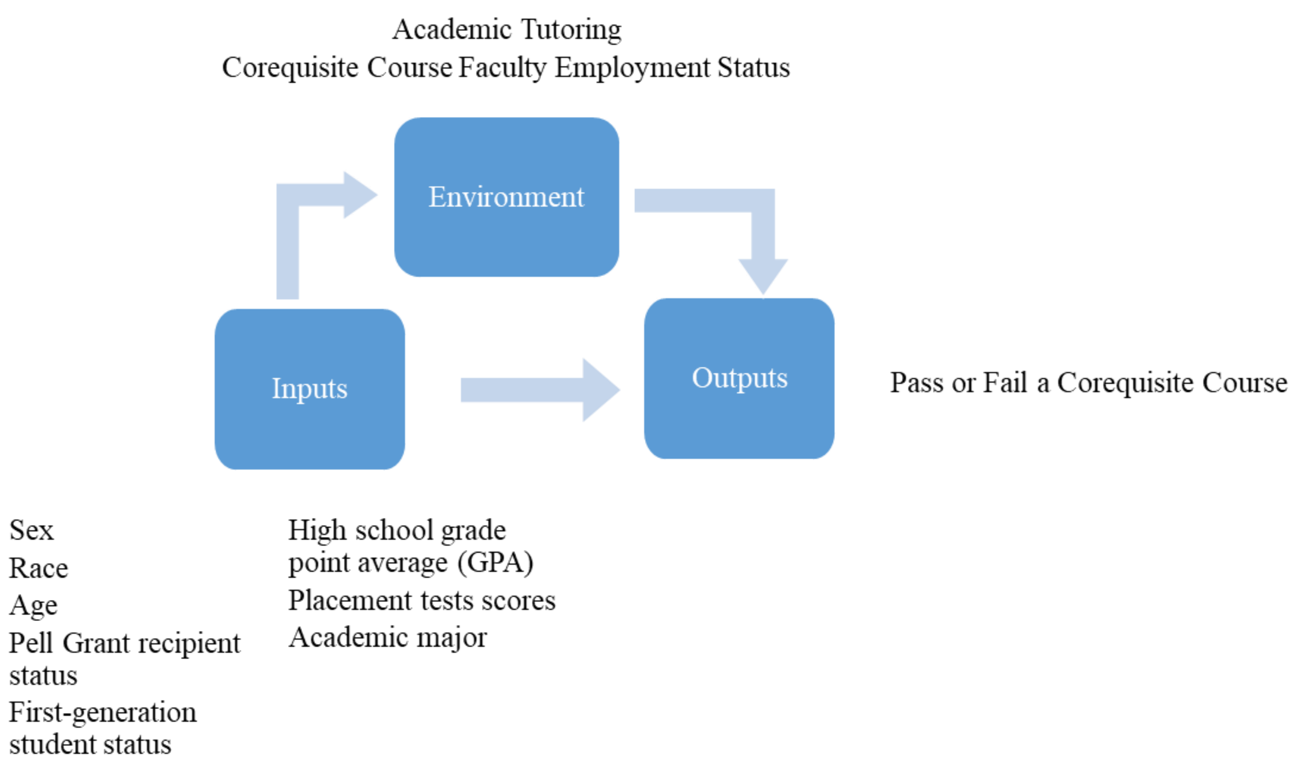

Figure 2: Astin's Inputs-Environment-Outcome (I-E-O) Model with Predictors.

Predictors of Student Academic Success in Corequisite Courses

Astin's I-E-O model was used as a framework with two components that interacted with respect to the corequisite model: (1) *Student Inputs* and (2) *Environmental Factors*. In this literature review *Student Inputs* and *Environmental Factors* will be reviewed specifically as it relates to corequisite and/or gateway courses. The *Student Inputs* component will focus on academic outcomes associated with a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, high school GPA, placement test scores, and academic major. Likewise, the *Environmental Factors* component will focus on academic outcomes associated with faculty employment status and academic tutoring.

Student Inputs

Sex. A predictor to consider when investigating student success in the corequisite model is a student's sex. Chen (2016) found that more female students enrolled in DE than male students at CCs, 71% versus 65%. However, Chen's results indicated that when sex was used as a control for students assigned to DE being female increased the probability of students earning college-level English credits and mathematics credits. Additionally, Wheeler and Bray (2017) sought to determine the interaction of sex, race, and DE student status on student academic success in a gateway mathematics course at a CC in rural Alabama of approximately 10,000 students. Academic success was defined dichotomously on a pass or fail basis. Using logistic regression, being a female student was found to be a statistically significant predictor of student academic success in a gateway mathematics course. In fact, the odds of a female student passing a gateway mathematics course were 1.52 that of a male student (Wheeler & Bray, 2017).

Likewise, Moss, Kelcey, and Showers (2014) sought to determine the impact of student demographics, student placement scores, classroom composition (e.g. average overall GPA, ratio of DE students, ratio of full-time students), and faculty demographics and employment status had on the academic success of 3,429 students in gateway English courses at a suburban CC in the Midwest. Moss et al. (2014) found that being a female student was a statistically significant predictor of increased odds of a student passing a gateway English course. Collectively, these studies highlight the need to consider a student's sex as a predictor of academic success in corequisite courses.

Race. Minority students, particularly African-American and Hispanic, are more likely to be placed into DE (CCA, 2016). Therefore, it is important to include race as an indicator of student success in the corequisite model. The impact of race on students assigned to DE cannot be understated particularly as it relates to earning college-level English and mathematics credit. Chen (2016) found that when race is used as a control for CC students assigned to DE, minority students, other than Asian students, had decreased probabilities of earning college-level English credits. Additionally, African American and Hispanic students had decreased probabilities of earning college-level mathematics credit. Likewise, Wolfle (2012) and Wheeler and Bray (2017) found that White students had higher odds of passing a gateway mathematics course than non-White students. Similarly, Moss et al. (2014) found that being a non-White student decreased the odds of a student passing a gateway English course. Moreover, Logue, Watanabe-Rose, and Douglas (2016) used logistic regression analysis of 717 students randomly assigned to one of two corequisite mathematics courses or a standalone DE course at three CUNY community colleges in the boroughs of the Bronx, Manhattan, and Queens. Logue et al. found that minority students had decreased odds of being academically successful in the corequisite mathematics courses. Taken together these studies support that race is indeed a predictor in determining student academic success in the corequisite model.

Age. Age is another predictor to consider in the success of students in the corequisite model. Snyder et al. (2019) found that 61% of the first-year undergraduate students who took DE classes were between the age of 15 and 23. Furthermore, Wolfle (2012) sought to determine the impact of DE status, age, and ethnicity on student academic success in first college-level mathematics courses at one Virginia CC of 756 first-time students enrolled at the college during the fall semester of 2006. He applied logistic regression to archival data and found that age and race were statistically significant in determining success in first college-level mathematics courses. His findings indicated that nontraditional-aged, 23 or older, and White students are more likely to succeed in first college-level mathematics courses. Similarly, Moss et al. (2014) found that as a student's age increased so did their odds of passing a gateway English course. Additionally, Logue et al. (2016) found that age did increase the odds of students being academically successful in corequisite mathematics courses. However, Quarles and Davis (2017) found that older students earned lower final letter grades in pre-calculus, but as older students earned higher final letter grades in statistics or a liberal arts math course. These studies suggest that older students have greater odds of passing gateway courses compared to their younger counterparts. Therefore, student age is another predictor to consider in student academic success in corequisite courses.

Pell Grant recipient status. A student's socioeconomic status is another predictor to consider in the success of students in the corequisite model. CCA notes that many students who are assigned to DE are more likely to be Pell Grant recipients (CCA, 2016). Likewise, Chen (2016) found a positive relationship between an increase in students' economic level and their probability of earning college-level credits for both English and mathematics. Additionally, Williams and Siwatu (2017) sought to determine if gateway course success could be predicted by the location where 4,336 students enrolled in DE courses, either at a CC or four-year institution with the state of Louisiana. Other predictors that were included in the study were race, sex, age, HS GPA, entrance exam scores, and Pell Grant status. Academic success was defined dichotomously on a pass or fail basis. Using logistic regression, Williams and Siwatu (2017) found that students who received a Pell Grant had decreased odds of passing gateway English and mathematics courses. Moreover, Woods, Park, Hu, & Betrand Jones (2018) found that low-income status measured by reception of free-and-reduced lunch status reduced the odds of passing gateway English and mathematics courses. Thus, as a student's economic level improve does the likelihood of earning college-level English and/or mathematics credits. Therefore, these studies highlight the need to consider student socioeconomic status as a predictor of student academic success in the corequisite model.

First-generation college student status. Early academic success in gateway English and mathematics courses has been shown to be critical to students earning a postsecondary credential (Denley, 2017). A student's first-generation college student status is another predictor to consider in the success of students in the corequisite model. First-generation college students are often at an increased risk of not completing college (Crisp & Delgado, 2014; Engle & Tinto, 2008). The reasons often range from not being able to assimilate to their new environments to running out of financial resources to return to school (Crisp & Delgado, 2014; Engle & Tinto, 2008). However, Berkopes and Abshire (2016) found that first-generation college students' utilization of academic services did not significantly differ from that of students who have parent(s) who have earned a postsecondary credential which indicated that first-generation students do assimilate to their new environments.

Furthermore, Chen (2016) grouped students assigned to DE into three groups based on their parents' educational level: high school or less, some college, and bachelor's degree or higher. Chen (2016) found a positive relationship between the highest education level of parents and a student's probability of earning college-level English credits. Thus, as parents' education level increase there is a greater probability of students earning college-level English credits. With respect to earning college-level mathematics credit Chen (2016) found that parental education level does not seem to have an impact. However, Houston & Xu (2016) found that students with parents with higher levels of education are less likely to enroll in DE mathematics courses. These studies indicated varying degrees of success of first-generation college students with respect to mathematics and English. Therefore, considering first-generation college student status as a predictor for academic success in the corequisite model is appropriate.

Placement testing and high school GPA. Most students enter DE courses because of their placement test scores (Bettinger et al., 2013). Wilson (2012) investigated state policies regarding placement into DE courses. She found that 35 states had policies that required the use of placement tests. The most prevalent placement test packages used for placement tests are College Board's ACCUPLACER and American College Testing's COMPASS exam which was discontinued in 2016. Wilson (2012) found that the states in her study had standard cutoff scores that could be adjusted by individual institutions and that many of the states had moved or eliminated DE coursework at four-year institutions and shifted the responsibility of providing DE coursework to two-year institutions.

Placement test scores have been showed not to be reliable indicators for assignment to DE when used in isolation. Xu (2016) found that placement tests scores are imprecise standalone measures for placement into DE or college-level courses. Likewise, Scott-Clayton, Crosta, and Belfield (2014) found high school GPA, when combined with placement test scores, was a superior predictor of student success, defined as earning a grade of C or better, for both college-level introductory math or English. Moreover, Logue et al. (2016) and Williams and Siwatu (2017) in logistic regression analyses found that high school GPA was a statistically significant predictor of student in both gateway English and mathematics courses. These studies reemphasized the point that placement tests alone are not the best predictors of student success and must be used in tandem with all available pre-admission data such as high school GPA, interviews, and/or portfolios to properly place students into DE or introductory college-level courses. Furthermore, states that allow individual institutions to raise their cutoff scores divert students from disadvantaged backgrounds from enrolling in college-level courses (Chen, 2016). Therefore, both placement test scores and high school GPA should be considered as predictors of student academic success in the corequisite model.

Academic major. A final student input to consider when investigating the success of students in the corequisite model is whether students are taking the appropriate mathematics courses for their academic major known as mathematics pathways. Mathematics pathways offer accelerated forms of DE mathematics courses so that students can earn gateway mathematics course credit within two semesters (Huang, 2018; Zachry Rutschow, 2018). There are currently two mathematics pathway programs in the United States the (1) Dana Center Mathematics Pathways and (2) Carnegie Math Pathways (Huang, 2018; Zachry Rutschow, 2018). These pathways offer alternatives to the traditional calculus pathway for STEM majors and include statistics for social science and health profession majors and quantitative reasoning for liberal arts and humanities majors (Zachry Rutschow, 2018).

Advocates of math pathways argue that college algebra should be reserved for only those students with majors that require calculus and that other students should enroll in mathematics courses that focus on quantitative reasoning or statistics (Huang, 2018). With respect to the Carnegie Pathways program descriptive statistics indicated a threefold increase in course pass rates from 6% with traditional DE to 54% in its statistics pathway and from 21% with traditional DE to 63% in quantitative skills pathway (Huang, 2018). The Dana Center Pathways have shown statistically significant increases in the percentage of students who earned gateway mathematics credit within two or three semesters (Zachry Rutschow, 2018). However, while mathematics pathways ensure that students enroll in the most appropriate mathematics course for their academic majors there is very little extant research on what factors determine the academic success of students enrolled in these courses.

Environmental Factors

Faculty employment status. After students are assigned to DE they receive academic instruction from faculty. In many cases, these faculty members are adjunct faculty. Shulman et al. (2017) reported an alarming trend in the academy: since 1975 the percentage of full-time tenured, tenure-track faculty, and graduate students has declined from 65.6% to 43.3% in 2015 which is a 34% decline. The trend in the American higher education system has moved toward a heavy reliance on part-time or non-tenure track adjunct faculty for undergraduate instruction. The same report revealed a 65% increase in part-time and full-time non-tenure track faculty from 34.3% in 1975 to 56.7% in 2015. Thus, Townsend's (2003) remarks, more than a decade earlier, about the current state of the instructional staff within the academy are more poignant:

> … [T]he academy has accommodated itself to a class of teachers who receive substandard pay, are largely excluded from the life of their departments, and receive

> minimal support for teaching, academic research, and professional development. This despite mounting evidence that an overreliance on part-time faculty fundamentally deforms and undermines the work and values of the academy. (p. 23)

Furthermore, Datray, Saxon, and Martirosyan (2014) examined extant literature on the utilization of adjunct faculty in DE. Their premise was that despite efforts to reform DE through policy and professional practice, adjunct faculty are critical stakeholders who are often forgotten in these efforts. They found that there is potentially an overreliance on adjunct faculty to teach DE courses and conflicting opinions about their commitment to the institutions where they teach. Additionally, based on their analysis of the literature they found mixed results regarding the effectiveness of adjunct faculty with respect to student success. They noted that a lack of student access to adjunct faculty via office hours in a dedicated space and minimal professional development opportunities for adjunct faculty had a negative impact on student success.

Overall, adjunct faculty members are critical to the success of their respective institutions and as such, must be recruited, trained, and supported in a way that improves their professional growth and consequently student academic outcomes. However, Moss et al. (2014) found that DE students who were taught by a full-time faculty member in gateway English courses had a 46% increase in their odds of earning a higher grade. Furthermore, Logue et al. (2016) found that faculty tenure status increased students' odds of being academically successful in corequisite mathematics courses. However, faculty members who did not teach a statistics corequisite course decreased students' odds of being academically successful. Therefore, based on these studies it seems reasonable to consider faculty employment status as a predictor of student academic success in the corequisite model.

Academic tutoring. Academic tutoring is another environmental factor to consider in the administration of DE. Boylan (2002) stated "Tutoring is one of the oldest forms of developmental education intervention" (p. 49). Academic tutoring provides a means for students to gain additional academic support. Laskey and Hetzel (2011) found that tutoring visits have a positive effect on GPA and retention. Additionally, Berkopes and Abshire (2016) found that both continuing generation students and first-generation students take advantage of academic learning centers. Academic tutoring can take on many forms including peer tutoring, small group tutoring, one-on-one tutoring, walk-in tutoring centers, and a multitude of online tutoring options such as Khan Academy, Tutor.com™, or YouTube. In fact, textbook publishers have acquired tutoring companies to further expand the level of services that they provide to institutions and students. For instance, Pearson acquired SmartThinking, a leading postsecondary online tutoring provider in February 2011 (Signal Hill, 2011). More importantly, despite the modality of tutoring services, tutoring provides opportunities for students to mitigate deficiencies in their learning and become academically successful.

Vick, Robles-Piña, Martirosyan, and Kite (2015) sought to determine if differences existed between final grades of students enrolled in DE English based on their utilization of tutoring services at a North Carolina CC. Vick et al. (2015) found that only 253 out of 2488 (10.2%) students used tutoring services. However, there was a statistically significant difference in final letter grades of students who utilized tutoring services versus students who did not use tutoring services. Together, these studies indicate student utilization of tutoring services should be considered as a predictor of student academic success in the corequisite model.

Chapter Summary

Many students often begin their higher education pursuits at CCs. However, some of these students are required to enroll in DE courses. Recent research on DE student outcomes has led to reform efforts aimed at reducing or eliminating the use of multiple DE courses prior to enrollment in college-level English and mathematics courses. One effort has been the use of corequisite course where students enroll in college-level courses while subsequently receiving academic support in an additional course. However, research is limited on predictors of student academic success in these corequisite courses. This study seeks to fill that void in the literature.

CHAPTER 3: METHODOLOGY

Population

The setting for this study was a small, rural, CC in Georgia that offers associate and baccalaureate degrees. The institution is an open-access institution that serves approximately 3,000 students each fall semester. Most of the students that attended the institution were minority students. The population in this study, based on archival data, included *n* = 1,933 students who enrolled in at least one corequisite English and/or mathematics course between the fall semester of 2015 and summer semester of 2018, see Table 4. The average age of students enrolled in corequisite courses was 20.18 years (*SD* = 4.70) with ages that ranged from 16-58. The average high school GPA was 2.61 (*SD* = 0.38).

Table 4

Descriptive Statistics for Students Enrolled in Corequisite Courses

Student Characteristics		***n***	**%**
Sex	Female	1,102	58.5
	Male	831	41.5
Ethnicity	American Native	8	0.5
	Black	1238	71.4
	White	496	18.8
	Multiracial	129	6.4
	Hispanic	25	1.2
	Unknown	22	1.0
	Native Hawaiian	5	0.3
	Asian	10	0.5
Age	Younger than 18	44	2.3
	18-20	1523	78.8
	21-24	195	10.1
	25+	171	8.8
Pell Grant Recipient Status	Received	1,493	77.2
	Did not receive	440	22.8
First-Generation Student Status	Yes	597	30.9
	No	1,336	69.1
High School GPA	No GPA Available	93	4.8
	Less than 2.00	37	1.9
	2.00 – 2.49	737	38.1

	2.50 – 2.99	756	39.1
	3.00 – 3.49	272	14.1
	3.50+	38	2.0
Major	STEM	372	19.2
	Non-STEM	1,561	80.8

Variables

Student Inputs. The *Student Inputs* included a student's sex, race, age at time of initial enrollment in a corequisite course, Pell Grant recipient status, first-generation student status, high school grade point average (GPA) and students' placement tests scores, and academic major. A student's self-reported sex was categorized as either female or non-female. A student's race was categorized as either minority or non-minority. Age was a student's age at time of enrollment at the institution involved in this study. Students who received Pell Grants were categorized as Pell Grant recipients or non-Pell Grant recipients otherwise. Students' high school grade point averages were measured on a 0.00 to 4.00 scale. Students' placement test scores from the ACT, ACCUPLACER, COMPASS, and/or SAT in reading, math, and/or writing. Students' academic majors at time of enrollment were classified as either Science, Technology, Engineering, Mathematics, or Business (STEMB) or non-STEMB (all other majors) otherwise.

Environmental Factors. The *Environmental Factors* in this study included corequisite course faculty employment status and the time students spent receiving academic tutoring offered by the institution. A faculty member's employment status was categorized as either full-time or part-time during the term the faculty member taught the corequisite course. The amount of time students received tutoring services offered by the institution was measured in minutes.

Archival Datasets

The researcher first acquired Institutional Review Board (IRB) approval and a letter of cooperation from the research location and Georgia Southern University. Next, three de-identified datasets containing archival student data from the Fall 2015 to Summer 2018 semesters, inclusive, were provided to the researcher for data analysis as Microsoft Excel spreadsheets. The first dataset included student utilization of the institutional tutoring center. The second dataset included the following information for students: sex, race, age, Pell Grant recipient status, first-generation college student status, high school grade point average, placement test scores (i.e. reading, writing, and mathematics), academic major, corequisite course faculty employment status, and outcome in corequisite mathematics courses. The third dataset included the following information for students: sex, race, age, Pell Grant recipient status, first-generation college student status, high school grade point average, placement test scores (i.e. reading, writing, and mathematics), academic major, corequisite course faculty employment status, and outcome in corequisite English.

These datasets were appended to create one Microsoft Excel workbook that contained both an English and mathematics worksheet. Data for students not enrolled in corequisite courses were removed from the datasets. Microsoft Excel's Pivot Table tool was used to determine cases where students had multiple attempts of the same course, the number of attempts was recorded and added to Tables A-2 and A-3. Finally, because students could have multiple reading, writing, and mathematics placement test scores all placement test scores were converted to z-scores and composite reading, writing, and mathematics scores was created.

Data Analysis

The English and mathematics datasets, Tables A-4 and A-5, were imported into the Statistical Package for the Social Sciences (SPSS) version 25 for statistical analysis. Descriptive statistics were computed for both datasets. These descriptive statistics included students' sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, placement test scores, high school GPA, academic major, corequisite course faculty employment status, time spent receiving academic tutoring, and corequisite course outcome.

Logistic regression is used to predict whether a subject will belong to a dichotomous or polytomous group based on one or more independent variables (Lomax, 2007; Menard, 1995; Menard, 2010). As this study's dependent variable was whether a student passed or failed corequisite courses, logistic regression was an appropriate analysis technique (Lomax, 2007; Menard, 1995; Menard, 2010). A best-practice in logistic regression is the analysis of a complete datasets to increase the generality of the results of the statistical analysis to the population being studied (Field, 2013; Osborne, 2015). Therefore prior to conducting logistic regression, the datasets were analyzed for missing data.

Analysis of the dataset found that only 1.6% of the English dataset and 4.2% of the mathematics dataset had missing data. Subsequently, both datasets were analyzed to determine how to handle the missing data. One test that is commonly used to determine whether data can be excluded from data analysis is Little's Missing Completely at Random (MCAR) Test (Garson, 2015). If the *p*-value of Little's MCAR Test is greater than 0.05, then missing data can be excluded from further analysis (Garson, 2015). Missing data in this study were not determined to be MCAR. Therefore, mean substitution was chosen to replace the small percentages of missing data for both datasets (Tabachnick & Fidell, 2013).

Following mean substitution of missing data values, logistic regression analysis was conducted. Logistic regression does not have any distributional assumptions because it is a nonparametric analysis technique (Osborne, 2015). However, several assumptions were tested prior to utilizing logistic regression: (1) the logit link function was appropriate for data analysis; (2) independent variables were linearly and additively related to the logit, meaning after data transformation there is a linear relationship between the independent variables and the logit of the dependent variable and each independent variable adds to the model; (3) there was no multicollinearity between variables, meaning predictors are not highly correlated; (4) each case was independent, meaning each case is assigned to one group; (5) each variable was measured without error, for example there are no negative high school GPAs in the dataset; (6) only relevant independent variables were included in the analysis to reduce bias; (7) irrelevant independent variables were excluded to reduce standard errors; and (8) a minimum of 50 cases per predictor because logistic regression relies on maximum likelihood coefficients (Burns & Burns, 2006; Menard, 2010; Mertler & Reinhart, 2016; Osborne, 2015). After assumption testing, logistic regression analyses of both datasets were completed using block-wise entry of independent variables into the models. Block-wise entry allows researchers to determine model fit and independent variables' effects after each block or group of variables are entered in the model (Osborne, 2015). Thus, as this study's theoretical framework included variables associated with *Student Inputs* and *Environmental Factors* block-wise entry was an appropriate technique.

Ethical Considerations

The design of this study sought to minimize ethical issues. This study used archival data and did not contain any personally identifiable student or faculty information. Additionally, external funding was not provided to the researcher to conduct this study. The researcher received IRB approval to conduct the study from both Georgia Southern University and the institution involved in this study.

Chapter Summary

This quantitative study sought to determine predictors of CC student academic success in the corequisite model. The study included 1,933 students enrolled in corequisite English and/or mathematics from the Fall 2015 semester through the Summer 2018 semester, inclusive. Archival student data was used for logistic regression analysis using the SPSS, version 25.

CHAPTER 4: RESULTS

The following chapter presents a summary of the research findings. First, descriptive statistics for students who enrolled in corequisite English and mathematics courses are presented. These include student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, placement test scores, high school GPA, academic major, corequisite course faculty employment status, and time spent receiving academic tutoring. Finally, results from logistic regression analyses will be presented for both corequisite English and mathematics.

Corequisite gateway courses are one recent DE course reform effort that has been implemented throughout the United States (CCA, 2016; Denley, 2016; H.B. 2223, 2017; USG, 2018). The success of corequisite courses along with other DE reform efforts has changed the way DE courses are delivered. Although these changes have occurred in DE, we do not know the best predictors of CC student academic success in the corequisite model. Specifically, this quantitative study used archival student data to answer the following research question:

What are the best predictors of student academic success in the corequisite model: a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, placement test scores, high school GPA, academic major, corequisite course faculty employment status, or time spent receiving academic tutoring?

This research question is answered below in narrative and tabular form.

Descriptive Statistics

In this study *n* = 776 students enrolled in corequisite English courses during the fall 2015 semester through the summer 2018 semester, see Table 5. The average age of these students was 19.16 years (*SD* = 2.47) with ages that ranged from 16-58. The average high school GPA was

2.57 (*SD* = 0.39). The dependent variable was whether a student passed or failed a corequisite English course. More female students (59%) passed corequisite English courses, see Table 6. A student who passed a corequisite English course was coded as a 1 and 0 otherwise.

Table 5

Descriptive Statistics for Students Enrolled in Corequisite English Courses

Predictors		***n***	***%***
Sex	Female	440	56.7
	Male	336	43.3
Ethnicity	American Native	3	0.4
	Black	551	71.0
	White	141	18.2
	Multiracial	55	7.1
	Hispanic	9	1.2
	Unknown	9	1.2
	Native Hawaiian	1	0.1
	Asian	7	0.9
Age	Younger than 18	16	2.1
	18-20	680	87.6
	21-24	55	7.1
	25+	25	3.2
Pell Grant recipient status	Received	615	79.3
	Did not receive	161	20.7
First-generation student status	Yes	246	31.7
	No	530	68.3
High school GPA	No GPA Available	10	1.3
	Less than 2.00	16	2.1
	2.00 – 2.49	356	45.9
	2.50 – 2.99	268	34.5
	3.00 – 3.49	109	14.0
	3.50+	17	2.2
Major	STEM	136	17.5
	Non-STEM	640	82.5
Full-time faculty status	Yes	585	75.4
	No	191	24.6
Number of attempts in course	1	669	86.2
	2	101	13.0
	3	5	0.6
	4	1	0.1
Tutoring center utilization (min)	0 minutes	747	96.3
	1 – 60 minutes	13	1.7
	61 – 119 minutes	6	0.8

	120+ minutes	10	1.3
Dependent Variable (Dichotomous)		***n***	***%***
Passed Corequisite English Course	Yes	412	53.1
	No	364	46.9

Table 6

Descriptive Statistics of Students in Corequisite English Courses by Outcome

Predictors		***Outcome***	
		Passed (%)	***Failed (%)***
Sex	Female	261 (59)	179 (41)
	Male	151 (45)	185 (55)
Ethnicity	American Native	2 (67)	1 (33)
	Black	275 (50)	276 (50)
	White	89 (63)	52 (37)
	Multiracial	32 (58)	23 (42)
	Hispanic	6 (67)	3 (33)
	Unknown	5 (56)	4 (44)
	Native Hawaiian	1 (100)	
	Asian	2 (29)	5 (71)
Age	Younger than 18	10 (62.5)	6 (37.5)
	18-20	357 (52.5)	323 (47.5)
	21-24	32 (58)	23 (42)
	25+	13 (52)	12 (48)
Pell Grant recipient status	Received	317 (52)	298 (48)
	Did not receive	95 (59)	66 (41)
First-generation student status	Yes	128 (52)	118 (48)
	No	284 (54)	246 (46)
High school GPA	No GPA	6 (60)	4 (40)
	Available	6 (37.5)	10 (62.5)
	Less than 2.00	150 (42)	206 (58)
	2.00 – 2.49	156 (58)	112 (42)
	2.50 – 2.99	79 (.72)	30 (28)
	3.00 – 3.49	15 (88)	2 (12)
	3.50+		
Major	STEM	61 (45)	75 (55)
	Non-STEM	351 (55)	289 (45)
Full-time faculty status	Yes	321 (55)	264 (45)
	No	91 (48)	100 (52)
Number of attempts in course	1	372 (56)	297 (44)
	2	38(38)	63 (62)
	3	1(20)	4 (80)
	4	1(100)	
Tutoring center utilization (min)	0 minutes	396 (53)	351 (47)
	1 – 60 minutes	6 (46)	7 (54)
	61 – 119 minutes	4 (67)	2 (33)

	120+ minutes	6 (60)	4 (40)

In this study *n* = 1,551 students enrolled in corequisite mathematics courses during the fall 2015 semester through the summer 2018 semester, see Table 7. The average age of these students was 20.48 years (*SD* = 5.12) with ages that ranged from 16-58. The average high school GPA was 2.60 (*SD* = 0.37). The dependent variable was whether a student passed or failed a corequisite mathematics course. More female students (56%) passed corequisite mathematics courses, see Table 8. A student who passed a corequisite mathematics course was coded as a 1 and 0 otherwise.

Table 7

Descriptive Statistics for Students Enrolled in Corequisite Math Courses

Predictors		***n***	***%***
Sex	Female	883	56.9
	Male	668	43.1
Ethnicity	American Native	6	0.4
	Black	982	63.3
	White	416	26.8
	Multiracial	104	6.7
	Hispanic	19	1.2
	Unknown	16	1.0
	Native Hawaiian	5	0.3
	Asian	3	0.2
Age	Younger than 18	38	2.5
	18-20	1175	75.8
	21-24	177	11.4
	25+	161	10.4
Pell Grant recipient status	Received	1211	78.1
	Did not receive	340	21.9
First-generation student status	Yes	475	30.6
	No	1076	69.4
High school GPA	No GPA	90	5.8
	Available	28	1.8
	Less than 2.00	579	37.3
	2.00 – 2.49	626	40.4
	2.50 – 2.99	205	13.2
	3.00 – 3.49	23	1.5
	3.50+		

Major	STEM	229	14.8
	Non-STEM	1322	85.2
Full-time faculty status	Yes	1,140	73.5
	No	411	26.5
Number of attempts in course	1	1,182	76.2
	2	318	20.5
	3	43	2.8
	4	8	0.5
Tutoring center utilization (min)	0 minutes	1,452	93.6
	1 – 60 minutes	24	1.5
	61 – 119 minutes	15	1.0
	120+ minutes	60	3.9
Dependent Variable (Dichotomous)		***n***	***%***
Passed corequisite math course	Yes	791	51.0
	No	760	49.0

Table 8

Descriptive Statistics of Students in Corequisite Math Courses by Outcome

		Outcome	
Predictors		***Passed (%)***	***Failed (%)***
Sex	Female	492 (56)	391 (44)
	Male	299 (45)	369 (55)
Ethnicity	American Native	2 (33)	4 (67)
	Black	451 (46)	531 (54)
	White	249 (60)	167 (40)
	Multiracial	63 (61)	41 (39)
	Hispanic	11 (58)	8 (42)
	Unknown	11 (69)	5 (31)
	Native Hawaiian	3 (60)	2 (40)
	Asian	1(33)	2 (67)
Age	Younger than 18	23 (61)	15 (39)
	18-20	575 (49)	600 (51)
	21-24	95 (54)	82 (46)
	25+	98 (61)	63 (39)
Pell Grant recipient status	Received	590 (49)	621 (51)
	Did not receive	201 (59)	139 (41)
First-generation student status	Yes	222 (47)	253 (53)
	No	569 (53)	507 (47)
High school GPA	No GPA Available	45 (50)	45 (50)
	Less than 2.00	15 (54)	13 (46)
	2.00 – 2.49	234 (40)	345 (60)
	2.50 – 2.99	334 (53)	292 (47)
	3.00 – 3.49	142 (69)	63 (31)
	3.50+	21 (91)	2 (09)

Major	STEM	113 (49)	116 (51)
	Non-STEM	678 (51)	644 (49)
Full-time faculty status	Yes	544 (48)	596 (52)
	No	247 (60)	164 (40)
Number of attempts in course	1	623 (53)	559 (47)
	2	142 (45)	176 (55)
	3	23 (53)	20 (47)
	4	3 (38)	5 (63)
Tutoring center utilization (min)	0 minutes	732 (50)	720 (50)
	1 – 60 minutes	11 (46)	13 (54)
	61 – 119 minutes	10 (67)	5 (33)
	120+ minutes	38 (63)	22 (37)

Results of Mean Imputation

Both the corequisite English and mathematics datasets included missing data for the following variables: high school GPA, reading placement test z-score, mathematic placement test z-score, and writing placement test z-score. Little's MCAR test was significant, $p = 0.000$, indicating that data were not MCAR and data could not be dropped from the logistic regression analysis. However, only 1.6% of the English dataset and 4.2% of the mathematics dataset had missing data. Therefore, mean substitution was used to replace missing data, see Table 9 (Tabachnick & Fidell, 2013). The complete datasets resulting from mean imputation where used for the logistic regression analyses.

Table 9

Results of Mean Substitution of Missing Data

English Dataset	**Original Dataset**			**MS Dataset**		
	M	***SD***	***n***	***M***	***SD***	***n***
High school GPA	2.57	0.39	766	2.57	0.39	776
Standardized reading score	0.00	0.92	757	0.00	0.92	776
Standardized math score	0.08	0.93	765	0.08	0.93	776
Standardized writing score	0.01	0.92	765	0.01	0.92	776
Mathematics Dataset						

	Original Dataset			MS Dataset		
	M	***SD***	***n***	***M***	***SD***	***n***
High school GPA	2.60	0.37	1,461	2.60	0.36	1,551
Standardized reading score	0.07	0.95	1,506	0.07	0.94	1,551
Standardized math score	0.02	0.91	1,536	0.02	0.91	1,551
Standardized writing score	0.07	0.95	1,439	0.07	0.91	1,551

Note. MS = Mean Substitution

Results of Logistic Regression Assumption Testing

Prior to completing logistic regression analysis, two underlying assumptions were tested. First, the independent variables were tested for multicollinearity. All variance inflation factors were below 2 indicating that multicollinearity did not exist between the predictors with a cutoff tolerance of 0.5, see Table 10 (Field, 2013).

Table 10

Multicollinearity Test Results

Model (English) Dependent Variable: Race	**Tolerance**	**Variance Inflation Factor (VIF)**
Sex	0.904	1.106
Age	0.965	1.037
Pell Grant recipient status	0.950	1.053
First-generation student status	0.950	1.052
Major	0.950	1.053
Full-time faculty status	0.973	1.027
Attempts	0.988	1.013
Tutoring center utilization	0.983	1.017
High school GPA	0.860	1.163
Standardized reading score	0.965	1.036
Standardized math score	0.902	1.108
Standardized writing score	0.954	1.048
Model (Math) Dependent Variable: Race	**Tolerance**	**Variance Inflation Factor (VIF)**
Sex	0.892	1.121
Age	0.896	1.115
Pell Grant recipient status	0.960	1.042

First-generation student status	0.947	1.056
Major	0.569	1.756
Full-time faculty status	0.574	1.743
Attempts	0.969	1.032
Tutoring center utilization	0.951	1.051
High school GPA	0.992	1.008
Standardized reading score	0.868	1.152
Standardized math score	0.691	1.447
Standardized writing score	0.932	1.073
Sex	0.738	1.355

Second, a minimum of 50 cases per predictor was tested for each dataset (Burns & Burns, 2006). The English dataset included 13 independent variables which would require 650 cases for logistic regression. The complete English dataset included 776 cases which exceeded the number of cases required. The mathematics dataset included 14 independent variables which would require 700 cases for logistic regression. The complete mathematics dataset included 1551 cases which exceeded the number of cases required.

Logistic Regression Results of English Dataset

Logistic regression analysis of the student input predictors associated with this study's theoretical framework, Model 1, was conducted, see Table 11. The model was statistically significant, $\chi 2 = 76.024$, $df = 10$, $p = 0.000$. Of the ten *Student Input* predictors only two were statistically significant: sex, $p = 0.017$ and high school GPA, $p = 0.000$. An additional block of *Environmental Factors* associated with this study's theoretical framework was added to Model 1 to create Model 2, see Table 12. The additional block was statistically significant, $\chi 2 = 13.083$, $df = 3$, $p = 0.004$. Model 2 was statistically significant, $\chi 2 = 89.106$, $df = 13$, $p = 0.000$. Of the thirteen predictors only three were statistically significant: sex, $p = 0.022$; high school GPA, $p = 0.000$; and number of attempts in corequisite English, $p = 0.003$.

Table 11

Logistic Regression with Student Inputs Only – English

Predictor	B	SE	Wald	*df*	*p*	OR	95% CI Lower	95% CI Upper
Minority student	-0.126	0.212	0.354	1	0.552	0.882	0.582	1.335
Female student	0.379	0.159	5.700	1	0.017*	1.461	1.070	1.994
Age	0.015	0.031	0.226	1	0.635	1.015	0.955	1.078
Pell grant recipient	-0.239	0.199	1.450	1	0.228	0.787	0.533	1.162
First-generation student	-0.166	0.166	1.002	1	0.317	0.847	0.611	1.173
High school GPA	1.375	0.224	37.639	1	0.000*	3.954	2.548	6.134
Reading score (std.)	0.153	0.086	3.201	1	0.074	1.165	0.985	1.378
Math score (std.)	-0.007	0.086	0.006	1	0.938	0.993	0.839	1.176
Writing score (std.)	0.113	0.085	1.784	1	0.182	1.120	0.948	1.322
Major	-0.222	0.201	1.213	1	0.271	0.801	0.540	1.189
Constant	-3.502	0.902	15.064	1	0.000	0.030		
Model $\chi2$(*df*)				76.024 (10)				
% Correct Predictions				62.9				

Note. OR = Odds Ratio; CI = confidence interval; * p < 0.05

Table 12

Logistic Regression with Student Inputs and Environmental Factors – English

Predictor	B	SE	Wald	*df*	*p*	OR	95% CI Lower	95% CI Upper
Minority student	-0.110	0.214	0.263	1	0.608	0.896	0.589	1.364
Female student	0.368	0.160	5.280	1	0.022*	1.445	1.056	1.979
Age	0.012	0.031	0.141	1	0.707	1.012	0.952	1.075
Pell grant recipient	-0.225	0.202	1.246	1	0.264	0.798	0.538	1.185
First-generation student	-0.190	0.168	1.270	1	0.260	0.827	0.595	1.150
High school GPA	1.380	0.226	37.180	1	0.000*	3.976	2.551	6.197
Reading score (std.)	0.165	0.087	3.613	1	0.057	1.180	0.995	1.399
Math score (std.)	-0.013	0.087	0.023	1	0.880	0.987	0.833	1.170
Writing score (std.)	0.097	0.086	1.277	1	0.258	1.102	0.931	1.303
Major	-0.256	0.204	1.577	1	0.209	0.774	0.519	1.155
Full-time faculty	0.273	0.180	2.305	1	0.129	1.313	0.924	1.867
Attempts	-0.615	0.205	9.018	1	0.003*	0.541	0.362	0.808
Tutoring	0.002	0.002	0.590	1	0.442	1.002	0.998	1.006
Constant	-2.969	0.946	9.854	1	0.002	0.051		
Model $\chi2$(*df*)				89.106 (13)				
Block $\chi2$(*df*)				13.083 (3)				

% Correct Predictions	64.9

Note. OR = Odds Ratio; CI = confidence interval; * $p < 0.05$

Logistic Regression Results of Mathematics Dataset

Logistic regression analysis of the student input predictors associated with this study's theoretical framework, Model 1, was conducted, see Table 13. The model was statistically significant, $\chi2 = 131.079$, *df* = 10, *p* = 0.000. Of the ten *Student Input* predictors, six were statistically significant: sex, *p* = 0.012; age, *p* = 0.001; Pell Grant status, *p* = 0.018; first-generation college student status, *p* = 0.004; high school GPA, *p* = 0.000; and standardized writing placement test score, *p* = 0.002. An additional block of *Environmental Factors* associated with this study's theoretical framework was added to Model 1 to create Model 2. The additional block was statistically significant, $\chi2 = 28.102$, *df* = 4, *p* = 0.000. Model 2 was statistically significant, $\chi2 = 159.181$, *df* = 14, *p* = 0.000. Of the thirteen predictors, seven predictors were statistically significant: sex, *p* = 0.013; age, *p* = 0.001; Pell Grant status, *p* = 0.011; first-generation college student status, *p* = 0.007; high school GPA, *p* = 0.000; standardized writing placement test score, *p* = 0.001; and faculty employment status, *p* = 0.000, see Table 14.

Table 13

Logistic Regression with Student Inputs Only – Math

							95% CI	
Predictor	**B**	**SE**	**Wald**	***df***	***p***	**OR**	**Lower**	**Upper**
Minority student	-0.103	0.135	0.581	1	0.446	0.902	0.692	1.176
Female student	0.283	0.112	6.341	1	0.012*	1.327	1.065	1.655
Age	0.039	0.012	11.185	1	0.001*	1.040	1.016	1.064
Pell grant recipient	-0.324	0.137	5.599	1	0.018*	0.723	0.553	0.946
First-generation student	-0.341	0.118	8.336	1	0.004*	0.711	0.564	0.896
High school GPA	1.197	0.167	51.101	1	0.000*	3.309	2.384	4.595
Reading score (std.)	-0.016	0.069	0.056	1	0.813	0.984	0.860	1.126
Math score (std.)	0.072	0.061	1.404	1	0.236	1.075	0.954	1.212
Writing score (std.)	0.212	0.068	9.655	1	0.002*	1.236	1.081	1.413

Major	0.072	0.152	0.221	1	0.638	1.074	0.797	1.448
Constant	-3.611	0.545	43.863	1	0.000	0.027		
Model χ2(*df*)				131.079 (10)				
% Correct Predictions				61.8				

Note. OR = Odds Ratio; CI = confidence interval; * p < 0.05

Table 14

Logistic Regression with Student Inputs and Environmental Factors – Math

							95% CI	
Predictor	**B**	**SE**	**Wald**	***df***	***p***	**OR**	**Lower**	**Upper**
Minority student	-0.086	0.137	0.397	1	0.529	0.918	0.702	1.199
Female student	0.282	0.114	6.177	1	0.013*	1.326	1.062	1.657
Age	0.038	0.012	10.509	1	0.001*	1.039	1.015	1.063
Pell grant recipient	-0.351	0.139	6.404	1	0.011*	0.704	0.536	0.924
First-generation student	-0.325	0.120	7.403	1	0.007*	0.722	0.571	0.913
High school GPA	1.236	0.170	52.737	1	0.000*	3.442	2.466	4.805
Reading score (std.)	-0.019	0.069	0.072	1	0.789	0.982	0.857	1.125
Math score (std.)	0.080	0.062	1.697	1	0.193	1.084	0.960	1.223
Writing score (std.)	0.233	0.069	11.448	1	0.001*	1.262	1.103	1.445
Major	-0.181	0.200	0.821	1	0.365	0.834	0.564	1.235
Math for major	0.265	0.162	2.662	1	0.103	1.304	0.948	1.792
Full-time faculty	-0.578	0.124	21.570	1	0.000*	0.561	0.440	0.716
Attempts	-0.069	0.102	0.452	1	0.501	0.934	0.764	1.141
Tutoring	0.001	0.000	2.490	1	0.115	1.001	1.000	1.001
Constant	-3.224	0.573	31.682	1	0.000	0.040		
Model χ2(*df*)				159.181 (14)				
Block χ2(*df*)				28.102 (4)				
% Correct Predictions				62.7				

Note. OR = Odds Ratio; CI = confidence interval; * p < 0.05

CHAPTER 5: DISCUSSION

This chapter will provide a summary of this study including the problem statement, purpose of the study, research question, and the research methodology utilized for this study. A summary of the results from Chapter 4 will guide a discussion of the research question. Next, implications for practice and recommendations for future research will be discussed. Finally, the chapter will close with a conclusion of the study, an impact statement, and a dissemination plan for this study.

Introduction

DE is designed to support students in their collegiate academic pursuits. This is accomplished by the coordination and interaction of three major components: (a) academic instruction, (b) academic advising, and (c) academic tutoring (Boylan, 2002). Academic instruction prepares students for academic success in freshmen level collegiate English and mathematics courses. Academic advising provides guidance to students as it relates to their academic program (O'Banion, 2012). Finally, academic tutoring provides students with assistance in their academic courses using peer-to-peer or professional tutoring (Boylan, 2002; Laskey & Hetzel, 2011; Vick et al., 2015).

Although these DE components are designed to support students, DE has not been without criticism. One major criticism has been that the use of placement test scores to determine whether students enroll in DE. Placement test scores have been shown to be imprecise and inadvertently cause students to enroll in unnecessary courses (Scott-Clayton, Crosta, & Belfield, 2014; Xu, 2016). An additional criticism has been that many students who start in multiple DE course sequences never enroll in gateway courses which severely limits their ability to earn postsecondary credentials (Venezia & Hughes, 2013). Therefore, several organizations, states, and DE practitioners have undertaken reform efforts to mitigate the negative effects associated with DE (Cal. Ed. Code §78213, 2017; CCA, 2014; Collins, 2013; H.B. 2223, 2017; USG, 2018a; Venezia & Hughes, 2013). One of the more recent reform efforts has been the use of the corequisite model. The corequisite model enables students to enroll in a gateway course in addition to a DE course that provides academic support.

The present study focused on predictors of student academic success in the corequisite model using Astin's *Inputs-Environment-Outcome* (I-E-O) model as a theoretical framework (Astin & Antonio, 2012). In this study the *Inputs* were a student's sex, race, age at time of enrollment, Pell Grant recipient status, first-generation college student status, high school GPA, placement test scores, and academic major. The *Environment* included corequisite course faculty employment status and student utilization of the college's academic tutoring center. The *Outcome* was whether a student passed or failed a corequisite English or mathematics course.

Problem Statement

One major problem with the implementation of the corequisite model is that predictors have not been identified that are related to student academic success. In this study, academic success is defined as passing or failing a corequisite English or mathematics course. This study sought to add to the current literature by identifying predictors of student academic success in the corequisite model. The identification of these predictors would enable institutions to improve their academic support systems thereby improving student academic success in the corequisite model.

Research Question

The purpose of this quantitative study was to determine predictors of CC student academic success in the corequisite model. Academic success was defined dichotomously on a pass or fail basis. The following research question guided this study:

> What are the best predictors of student academic success in the corequisite model: a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, placement test scores, high school GPA, academic major, corequisite course faculty employment status, or time spent receiving academic tutoring?

Summary of Findings

This study used de-identified archival data of students enrolled in corequisite courses at a CC in the state of Georgia between the fall semester of 2015 and summer semester of 2018. Data included a student's sex, race, age at time of enrollment, Pell grant recipient status, first-generation college student status, placement test scores, high school GPA, academic major, corequisite course faculty employment status, and time students spent receiving academic tutoring. The population included 1,933 students that enrolled in at least one corequisite English and/or mathematics course.

These data were categorized as either *Student Inputs* or *Environmental Factors* based on Astin's I-E-O model as a theoretical framework (Astin & Antonio, 2012). Logistic regression analysis of the data identified three statistically significant predictors of student academic success in corequisite English courses: (1) being female, (2) high school GPA, and (3) number of attempts in corequisite English courses. Additionally, logistic regression analysis identified seven statistically significant predictors of student academic success in corequisite mathematics courses: (1) being female, (2) age, (3) high school GPA, (4) student Pell Grant recipient status,

(5) student first-generation college student status, (6) standardized writing placement test score, and (7) corequisite course faculty employment status. In both analyses, the most statistically significant predictor of student academic success in corequisite courses was high school GPA. This finding agreed with prior research that high school GPA was a better predictor of student academic success compared to placement test scores when used in isolation (Scott-Clayton, Crosta, & Belfield, 2014; Xu, 2016).

Furthermore, with respect to Astin's I-E-O model, the results of this study indicated that *Student Inputs* were better predictors than *Environmental Factors* of student academic success in the corequisite model. This finding is consistent with that of Astin who found that student inputs were more important than collegiate resources on student outcomes (Astin & Antonio, 2012). However, Astin cautioned that inputs and outcomes should not be interpreted outside of the context of the learning environment (Astin & Antonio, 2012). In fact, the current study found the best predictors of academic success in the corequisite model included both *Student Inputs* and *Environmental Factors*.

Research Question Discussion

This study investigated the relationship of predictors on student academic success in the corequisite model. Data were analyzed using descriptive statistics and logistic regression. This discussion will be guided by Astin's I-E-O model which served as this study's theoretical framework and results will be placed in the context of the literature review from Chapter 2. The results for each predictor will be discussed below.

Student Inputs

Sex. The results of the present study found that a student's sex was a significant predictor of student academic success in corequisite courses. Specifically, if a student's sex was female the student's odds of passing corequisite English or mathematics courses increased. As an example, in corequisite English courses, if all the other predictors investigated in this study were the same between two students, except a student's sex, female students' odds of passing corequisite English were approximately 1.5 times that of male students. This result is consistent with prior DE research findings that female students had an increased probability of students earning college-level English credits and mathematics credit (Chen, 2016; Moss et al., 2014; Wheeler & Bray, 2017). However, a plausible explanation for this result is that approximately 57% of the present study's population was female. Nevertheless, it would be appropriate for institutional administrators, faculty, and academic support professionals to develop and implement strategies to guide non-female students to the academic support offered by their professors and academic tutoring centers.

Race. The results of this study indicated that the corequisite model does appear to provide minority students with an opportunity to earn gateway course credits faster. One potential explanation was that 81.2% of the students in the present study were racial/ethnic minorities. This result agrees with Complete College America's advocacy for the use of the corequisite model (CCA, 2016). Additionally, the results of the present study were consistent with prior research that minority students have decreased odds of being academically successful in gateway courses although the effect size is relatively small (Chen, 2016; Wheeler & Bray, 2017; Wolfe, 2012). For example, in corequisite mathematics courses, if all the other predictors investigated in this study were the same between two students, except a student's race, a White students' odds of passing corequisite mathematics were approximately 1.09 times that of minority students. Thus, the findings of this study indicated that despite the racial distribution of students enrolled in corequisite courses an achievement gap continues to exist between minority and White students. Therefore, institutional administrators, faculty, and academic support professionals should continue to implement best-practices that narrow the achievement gap.

Age. The results of the present study found that student age had a positive effect on student academic success in corequisite courses. Thus, older students were more likely to be successful in both corequisite English and mathematics courses. These findings agree with prior research by Wolfle (2012) and Moss et al. (2014) who found that age was an important factor in determining success in first college-level mathematics courses. In corequisite English courses for every one-year increase in a student's age the odds of passing the course would increase by 1%. Likewise, in corequisite mathematics courses for every one-year increase in a student's age the odds of passing the course would increase by 4%. These findings are interesting because they indicate that nontraditional students are not at an academic disadvantage when they enroll in gateway courses.

Pell grant recipient status. Pell Grant recipients comprised 77.2% of the students enrolled in corequisite courses in this study. Therefore, the corequisite model provided economically disadvantaged students with opportunities to earn gateway course credits faster in agreement with Complete College America's advocacy for the use of the corequisite model (CCA, 2016). However, the findings of this study suggest that students who received Pell grants had decreased odds of being academically successful in corequisite courses. For example, in corequisite English, if all the other predictors investigated in this study were the same between two students, except one student received a Pell Grant and the other did not, a non-Pell Grant recipient's odds of passing corequisite English were approximately 1.25 times that of a Pell Grant recipient. Thus, students who were Pell grant recipients were at a disadvantage of being academically successful in both corequisite English and mathematics courses. These findings agreed with Chen's (2016) and Woods et al. (2018) finding that as a students' income level increased their probability of earning college-level English and mathematics credit improved. Therefore, institutional administrators, faculty, and academic support professionals should continue to create opportunities that support Pell Grant recipients.

First-generation college student status. The present study found that first-generation college students had decreased odds of being academically successful in corequisite courses. Thus, first-generation college students are at an academic disadvantage in both corequisite English and mathematics courses. For example, in corequisite mathematics, if all the other predictors investigated in this study were the same between two students, except one student was a first-generation college student, a non-first-generation college student's odds of passing a corequisite mathematics course were approximately 1.38 times that of a first-generation college student. The results of the present study agreed with Houston and Xu's (2016) findings that first-generation college student status had a negative effect on student academic success in mathematics. However, the present study's findings were not in alignment with Chen's (2016) findings that parental education level does not seem to have an impact on earning college-level mathematics credit. In either case it would be appropriate for institutional administrators, faculty, and academic support professionals to create an environment where first-generation students can readily find the support that they need to be academically successful in corequisite courses.

Placement testing and high school GPA. High school GPA was found to be the strongest predictor of student academic success in corequisite courses. Thus, as a student's high school GPA increased his or her odds of passing a corequisite course increased. This finding is consistent with the work of Scott-Clayton et al. (2014) that found high school GPA was a better predictor than placement test scores of students' academic success in both introductory college-level math or English. A possible explanation for this result is that high school GPA is a composite of a student's academic performance over several years as opposed to placement test scores which are static attempts to measure student academic performance. Better predictors may result if students' overall high school GPAs are parsed down to (1) high school English GPA and (2) high school mathematics GPAs with the aim that this would provide more precision to the findings related to high school GPA in this study.

This study's findings are consistent with those of Xu (2016) who found that placement tests scores are imprecise predictors of student academic success in college-level courses. For instance, in this study writing placement test scores were a better predictor of corequisite mathematics course than mathematics placement test scores. The impreciseness of placement test scores as predictors of academic success in corequisite courses in this study may have resulted because the institution involved in this study allowed students to use a variety of placement test scores for admission to the college. For example, students could use scores from the ACT, SAT, COMPASS, ACCUPLACER, or a combination of scores from any of these tests. Thus, it was difficult to determine if one testing package was superior to the others.

Academic major. The present study found that students who were STEM majors had decreased odds of passing both English and mathematics corequisite courses. This means that the odds of a student who was a non-STEM major passing a corequisite English course is 1.25 times that of a student who was a STEM major. With respect to corequisite mathematics courses, the odds of a student who was a non-STEM major passing is 1.20 times that of a student who was a STEM major. Moreover, these findings suggest that students who are STEM majors would benefit from English faculty emphasizing the importance of writing in STEM and mathematics faculty emphasizing writing as a form of mathematical communication.

Additionally, with respect to mathematics courses, the findings of this study suggest that students who were placed in an appropriate mathematics corequisite course for their academic major had increased odds of being academically successful. This result agrees with the recommendation of Huang (2018) and Zachry Rutschow (2018) that students enroll in mathematics courses based on mathematics pathways. A factor that might have contributed to this result is the college's recent efforts to advise students to enroll in courses based on mathematics pathways. Therefore, academic advisors should continue their efforts of advising students to enroll in mathematics courses. A simultaneous effort should be implemented by institutional leaders to ensure that academic policy is created, revised, and implemented to reflect the positive effects of mathematics pathways.

Environmental Factors

Faculty employment status. In contrast to findings by Shulman et al. (2017), Townsend (2003), and Datray et al. (2014), the institution involved in this study used approximately 75% full-time faculty to teach both corequisite English and mathematics courses. This commitment by the institution increased the odds of students being academically successful in corequisite English courses in agreement with Moss et al. (2014). However, students had decreased odds of being academically successful in corequisite mathematics courses taught by full-time faculty members. One reasonable explanation based on the literature is that some instructors had not taught one of the mathematics courses before (Logue et al., 2016). Therefore, these findings should be interpreted with caution because in this study only the employment status of faculty members was considered, and no assumptions should be made about faculty with respect to their training, instructional experience, pedagogical skill, or teaching loads which all contribute to instructor effectiveness. Nonetheless, institutional academic leaders and faculty should continue to engage in professional development activities designed to improve student learning.

Academic Tutoring. The results of this study indicated that 96.3% of corequisite English students and 93.6% of corequisite mathematics students did not utilize the tutoring services offered by the college for the respective corequisite courses. Additionally, the results of this study indicated that academic tutoring had no impact on student academic success in corequisite courses. This result conflicted with prior research on the impact of academic tutoring on student academic success in DE, student retention, and student GPA (Boylan, 2002; Laskey & Hetzel, 2011; Vick et al., 2015). The most plausible explanation for these findings is that the students received academic assistance primarily through their required DE courses which met weekly throughout the semester. Additionally, it is possible that students did in fact utilize the institutions tutoring center yet had no way of selecting multiple courses during a tutoring session. Therefore, academic support professionals should collaborate with faculty to communicate the availability of the academic tutoring center. Additionally, academic support professionals should collaborate with their software vendor to create a method that allows students to modify their initial course selection following their entry into the academic tutoring center.

Implications for Practice

From the previous discussion with respect to Astin's I-E-O model it follows that there are implications of practice for the institutional administrators, faculty, and academic support professionals at the institution in this study. With respect to Astin's I-E-O model, these changes could strengthen the impact of *Environmental Factors* on student academic success in the corequisite model. As noted earlier, no single *Student Inputs* predictor works independently of

Environmental Factors to produce an outcome (Astin & Antonio, 2012). These implications apply to academic administrators, faculty, and academic support professionals. The following section will discuss specific implications for each of the three groups.

Implications for Administrators

The results of this study warrant that institutional leaders engage in an investigation of institutional policy as it relates to placement in corequisite courses. Students in this study were placed in corequisite courses based on placement test scores. However, one major finding of this study was that placement test scores were not the best predictors of student academic success in corequisite English or mathematics courses when high school GPA data is available. Therefore, the institution could consider using high school GPA to determine whether students are placed in corequisite courses. This policy would be comparable to the Massachusetts Board of Higher Education's (MBHE) policy that allows Massachusetts high school graduates to use their high school GPA to determine placement into DE mathematics (MBHE, 2016). Additionally, results from this study indicated that enrolling in mathematics courses based on mathematics pathways increased students' odds of being academically successful in corequisite mathematics courses. Therefore, institutional leaders could continue to ensure that institutional mathematics pathways policy is implemented consistently. This includes informing students who have been accepted to the institution of the respective mathematics course they will be enrolled in based on their declared academic major. Institutional leaders could also work with academic advisors to ensure students are registered for mathematics courses based on mathematics pathways (Huang, 2018; Zachry Rutschow, 2018).

A second implication is that institutional leaders work to ensure that students who are not successful in corequisite English courses re-enroll the following term. The data from this study indicated that many students did not pass corequisite English courses. However, during the three-year period of this study most students only attempted corequisite English courses once and did not re-enroll after an unsuccessful attempt. This is problematic because these students are not able to progress through the required English and literature sequence for degree completion. Encouraging students to re-enroll in corequisite courses the following term following an unsuccessful attempt enables students to earn gateway course credit as soon as possible which has been shown to be an important factor in earning a postsecondary degree (Denley, 2017).

A third implication is that institutional leaders continue to offer faculty professional development opportunities. The findings of this study showed full-time faculty increased the odds of passing corequisite English courses but decreased the odds of passing corequisite mathematics courses. It would be ill-advised for institutional leaders to use this finding as justification for offering full-time or part-time positions to faculty as the present study used a small population. However, institutional leaders could conduct further research related to faculty demographics and teaching experiences to determine their impact on student success in corequisite courses and create opportunities focused on improving the teaching and learning process.

Implications for Faculty

Data from the present study indicated that minority, first-generation, Pell grant recipients, and being a STEM major all decreased student odds of being academically successful in corequisite courses. Thus, the major implication for faculty is that they could implement content-specific best-practices and take advantage of professional development opportunities related to working with students who are minority, first-generation, Pell grant recipients, or

STEM majors. This could include exercising an awareness of how classroom composition impacts student academic success. Moss et al. (2014) noted that as the proportion of DE students in a gateway course increased that their subsequent success in college-level courses declined. The application for faculty at the institution involved in this study is to advocate for a fixed percentage of seats in gateway courses designated for students enrolled in corequisite DE. This modification in the allocation of course seats would hopefully lead to more students being academically successful in corequisite courses.

Implications for Academic Support Professionals

Data from this study indicated that students who attempted a corequisite English or mathematics course multiple times had decrease odds of passing these courses. This was especially true in corequisite English courses. Therefore, one implication for academic support professionals is that they continue to effectively communicate to students the importance of being academically successful during their first attempts in corequisite courses. This can be accomplished by utilizing the institution's academic monitoring and automated call systems to communicate with students about visiting their professors and the academic tutoring center for support.

Additionally, academic support professionals can work with faculty to develop an intervention procedure. This can be accomplished by academic support professionals contacting students who have been identified by faculty as potentially not being successful in a course. Then, the actions students take, whether it be visiting a professor, academic advisor and/or academic tutoring center, following this initial intervention notification can be tracked. The tracking of these activities can be used by academic support professionals to determine the best methods for contacting students that need assistance and which academic resources students use.

Finally, data from this study indicated that very few students enrolled in corequisite courses utilized the academic tutoring provided by the institution involved in this study. Therefore, academic support professionals need to implement strategies to increase visits to the academic tutoring center. One potential strategy is for academic support professionals to collaborate with faculty members to communicate to students that free academic tutoring is available to any student who may need additional academic support. Finally, academic support professionals need to work with their software vendor to add functionality to the check-in stations to allow students to select multiple courses upon entry into the academic tutoring center.

Recommendations for Future Research

The present study focused solely on predictors of student academic success in corequisite English and mathematics courses. However, the results of this study indicate that there are opportunities for further research. For instance, the student population could be adjusted to include all students enrolled in gateway English and mathematics courses. This expanded student population would allow corequisite course enrollment to be used as an additional predictor of student academic success in gateway courses. The benefits of this modification are twofold. First, more clarity would be provided with respect to student utilization of the academic tutoring center. The results from the present study indicated that most students enrolled in corequisite courses did not take advantage of tutoring services offered by the institution. Therefore, it would be interesting to determine if this finding was unique to only students enrolled in corequisite courses. Second, the expanded student population would provide an opportunity to determine if the predictors identified in this study are consistent with a larger population of students.

Additionally, several methodological modifications can be made to the present study. First, because female students had increased odds of being academically successful in corequisite courses it would be interesting to complete a within-group comparison for both female and non-female students. This modification would help to identify a set of best predictors of student academic success in the corequisite model for both groups. Second, the study could be replicated by excluding placement tests scores because the results of the present study have shown that high school GPA is a better predictor than placement test scores of student academic success in the corequisite model. Third, it would be interesting to replicate the study with high school GPA replaced by high school English GPA and high school mathematics GPA. This would provide better precision than the high school GPA predictor that was used in this study. Fourth, more *Environmental Factors* related to faculty could be included in this study to provide more clarity on the impact of faculty on student academic success in the corequisite model. These factors could include teaching experience and faculty demographics (Moss et al., 2014).

Limitations, Delimitations, and Assumptions

This study was limited to a small, public, rural CC in Georgia. This was permissible as this study is a dissertation of practice and the results can be used by the institution for continuous improvement of its academic programs. Second, it cannot be understated that other confounding variables existed that were not identified by the researcher which may have impacted the results. For example, student self-advisement, participation in campus events and/or organizations, utilization of campus counseling services, and students' family dynamics.

Also, there were several assumptions associated with this study. First, there was an assumption that the participants involved in this study are representative of students at the other public CCs in the state of Georgia. Second, that the independent variables selected for analysis were the most important and appropriate for this study's research question.

Conclusion

The findings of the present study indicated that high school GPA was the best predictor of student academic success in corequisite courses. Depending on the subject matter of the corequisite course additional predictors contributed to students' academic success in these courses. In no specific order these included a student's sex, full-time faculty status, academic major, first-generation student status, and the number of times a student enrolled in a corequisite course. Viewing these predictors from the lens of Astin's I-E-O model, students' academic success in corequisite courses depends both on *Student Inputs* and *Environmental Factors*. Therefore, it is important for institutions, particularly those such as CCs, to leverage their resources to create environments that enable their students to be successful in corequisite courses.

Impact Statement

The present study has provided further support to the current literature on the use of placement test scores solely as a metric for collegiate academic success. This study has shown that, at least at an institutional level, high school GPA is a superior predictor to compared to placement tests of students' academic success in corequisite courses. Additionally, this study has left me resolved that although student demographics are fixed and cannot be changed, I must continue to work with colleagues to create an environment that enables students to be academically successful. This will require a continued commitment to professional development focused on improving instructional practices, academic tutoring, and academic advising.

Dissemination of Findings & Reciprocity

The results of this study will be of immediate interest to administrators and professional staff at the college involved in this study. Therefore, institutional leaders will receive an executive summary of the present study. Additionally, the study will be disseminated electronically through the Georgia Southern University library. Finally, there are plans to publish this study in a peer-reviewed journal.

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APPENDIX

Table A-1

Student Data Extraction #1

Student	ID #	Total Tutoring Minutes
001		

Table A-2

Student Data Extraction #2 (Math)

Student	SEX	RACE	AGE	PLGNT	FSTGN	HSGPA	MATH PSCRE	ENGL PSCRE	READ PSCRE	MAJOR	1STMT CORQ FCSTA	MT ATMP TS	MTHO TCM
001													

Table A-3

Student Data Extraction #2 (English)

Student	SEX	RACE	AGE	PLGNT	FSTGN	HSGPA	MATH PSCRE	ENGL PSCRE	READ PSCRE	MAJOR	FCSTA	ENG ATMPTS	ENGOTCM
001													

Table A-4

Finalized Student Data Extraction File (Math)

Student	SEX	RACE	AGE	PLGNT	FSTGN	HSGPA	MATH PSCRE	ENGL PSCRE	READ PSCRE	MAJOR	FCSTA	MTATMPTS	TUTRMINS	MTHOTCM
001														

Table A-5

Finalized Student Data Extraction File (English)

Student	SEX	RACE	AGE	PLGNT	FSTGN	HSGPA	MATH PSCRE	ENGL PSCRE	READ PSCRE	MAJOR	FCSTA	ENGATMPTS	TUTR MINS	ENGOTCM
001														

Legend
Student = Student number assigned by researcher
SEX = male or female
RACE = ethnicity
AGE = age
PLGNT = Pell Grant Status
FSTGN = First-generation Student Status
HSGPA = High School Grade Point Average
MATH PSCRE = Math Placement Test Score
ENGLPSCRE = English Placement Test Score
READ PSCRE = Reading Placement Test Score
MAJOR = Academic Major
MTATMPTS = Number of Corequisite Math Attempts
ENGATMPTS = Number of Corequisite English Attempts
FCSTA = First English Corequisite Course Faculty Status
TUTR MINS = Total Tutoring minutes
ENGOTCM = Corequisite English Course Outcome
MTHOTCM = Corequisite Math Course Outcome