STUDENT SUCCESS OF ONLINE VS. IN-PERSON BIOLOGY COURSES AT VIRGINIA

COMMUNITY COLLEGES

by Jennifer C. Scott

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Community colleges have a significant role in preparing students for STEM-related careers through certificates, degrees, and transfers to four-year institutions. In addition, online education is a growing mode of higher education, particularly for community college students. However, community college and online students are both at a high risk of attrition and show a lower success rate for degree completion. The purpose of this study was to identify differences in attrition and success between students in online and in-person biology courses at Virginia community colleges. Also, this study addressed downstream effects of online education by examining course completion of second-semester biology students. A correlational research design was used to examine student success of general biology students enrolled online versus in-person. In this study, the predictor variable (i.e., delivery mode) was used with three criterion variables of interest: course attrition, successful course outcome, and successful course outcome of subsequent general biology course. A significant difference was detected between course attrition and successful course completion for first-semester biology online students versus in-person students. Online students showed a significantly greater probability of withdraw and significantly lower success than in-person students. However, there was no significant difference in successful course completion of second-semester biology students. As the development of online lab science courses continues, the quality of courses must be improved in order to close the achievement gap. Research comparing online and in-person courses should be continued to monitor the achievement gap as improvements are made. In addition, a study comparing student success in online lab science courses between 2-year community colleges and 4-year institutions is recommended.

Keywords: STEM, biology, student success, attrition, online, in-person, VCCS

Dedication

   This study is dedicated to all 'my people' who supported me throughout this long journey. My husband, Keith, was always willing to pick up the slack to allow me to complete assignments and spend hours of our weekends writing. He was always there to encourage me to keep going whenever I suggested it was "time to quit". Our children, Jesse, Jane, Wyatt, and Lucy, were always patient and supportive of my goal of achieving this degree. Wyatt and Lucy, who spent a large part of their childhoods watching mom work on this dissertation to become "doctor mom", were especially supportive and understanding. Last, but certainly not least, my sister, Nicki, has always been my main cheerleader and supporter in life and this process was no different. Her endless encouragement, admiration, and support made my success possible. I know with all certainty that I would not have completed this journey if it weren't for the support of each of these special people in my life.

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List of Abbreviations

America's College Promise (ACP)

American Graduation Initiative (AGI)

Grade Point Average (GPA)

Institutional Review Board (IRB)

Massive Open Online Courses (MOOCs)

Science, Technology, Engineering, and Math (STEM)

State Council of Higher Education for Virginia (SCHEV)

Virginia Community College System (VCCS)

CHAPTER ONE: INTRODUCTION

Overview

Community colleges are significant participants in preparing students for a growing and rapidly changing workforce in Science Technology Engineering and Mathematics (STEM)-related fields for the 21st century. Therefore, community colleges across the country have shifted from an access-focused to a performance-focused measure of institutional success. Institutions are now being assessed based on the number of certificates and degrees awarded and the number of transfers to four-year institutions. In order to improve institutional success, student success is being examined as course completion, course grade, content knowledge, grade point average, certificate and degree completion, and transfer rate. In addition, the offering of online courses has grown substantially in higher education, with much research focusing on student success in online courses compared to in-person courses.

Background

With rapid improvements in technology, online education has grown substantially both in K-12 and post-secondary education in recent years. Beginning in 2011 to 2012 several prestigious institutions such as Stanford, Harvard, Massachusetts Institute of Technology (MIT), and John Hopkins began developing Massive Open Online Courses (MOOCs) which legitimized and increased acceptance of online education both in professional and educational fields (Croninger, Mao, Stapleton, & Wooley, 2015). Most of the online development has occurred in non-laboratory courses with acceptance of comparable experiences for online and traditional lecture courses. Development of online laboratory courses has lagged behind other online course offerings. Many faculty members believe that virtual laboratory simulations are not comparable to traditional laboratory experiences, and, therefore, have been hesitant to embrace online

laboratory learning. In spite of faculty resistance, the demand for online laboratory course offerings continues to grow encouraging the development of improved laboratory experiences such as improved simulations and better laboratory kits to conduct experiments away from campus (van Hunnik, 2015). Community colleges, in particular, account for the highest proportion of online students in higher education with nearly 100% of all community colleges across the country offering some form of online education. "Online education has become an accepted – and even expected – form of teaching and learning in community colleges" (Mitchell, 2017). With increased demand for online laboratory courses and continued improvements to online laboratory learning, it is expected that development of online laboratory courses will continue to expand. Therefore, it is important to gain a full understanding of student success through attrition and course outcome of first-semester online general biology courses as well as the downstream effects of second-semester general biology courses.

In a 2009 study, American students were shown to significantly lag behind students of other developed countries in areas of math and science. The America Competes Reauthorization Act of 2010 was passed to address American student performance in STEM courses and ultimately increase the number of STEM degrees awarded in the United States (Hagedorn & Purnamasari, 2012). Further, the American Graduation Initiative (AGI) and America's College Promise (ACP) Act were developed to address the goals of increasing college graduates, particularly in STEM-related fields (Palmadessa, 2016). The STEM-related workforce grew exponentially in the latter half of the 20th century and continues to grow, albeit at a much slower pace, since the turn of the 21st century (Street et al., 2012). The majority of positions in STEM-related fields require less than a bachelor's degree, placing the burden on community colleges to produce educated workers to meet the workforce demands of the 21st century (Hagedorn &

Purnamasari, 2012). In 2015, the Obama administration called on America's community colleges to increase certificates and degrees awarded by 60% over a five-year period, which triggered a shift from an access-oriented approach to a success-oriented approach at community colleges across the country (Palmadessa, 2016). The years between 2000 to 2020 will be known as the "era of performance accountability and competition for community colleges" (Bahr & Gross, 2016, p. 470) as institutions compete to increase student success and produce more degrees and certificates. Community colleges bear a significant responsibility in awarding certificates and degrees for entry-level STEM-related positions in the workforce and also attract a high-risk student population (Gregory & Lampley, 2016). Therefore, it is essential to examine student success of community college students enrolled in STEM-related courses and the specific needs of the community college student population.

Community colleges, known initially as junior colleges, were initially conceived in the early part of the 20th century as institutions to prepare students for higher education (i.e., senior colleges). They grew rapidly throughout the 20th century and expanded by offering certificate and associate degree programs (Bahr & Gross, 2016). The most significant growth of community college institutions occurred between 1965 to 1972, with the opening rate of one college per week (Geiger, 2016). Regardless of the evolution of community colleges throughout history, they have maintained the mission of enrolling students from the local community to serve the job market of the community. Therefore, each community college comprises a unique student body that represents the demographics of the local community (Bahr & Gross, 2016).

The Virginia Community College System (VCCS) showed similar historic growth as it was established in 1966 and grew to currently include twenty-three colleges serving nearly 250,000 students each year (VCCS, n.d.a). In 2005, Virginia passed the Higher Education

Restructuring Act, which allowed all students graduating with an associate's degree from one of the twenty-three community colleges in Virginia, guaranteed admission to any public, four-year institution in the state. Since that time, twenty-five public and private four-year institutions in Virginia have adopted a guaranteed transfer agreement with the VCCS (SCHEV, n.d.). Each institution maintains unique minimum transfer requirements for transfer students; however, they are required to admit a specified number of transfer students per year and honor general education requirements toward a four-year degree (VCCS, n.d.b). Unfortunately, the rate of degree completion of through bachelor's degree remains very low (less than 10%) for community college students. To address the need for improved success in transfer to completion rates, the Virginia General Assembly announced in 2018 their support of a more efficient process for Virginia students to transfer from community colleges to four-year institutions. Therefore, a collaborative partnership was developed between the State Council of Higher Education, the VCCS, and all public four-year institutions in support of *Transfer Virginia*. The goals of *Transfer Virginia* are to improve communication and collaboration and align academic expectations between two-year and four-year institutions in Virginia, develop clear pathways to guide students from high school dual enrollment courses through degree attainment at two-year colleges and degree attainment at four-year colleges, streamline the transfer process from two-year to four-year institutions, and develop an online transfer portal to serve students more efficiently (VCCS, 2019).

Online education is a rapidly growing modality in higher education, particularly at community colleges, that may help address the need for more college graduates in STEM-fields. Online education offers flexibility for students while increasing accessibility to meet more students without the need for additional classroom space. In theory, it allows for an increase in

educational outcomes with minimal increase in costs for institutions. However, many studies have shown lower student success rates for online courses compared to traditional in-person courses (Johnson, Mejia, & Cook, 2015). It has also been shown that minority students are less likely to enroll in online courses than white students, particularly in STEM courses. Women, on the other hand, are more likely to enroll in online courses than men. Therefore, as community colleges offer more online STEM courses, female students enrolled and receiving STEM degrees may increase while minority students receiving STEM degrees is expected to remain low (Wladis, Hachey, & Conway, 2015a). However, when comparing student success in online STEM courses compared with traditional, in-person STEM courses, women performed worse in the online environment than in-person, and minority students performed worse in both modes of delivery than white students, but not significantly different between the two modes of delivery (Wladis, Hachey, & Conway, 2015b). As a result, significant gender and racial gaps continue to be apparent in the STEM-related workforce (Hagedorn & Purnamasari, 2012; Malcom & Feders, 2016). Unless student success via online education equals in-person education, the modality will not contribute to increasing an educated society, particularly in STEM-related fields, nor will it decrease educational costs.

Tinto's theory of departure includes students integrating into their new lives through three steps: separation, transition, incorporation. First, students must separate from their old lives, transition into their new lives, and lastly, fully incorporate their new lives as students. If students do not navigate through all three steps successfully, they are more likely to withdraw from college (Tinto, 1987). In addition, Bean & Eaton (2001) describe four theories of the retention model that lead to student success in college: attitude-behavior theory, coping behavioral theory, self-efficacy theory, and attribution theory. Each of these theories relates to

the behaviors of students and how they respond to the stresses and demands of college life (Bean & Eaton, 2001).

Non-traditional students (older, part-time, and non-residential), as typically found in community college student populations, are at a higher risk of departure than traditional students. They unavoidably remain connected with their previous lives and experience fewer interactions and connections with classmates and faculty, making the separation, transition, and incorporation more challenging and increasing the risk of attrition (Bean & Metzner, 1985). Also, the circumstances of online courses further blur the boundaries between students' old lives and new lives as college students. Therefore, it is crucial to explore course attrition and success of online students in different educational programs and courses.

Problem Statement

Historically, state-funded support for higher education has been determined by the number of students enrolled in an institution rather than student success. However, in recent years, nearly all states have adopted a performance-based funding approach tied to student success (Bahr & Gross, 2016). Community colleges, in particular, are faced with low success and completion rates, with only approximately 50% of freshman students returning for their sophomore year, and only approximately 36% of those students earning a degree within six years (Bailey, Jaggars, & Jenkins, 2015; Lincoln, 2009). Not only is this a disservice to the college student, but also results in the loss of state funding support. In response to this, community colleges are feeling the pressure to increase graduation and transfer rates to meet the demand of a growing workforce (Palmadessa, 2016), particularly in STEM-related fields (Hagedorn & Purnamasari, 2012; Malcom & Feders, 2016). In addition, the online modality is a rapidly growing field in higher education and provides increased access to education, particularly for the

community college student (Ortagus, 2017; Huntington-Klein, Cowan, & Goldhaber, 2017).

However, it has been shown that online students show higher course attrition and lower success

rate than in-person students (Johnson et al., 2015; Wladis et al., 2015a). The problem is that the

literature has not fully addressed student success in online laboratory science courses particularly

the downstream effects of sequenced laboratory science courses. Online education in STEM-

related courses, such as biology, is proliferating with little information available regarding

immediate and downstream student success.

Purpose Statement

The purpose of this study was to compare student success of two modes of delivery

(online vs. in-person) for general biology courses. Three measures of student success were

examined: course attrition of first-semester general biology, successful course completion

outcome of first-semester general biology, and successful course completion outcome of second-

semester general biology (i.e., downstream effect). A quantitative, ex post facto, correlational

research design was used to examine student success of general biology students enrolled online

versus in-person at Virginia Community Colleges. The participants in this study were drawn

from archival data provided by the Virginia Community College System (VCCS). All

participants were enrolled in general biology courses at one of the Virginia community colleges

delivered either online or in-person between the academic years of 2015 to 2019.

Data was collected from the VCCS database of previously enrolled students. The

predictor variable included mode of delivery (online vs. in-person), and the criterion variables

comprised course attrition, successful course completion outcome of first-semester general

biology, and successful course completion outcome of second-semester general biology. Course

attrition was measured as students who withdrew from a class regardless of their grade. Students

who withdrew from the course (received W) were coded with '1' and students who did not withdraw from the course (received A, B, C, D, or F) were coded with '0'. Successful completion of first-semester and second-semester general biology were determined by students who received A, B, or C grade in Biology 101 and 102 and were coded with '1' indicating successful while students who received D or F grade in Biology 101 and 102 were coded with '0' indicating unsuccessful.

Significance of the Study

Community colleges across the country, and in Virginia, have moved toward a performance-based accountability system that determines student certificate, degree, and transfer rate as a measure of success with much of state funding tied with the rate of student success (Palmadessa, 2016; VCCS, n.d.a). In addition, STEM-related fields require a more educated workforce with STEM degrees and certificates (Hagedorn & Purnamasari, 2012; Malcolm & Feders, 2016). Lastly, online education is a rapidly growing mode of teaching and learning of higher education. In 2002, there were 1.6 million students of higher education enrolled in at least one online course whereas by 2015, online enrollment increased to over 6 million (Martin, Budhrani, Kumar, & Ritzhaupt, 2019). This equates to approximately 20% increase from 9.6% in 2002 to 29.7% in 2015. Of the students enrolled in online education, 55.3% are enrolled in a four-year institution and 44.7% enrolled in a two-year institution (Allen & Seaman, 2017). Overall, online education is a growing mode of delivery for all higher education institutions and most significantly in community colleges and is being embraced as standard mode of instruction for most colleges and universities (Hachey, Wladis, & Conway, 2014; O'Banion, 2019). Online classes offer flexibility and convenience required by many non-traditional, community college students to attain a degree or certificate (Gregory & Lampley, 2016). Red Rock Community

College found that adding 24 online and hybrid courses in the Water Quality Management program more than doubled the certificate degrees awarded. It was concluded that increased accessibility of online and hybrid courses allowed for more students to complete the program (Campbell, 2017).

Substantial research has been conducted comparing student success of varying modes of instruction in higher education (Bettinger, Fox, Loeb, & Taylor, 2017; Gregory & Lampley, 2016; Faulconer, Griffith, Wood, Acharyya, & Roberts, 2018) with mixed and inconsistent results. Most agree that course attrition is higher for online students than in-person students (Faulconer et al., 2018; Gregory & Lampley, 2016; Hachey et al., 2014); however, student success varies from study to study. Faulconer et al. (2018) determined if students persisted in online physics courses, they were more likely to receive an A than in courses with other modes of instruction. Gregory & Lampley (2016) determined if students persisted in online biology courses, they were more likely to receive extreme grades (i.e., A or F) than students in in-person courses. Students in in-person biology courses were more likely to receive a mid-range grade of B, C, or D (Gregory & Lampley, 2016). Hachey et al. (2014) concluded that prior online course outcome was a good predictor of future online course successful outcomes in STEM courses. From these previous studies, it is clear that course attrition is higher for students in online college courses; however, it is not clear when students persist in online courses if they will experience a similar successful course completion for the current general biology course or the subsequent general biology course.

Research Questions

RQ1: How accurately can *course attrition* (receiving W) of first-semester general biology students be predicted by *online versus in-person* courses at Virginia Community

Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

RQ2: How accurately can *successful course completion outcome* (receiving A, B, or C) of first-semester general biology students be predicted by *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

RQ3: How accurately can downstream effects, measured as *successful course completion outcome* (receiving A, B, or C) of second-semester general biology in-person students, be predicted by enrollment in first-semester general biology students *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

Definitions

The following terms are specific to higher education and are defined to provide clarity for the purposes of this study.

1. *Course Attrition* – Course Attrition is defined as a student choosing to withdraw from a course, as opposed to withdrawing from the institution (Cochran, Campbell, Baker, & Leeds, 2014).

2. *Community College* – A community college is an accredited institution of higher education that offers an associate degree as its highest degree (Vaughan, 2006).

3. *In-person* – An in-person course is also known as an on-campus course defined as a course where more than 50% of instruction is delivered in a face-to-face setting (Jaggars & Xu, 2010).

4. *Non-traditional Student* – A non-traditional student is a student who is 25 years or older, likely delayed attending college, maintains full-time employment, is financially independent, has dependent children and/or spouse, enrolls in school part-time, is a single parent, or earned a GED instead of a high school diploma (Wyatt, 2011).

5. *Online Course* – An online course is where most or all content is delivered online (Jaggars & Xu, 2010).

6. *Student Success* – Student success in Virginia Community College System is defined as a grade of A, B, C, P (pass), or S (satisfactory). Grades of D, F, U (unsatisfactory), R (repeat), or W (withdraw) are considered unsuccessful (Wladis, Conway & Hachey, 2017).

CHAPTER TWO: LITERATURE REVIEW

Overview

A thorough review of the literature was conducted to identify studies that explore student success based on two modes of course delivery (online and in-person) in higher education with a primary focus on science, technology, engineering, and math (STEM) disciplines in community colleges. The first section will discuss the theories selected as a framework, the theory of departure and the retention model, and how they relate to the current study. The second section will synthesize recent literature about the comparison between student success of online and in-person courses with a focus on community college students. A history of higher education with a focus on community colleges and online education will be presented as well as the role of community colleges as transfer institutions and STEM education. Lastly, student success at community colleges, online education, and STEM-related education will be explored. After reviewing the literature, a gap in the literature will emerge and provide a focused area of need for this study.

Theoretical Framework

The foundation for this study is based on Vincent Tinto's (1987, 1993, 2012) theory of departure and John Bean's (2001) retention model. In the 1980's, institutions of higher education began experiencing shrinking enrollments for the first time in the history of higher education and was projected to continue to decline for the next decade to come. Therefore, many institutions invested in recruitment campaigns to increase application pools and others invested in the retention of students and degree completion campaigns (Tinto, 1987). These campaigns launched many theories attempting to explain student persistence or departure from higher education. Before this point, students leaving college were given the negative label of being a

dropout when, in fact, many students viewed leaving college as a success since higher education was not working for them. In addition, the use of this term assumed that all forms of student departure were the same, when, in fact, there are many different forms and causes of students leaving their institutions of higher education. For example, there are many differences between students who leave institutions (i.e., institutional departure) and students who leave all forms of higher education (i.e., systems departure) (Tinto, 1987). At this point in history, and continuing through today, institutions began exploring, not only the multitude of causes of student departure but also the cures of departure and institutions' role and responsibility to help students persist to completion.

Some theories of departure focus on *sociological* reasons such as students' inability to separate from previous groups and adapt to college life that prevents them from succeeding (Tinto, 1975; 1987; 2017) and the importance of students' social safety network that is neither too tight nor too loose to provide the necessary support during challenging transitional times (Pescosolido, 1994, p. 276). Other theories focus on *organizational* reasons regarding the characteristics of individual institutions such as academic selectivity, size, and student-faculty ratio, which may prevent students from succeeding (Bean, 1983). Many theories examine *psychological* reasons such as students' self-efficacy and perseverance (Bean & Eaton, 2000), predisposition for campus activities (Kuh, 1999), and ability to form relationships with peers, faculty, and staff (Rousseau, 1995) that may influence student departure from or retention in higher education. *Cultural* reasons, such as underrepresented student populations, first-generation college students, and first-generation Americans have also been identified as influencing student retention (Tinto, 1987). Lastly, *economic* reasons such as costs and benefits of college life relating to costs of tuition, materials, and fees and loss of income as a student

compared with a potential increase in earnings in the future for college graduates (Becker, 1964) also impact students' decisions to continue with an educational path. Several of these theories, as described in more detail below, form the foundation for the current study as research points to many factors that influence student success and persistence in higher education. Overall, Tinto stated in 1987 that "institutions and students would be better served if concern for the education of students, their social and intellectual growth, were the guiding principle of institutional action" (p. 5). Over thirty years later, this principle continues to hold as institutions struggle to increase student retention and persistence to degree completion.

Theory of Departure

In Tinto's (1987) theory of departure, a student's process of entering college as a passage of breaking away from a previously established community and integrating into a new community of college life is described. The ease at which students make the transition is dependent on individual intentions and commitments as they enter higher education as well as their direct experiences after entry to the institution. Individual intentions relate to the degree to which students' educational goals are linked to occupational and future goals. Frequently, the occupational goals require degree completion, which becomes the motivating factor for students to complete educational programs and degrees. However, first-year indecision does not necessarily indicate a higher chance of student departure (Tinto, 1987). Tinto (1987) described in detail a complex theory of institutional departure including pre-entry attributes of students such as family background, skills and abilities, and prior schooling, the intentions, goals, and commitments of students before entry, academic and social experiences while at the institution, the degree of academic and social integration, which further leads to renewed intentions, goals, and commitments impacted by external factors and ultimately institutional departure (Figure 1).

Figure 1

Model of institutional departure (Tinto, 1987)
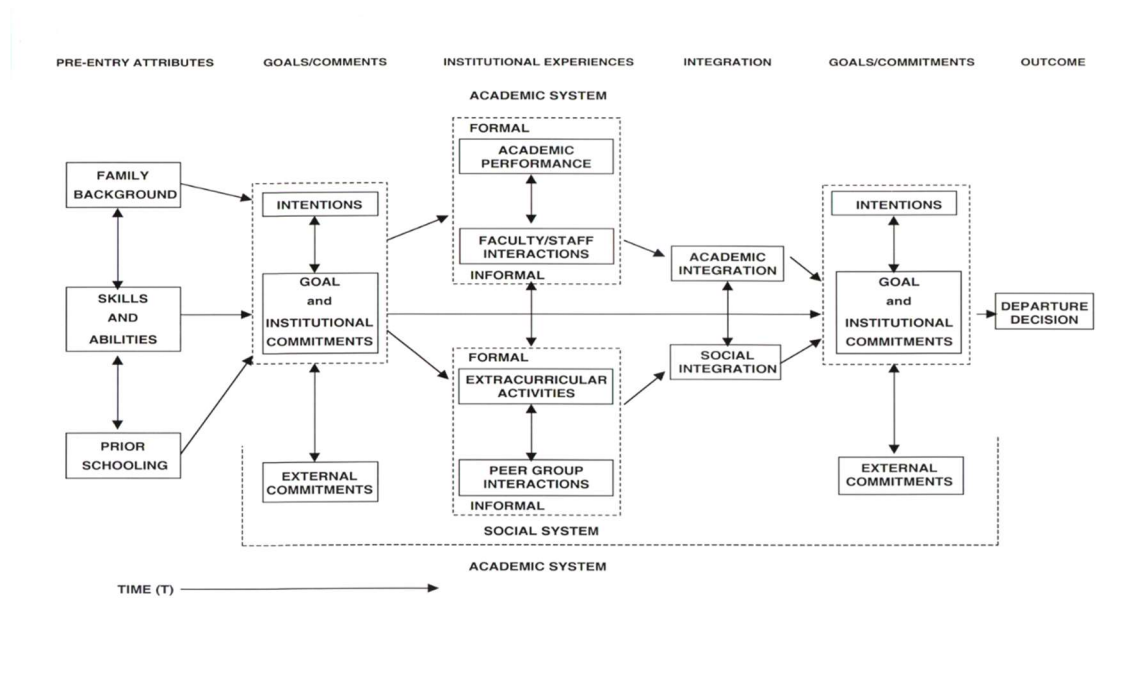
Tinto (1987) focused on three important stages of integration into college life as

separation, transition, and incorporation. For students to integrate successfully into college life,

they must first separate to varying degrees from previous communities of association such as

their family, high school, and hometown neighborhood. This separation causes some level of

stress and anxiety for students and may contribute or lead to a departure from the institution

(Tinto, 1987). The transition stage occurs during the passage between the old and the new

communities for college students. Students begin to separate from their old communities but

have not yet fully adopted the new community of the college or university. Depending on the

degree of difference between the two communities, students may have more difficulty or require

more extended periods to complete the transition. All students experience some degree of

difficulty and feelings of isolation during the transition phase into college; however, some

students are not able to handle the stresses during this period and elect to withdraw from the

institution (Tinto, 1987). Lastly, in order for students to persist and succeed in college, they

must become fully incorporated into the new community of college life. Frequently, new

students are left to navigate through the institution, to make connections with peers, faculty, and

staff before feeling fully incorporated into the new college community. Even if students make

their way through the first two stages of integration (separation and transition), they still may not

persist if they are not able to become incorporated into the new community of the college (Tinto,

1987).

More recently, Tinto (2017) explored college persistence from the student perspective.

For students to be successful and persist in higher education, they must want to persist and,

therefore, be motivated toward completion. In this model, Tinto (2017) described students'

perception of self-efficacy, sense of belonging, and relevance of the curriculum as three main

components impacting student motivation and, ultimately, completion (Figure 2).

Figure 2

Factors influencing student motivation toward persistence as presented by Tinto (2017)
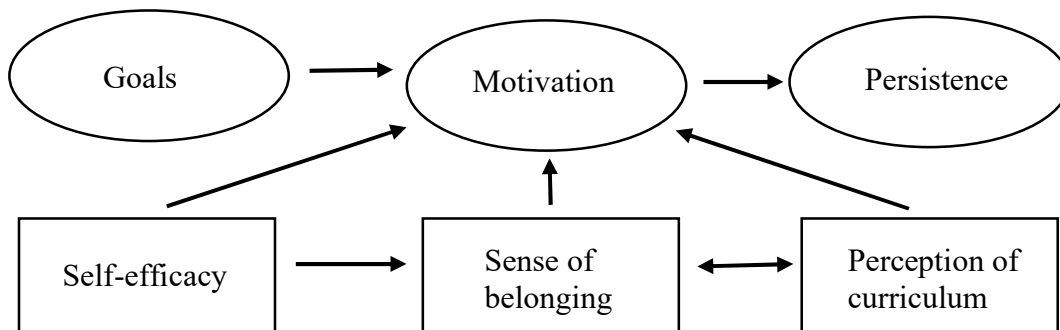
Student *self-efficacy* is a learned behavior based on prior educational and life

experiences. High self-efficacy causes students to engage more in a given task, expend more

effort, and persist longer. Students with low self-efficacy do not believe they will succeed and,

therefore, will not be motivated to persist. A *sense of belonging* to the community of faculty,

staff, and other students is essential to improve motivation and persistence. When students feel they matter and belong to the college community, they are more likely to overcome challenges and difficulties throughout their college career. If they feel out of place such as through a lack of representation or diversity of the faculty, staff, and student population, they are less likely to persist through challenges. Lastly, students' *perceptions of the curriculum* must be that it has value and relevance to their educational journey and future goals. The material should be sufficiently challenging with academic support systems in place to encourage student success. In addition, the use of problem and project-based assignments improve the sense of relevance and importance of material for students (Tinto, 2017).

Retention Model

John Bean developed several models regarding student retention based on psychological factors. He is primarily known for the retention model stating that "individual psychological processes form the foundation for retention decisions" (Bean & Eaton, 2001). There are four elements to Bean & Eaton's (2001) retention model: attitude-behavior theory, coping behavioral theory, self-efficacy theory, and attribution theory, each supporting students' roles and responsibilities for persisting to degree completion.

Attitude-behavior theory refers to pre-existing individual attitudes held by students and provides the foundation for the retention model theory. The remaining three elements are included within the attitude-behavior of students, which change and evolve as students adapt to their new environments. Coping behavioral theory refers to students developing coping strategies in response to new challenges experienced in social and academic realms during their academic journey. Self-efficacy theory includes students' perception of their ability to act specific ways to attain desired outcomes. As self-efficacy skills increase in academic and social

realms, academic and social integration also increase, creating a more successful outcome.

Lastly, attribution theory relates to a student's locus of control such that individuals relate past outcomes to either internal or external forces. Individuals with a strong sense of internal locus of control believe they are responsible for their successes and failures and, therefore, are strongly motivated to achieve academic and social successes. Individuals with a sense of external locus of control believe that their past outcomes were caused by external forces and, therefore, out of their control. Those individuals are less likely to be motivated to work toward and achieve academic and social success (Bean & Eaton, 2001). In summary, Bean & Eaton's (2001) retention model states that students come to an institution with entry characteristics, they respond and develop behaviors of coping, self-efficacy, and attributions while adapting to the institutional environment which lead to feelings of a strong institutional fit and commitment and ultimately to persistence (Table 1).

Table 1

Retention model adapted from Bean & Eaton (2001)

Characteristics of Students upon entry	Interactions and skills developed within the institutional environment	Student behavior leading to persistence
Past behaviors	Academic Interactions	Institutional fit
Personalities	Social Interactions	Institutional commitment
Initial self-efficacy	External Interactions	Intent to persist
Initial attributions	Self-efficacy	Persistence
Normative beliefs	Coping	
Coping strategies	Attributions	
Motivation to attend	Academic integration & performance	
Skills and abilities	Social integration	

Non-traditional Student Attrition

Tinto (1987) recognized that student departure was inversely related to institutional selectivity, with less selective institutions having a higher rate of student departure. In addition, he noted the relevance of this as it related to open-enrollment, 2-year institutions (i.e., community colleges). Community colleges score lowest on selectivity and highest on student departure rates compared with other higher education institutions (Tinto, 1987). Community colleges have a higher number of non-traditional students, typically defined as older (>24 years of age), part-time, and non-residential, who are at a higher risk of departure than traditional students. Older students are less susceptible to social influences, which may positively impact them, than traditional students, and, therefore, may not form secure connections to the institution. Part-time and non-residential students experience fewer interactions with faculty and other students, reducing opportunities for socialization. Each of these characteristics of non-traditional students reduces social interaction and influence, which makes integration into their institution more challenging and may increase their risk of attrition (Bean & Metzner, 1985).

There are four variables identified by Bean & Metzner (1985) that affect non-traditional student attrition – background, academic, environmental, and psychological. Each of these variables impacts traditional students, yet have a more significant impact on non-traditional students since they have more difficulty integrating into the college community. Academic and environmental variables, in particular, impact student success, with environmental variables having a greater influence than academic variables. For example, if both academic and environmental variables are influential, students succeed; when both academic and environmental variables are weak, students do not succeed; when academic variables are durable and environmental variables weak, students do not succeed; and when academic variables are

weak and environmental variables durable, students typically overcome academic challenges and succeed (Bean & Metzner, 1985).

The current study built on the theoretical frameworks described above, primarily Tinto's theory of departure, with a focus on non-traditional college students as represented by the community college student population in Virginia. The responsibility of student departure from Virginia community colleges lies, in part, with the institutions. As Tinto (1987) clearly stated:

> the key to successful student retention lies with the institution, in its faculty and
>
> staff, not in any one formula or recipe. It resides in the ability of faculty and staff
>
> to apply what is known about student retention to the specific situation in which
>
> the institution finds itself. (p. 5).

Tinto (1987) outlined six principals of institutional action to increase student retention: 1) ensure that new students are academically prepared or have the opportunity to acquire skills for academic success, 2) reach out to students to make personal contact beyond formal academic environments, 3) retention actions should be systematic in character (i.e., address formal and informal experiences and academic and social experiences), 4) start as early as possible in a student's academic career, 5) primary commitment of the institution should be the students, and 6) education rather than retention should be the goal of the institutional retention programs. It is as important today for institutions to be actively involved in student retention and completion as it was over 30 years ago. However, as quoted above, there is not one formula or recipe for successful student retention. Each institution must understand the specifics of their student population and mode of instruction in order to adopt practices to increase student success and retention (Tinto, 1987). Bean & Eaton (2001) also supported institutional responsibility for student retention suggesting that institutions develop programs to help students with self-

efficacy, internal locus of control, and academic and social support. All institutional programs should facilitate student psychological growth to support academic and social integration and ultimately increase student retention (Bean & Eaton, 2001).

This research adds to the existing literature information regarding student success in online biology courses at Virginia's community colleges. As administrators of the Virginia Community College System (VCCS) continue to support the growth and development of online courses, it is vital to expand educators' understanding of student success in online courses and, ultimately, the impact on subsequent courses and degree completion. This research fully supports the goals of Transfer Virginia as students enrolled in general biology courses at Virginia's community colleges, frequently seek to transfer those credits to four-year institutions. Therefore, additional information regarding student success of online courses provides college administrators a better understanding of the full extent of student success in these disciplines, which may lead to better informed decisions to support faculty in the development of coursework that achieves higher student success at two-year and four-year institutions.

Related Literature

History of Higher Education

During the years of 1940 to 1970, higher education in the United States experienced rapid growth with a 30% growth of college-age students attending college (Geiger, 2016) compared with only five percent growth in Europe during the same period (Altbach, 2016). The post-World War II era saw a diversification of higher education known as "massification" with 50% of the young adult population (18 to 22-year old) attending college by 1970. Eventually, other countries followed suit with some, South Korea, Russia, and Finland, passing the United States by enrolling 70% of their 18 to 22-year old population (Altbach, 2016). Altbach (2016) stated

that massification might have caused a decline in quality of education, but primarily provided much more variety and opportunity for students across the United States.

Community colleges. Junior colleges first appeared in the United States during the first decade of the 20th century and grew to 207 institutions by 1920 and 575 by 1939. They were conceived as institutions for remedial education to make up for inequality of primary and secondary education across the country and better prepare students for higher education (i.e., senior colleges) (Bahr & Gross, 2016). By 1940, 11% of college students in the U.S. were enrolled in junior colleges; however, it was recognized that 75% of junior college students were not transferring to senior colleges as initially intended. Therefore, community colleges began offering associate's degrees and certifications as an alternative to transferring to senior colleges (Bahr & Gross, 2016).

A second major expansion of junior colleges occurred as a result of the G.I. Bill (1944) and the President's Commission on Higher Education (1947) which increased access to higher education for many Americans recovering from the war and the Great Depression (Bahr & Gross, 2016). The most significant growth of community college institutions occurred between 1965 to 1972 with the opening rate of one college per week (Geiger, 2016) and continued growth to 1,231 institutions nationwide by 1980. Also, 43% of all undergraduate students were enrolled in community colleges by the year 2000. Since that time, community colleges have focused on academic, occupational, remedial, and community education with a return of focus on transferring to four-year colleges (Bahr & Gross, 2016). In 1975, seven states had adopted articulation agreements between two-year and four-year institutions, and by 2004 30 states had some form of legislation addressing articulation between institutions opening paths of articulation between community colleges and four-year institutions (Robertson-Smith, 1990).

Also, the years between 2000 to 2020 has become known as the "era of performance accountability, and competition for community colleges" (Bahr & Gross, 2016, p. 470) as nearly all states have adopted performance-based funding tied to student success rather than student enrollment (Bahr & Gross, 2016). Therefore, community colleges across the country have experienced reduced state and federal funding and increased pressure to improve student success and completion.

As the name implies, community colleges are designed to serve their communities. Each community represents a unique demographic with a unique set of needs. One-fourth of community colleges across America are located within rural areas with three-fourths located in urban and suburban areas. One-fifth of community college populations are comprised of less than two percent black and Hispanic students, while one-fourth are comprised of black and Hispanic student populations more significant than 20%. Combining this data with the fact that "95% of the U.S. population lives within commuting distance of a community college," (Bahr & Gross, 2016, p. 462) supports the role of community colleges serving the needs of residents within the community, very few students arrive from distant locations to attend community colleges (Bahr & Gross, 2016).

Community colleges have served many purposes, such as vocational, technical, higher education for veterans, and preparatory schools for four-year colleges and universities, since their inception at the beginning of the 20th century. Community colleges attract a diverse population of life-long learners and certificate-seeking students. They have become known as a low-cost college option to meet the needs of a diverse student body within a local community; therefore, they typically attract low-income, underprepared, underrepresented, non-traditional age, and first-generation college students. "Community colleges provide an avenue for

continuing workforce, civic, and personal development that cannot be met by any other sector of higher education" (Bahr & Gross, 2016, p. 480).

Virginia community colleges. The Virginia Department of Technical Education was developed in 1962 to establish two-year technical colleges to meet the demands of the technical industry workforce in Virginia at the time. The technical college system rapidly evolved into the Virginia Community College System (VCCS) established in 1966 (State Board for Technical Education, 1964b). By 1972, 23 community colleges were operating and continue to operate today under the VCCS serving nearly 250,000 students each year. The first online courses were offered through the VCCS in 1996, and today 54% of VCCS students enroll in at least one online course each year (VCCS, n.d.a). As described above, the VCCS has grown substantially over the past 50 years and plays a significant role in undergraduate education in Virginia.

Currently, the VCCS has a six-year strategic plan known as *Complete 2021* to triple the number of credentials awarded to students by the year 2021. The mission of *Complete 2021* is to educate students to prepare Virginia as a competitive workforce. There are five areas of focus to *Complete 2021* including connection, entry, progression, completion, and affordability and sustainability. Connection refers to increasing fall admission applications by connecting with potential student populations. Entry refers to increasing the number of students who follow through with enrollment after the application process is complete. Progression refers to increasing the number of students retained from fall to spring semesters and from fall to fall semesters. Completion refers to increasing the number of degrees and certificates awarded to students and the needs of local business communities. Affordability and sustainability refer to obtaining private funding for workforce credentialing and improve efficiencies of college system offices (VCCS, n.d.a). Each of the five areas of focus of *Complete 2021* is designed to increase

enrollment and degree completion to meet the demands of the local business community with progression and completion most directly tied to student success of Virginia community college students.

As recently as December 12, 2019, Governor Ralph Northam unveiled a tuition-free community college program for low and middle-income families. The initiative is known as the G3 program: Get Skilled, Get a Job, Give Back and is designed to educate more Virginians to meet the demand of a growing workforce in Virginia that do not require a four-year degree. The initiative targets healthcare, information technology, public safety, and early childhood education industries. To be eligible for assistance, students will be required to sign a Community Engagement Agreement and complete two hours of work, community service, or public service for every credit hour enrolled at the college. The Governor's proposal includes a $145 million G3 Grant Program to be a "last-dollar" plan to make up the difference between what financial aid covers and the costs of tuition, fees, and books for a given program (Governor Northam, 2019).

The G3 initiative is currently under review for inclusion in the 2020-21 Virginia State budget. It has received widespread support from VCCS college presidents around the state. Dr. Frank Friedman of Piedmont Virginia Community College states that the program "will enable thousands of Virginians every year to enroll in a community college and acquire the skills and credentials that will lead to a middle-class life for their family." In addition, Dr. Friedman states that G3 is the right thing to do to provide skills to individuals to advance their careers as well as it is the smart thing to do to invest in the future workforce in the fields of healthcare, childcare, and manufacturing (Friedman, 2020). Dr. Janet Gullickson of Germanna Community College states that the Virginia state employment commission has indicated a need of 2.6 million jobs by 2026 requiring more than a high school diploma and less than a bachelor's degree. G3 program

graduates are expected to see a 60% increase in wages within their designated field (Gullickson, 2020). Community colleges of Virginia are uniquely positioned to meet the need for training the workforce in these high demand fields. Therefore, if passed by the General Assembly, it is expected that community colleges will experience an increase in enrollment under the G3 program, making improving student success and degree completion at Virginia community colleges ever more important.

Online education. Distance learning in higher education began during the latter half of the 20th century, primarily including radio and television media as learning platforms. With the growth of the internet from nine percent of Americans having access to the internet in 1995 to 77% of Americans having in-home internet access in 2010, online education grew exponentially (Moore & Kearsley, 2012). In 2002, nine percent of higher education students enrolled in online courses, 20% in 2007 (Amro, Mundy, & Kupczynski, 2015), and 33.5% enrolled in 2012 (Ortagus, 2017) and continues to grow by nine to ten percent each year (Huntington-Klein, Cowan, & Goldhaber, 2017). The economic downturn of 2008, increased demand for higher education with excessive demand for online education as compared with face-to-face courses. In the 2007-08 academic year, four percent of undergraduate students were pursuing a degree entirely online (Amro et al., 2015) a number that has continued to grow in recent years. As overall higher education student enrollment increased by a modest 2% between 2002 – 2011, the number of students enrolled in at least one online course during the same time period increased by 21% (Croninger, Mao, Stapleton, & Wooley, 2015). In fact, since 2011, overall student enrollment has decreased in higher education while enrollment in online courses continues to increase (Allen & Seaman, 2017).

Higher education administrators, particularly in the public sector, support the need for growth in online education, partly due to the increased demand and partly due to the decrease in public funding support (Allen & Seaman, 2010). With a decrease in public funding support, many administrators look to online education as a cost-saving strategy compared with traditional face-to-faces courses. Since online courses do not require physical classroom space, course enrollment can be increased allowing for an increase in tuition funds per course. In has been determined that an increase class size of 10% for online courses does not have a negative impact on course learning outcomes such as course grade and subsequent online enrollment (Xu & Xu, 2019).

Online education has proliferated across higher education within the past decade; however, the most substantial growth in online education has occurred in public, two-year community colleges (Fishman, 2015). Community colleges have led the way in offering online courses allowing more students to pursue higher education without traveling to campus. The availability of online courses allows non-traditional, community college students to find a balance between pursuing higher education with work, family, and financial constraints (Huntington-Klein et al., 2017). It has been suggested that if class sizes are increased for online courses and costs are less due to lack of brick-and-mortar restrictions, tuition costs could be lowered for students further increasing accessibility for many student populations (Xu & Xu, 2019).

The VCCS recognized the growth in online education and constructed a distance learning strategic plan in January 2001. The strategic plan addressed student support services, faculty development, and student success in online education (Jaggars & Xu, 2010). By 2007, 97% of all community colleges across the country offered online courses (Ortagus, 2017), however, by

2015 the percentage of online students was greater at four-year institutions (55.3%) than two-year institutions (44.7%). Online course offerings are still growing substantially within the VCCS as indicated by the top fifty colleges and universities enrolling online students between 2012 – 2015 including two Virginia Community Colleges (Northern Virginia Community College and Tidewater Community College) (Allen & Seaman, 2017). In addition, as most community colleges experienced a decline in enrollment following the Great Recession as students returned to the workforce, colleges with many online course offerings, experienced a lower drop in enrollment as students continued to pursue their education while returning to work (Fishman, 2015).

Unfortunately, the cost-saving mindset of online education can be somewhat misleading, and, in fact, may not offer the opportunity for reduced cost for institutions or students. The development of high quality, online courses requires substantial upfront costs. A wide range of development costs from $10,000 to $60,000 per course may be required depending on course design features, student services, and faculty compensation. Some studies have suggested that well-designed online courses may be more expensive to develop than traditional face-to-face courses. One study showed that the average cost for developing an online course at the University of North Carolina is 6% higher than an on-campus course. The increase in cost is primarily associated with professional development of faculty to teach the courses. In addition, the average cost to deliver online courses was slightly higher than on-campus courses (Xu & Xu, 2019). However, the demand for online courses continues to increase (Xu & Xu, 2019) including the demand for online laboratory courses and institutions of higher education are attempting to meet the demand (van Hunnik, 2015).

Community Colleges' Role in Higher Education

Historically, community colleges have held a mission of open access, high quality, post-secondary education to meet the needs of the local community. However, in recent decades, the responsibilities of community college institutions have expanded to meet an increased demand of preparing students for Science, Technology, Engineering, and Math (STEM) related jobs of the future increasing transfer rates to four-year institutions (Hagedorn & Purnamasari, 2012) and increasing the number of college graduates in all fields (Palmadessa, 2016). Therefore, in recent years, there has been increased attention at community colleges on retention rates and completion and transfer rates (Fogg & Harrington, 2009). People with a college degree are more likely to participate in society, contribute time and money to the local community, require fewer public services, and commit fewer crimes. In addition, the salary gap between workers with a high school degree and a college degree is growing. Those with some college, but without an earned degree have only slightly higher earning potential than workers with a high school degree. Lastly, the unemployment rate is more significant for workers with a high school degree compared to a college degree (Tinto, 2004).

Transfer. The Higher Education Act of 1965 encouraged the curricular alignment of two-year and four-year colleges to form a seamless path of transfer credits from one institution to another, specifically from two-year to four-year institutions (Cohen, 2001). In 2004, Virginia instituted the first guaranteed transfer admission agreement between Virginia community colleges and Virginia Tech (VCCS, n.d.a). Currently, there are 25 public and private four-year colleges in Virginia with guaranteed admission agreements with VCCS colleges (VCCS, n.d.a). The Higher Education Restructuring Act of 2005 and Higher Education Opportunity Act of 2011 in Virginia states that each higher education institution in Virginia must develop a guaranteed

articulation agreement with the VCCS. Each institution may develop different standards for articulation; however, they all must honor transfer students with associate's degrees as meeting all general education requirements for the institution. Each publicly funded senior institution must develop guaranteed admissions guidelines with the VCCS consistent with State Council of Higher Education for Virginia (SCHEV)'s guidelines for transfer (SCHEV, n.d.).

Transfer Virginia, passed by the Virginia General Assembly in 2018, is a three-year initiative to develop a more efficient transfer process from Virginia's community colleges to Virginia's four-year colleges and universities. It includes improved communication and collaboration among institutions of higher education, better alignment of academic expectations at two-year and four-year institutions, development of clear pathways to help guide students from high school through degree completion, streamlined transfer and improved guaranteed admission agreements between two-year and four-year institutions, and development of an online transfer portal to serve all students. Overall, the goal of Transfer Virginia is to improve the efficiency of transfer students while closing the gap of degree completion between traditional and non-traditional college students. Successful attainment of this goal will result in an additional 6,600 bachelor degrees awarded to transfer students each year in Virginia (VCCS, 2019).

STEM. In 2009 American students were ranked 23rd in science and 30th in math out of 65 countries evaluated. Through America Competes Act of 2007 and America Competes Reauthorization Act of 2010, the goal was to improve student performance in STEM courses and increase the number of STEM degrees earned in order to meet the demand for STEM-related jobs in the future (Hagedorn & Purnamasari, 2012). In 2009 the Obama administration announced the American Graduation Initiative (AGI) to increase the number of college graduates

to meet the needs of a growing economy. In 2015, the Obama administration expanded the initiative further with the enactment of America's College Promise (ACP) Act, which specifically requested community colleges to meet the goals of increasing college graduates (Palmadessa, 2016). At that time, President Obama asked community colleges to take an important role in economic development in the U.S. through awarding five million associate's degrees by the year 2020 which amounted to a 60% increase in the number of associate's degrees awarded. In order to meet this goal, community colleges have shifted from an access-oriented focus to retention and completion-oriented focus (Fogg & Harrington, 2009).

Based on the AGI and ACP paradigm, the U.S. needs more scientists and engineers in the job market to strengthen the economy. The American workforce expanded by 130% from 1950 to 2000, while the STEM workforce grew 669% during that same period (Hagedorn & Purnamasari, 2012). From 2004 to 2014, STEM-related jobs continued to increase by 22% in the U.S. without qualified workers to fill the need (Dunn, Rabren, Taylor, & Dotson, 2012). In addition, the number of STEM degrees awarded has decreased over the past 30 years. In 1980, 30% of all bachelor's degrees were in STEM fields whereas in 2007 only 23% were in STEM fields. Large, introductory STEM courses, such as Chemistry and Calculus, frequently pose a challenge to new college students. One study showed that 40% of students enrolled in Chemistry 111 and 20% of students enrolled in Calculus 1 received a grade of a C, D, or F in the course, and 10% of students initially enrolled dropped the course (Street et al., 2012). Successful completion of introductory STEM courses such as Chemistry, Biology, and Mathematics directly relates to the number of degrees conferred to fill the STEM-related workforce.

Student Success

Student success is defined in many different terms from accessibility and affordability to student retention, completion, and content knowledge gains. Specifically, student success is usually defined as earning high-quality credentials such as degrees and certifications. In recent years in community colleges, student success has shifted from accessibility to persistence and completion (Kinzie & Kuh, 2016). Before 2007, most community colleges across the country were accountable based on the number of students they enrolled rather than student success or degrees awarded (Mayer et al., 2014). In recent years; however, state funding for community colleges has been increasingly tied to the number of certificates, associate's degrees, and transfers to four-year institutions (Bahr & Gross, 2016).

Before action can be taken to improve student success, a "culture of evidence" must be established to examine how students perform and identify barriers to success. Once community college student success and barriers to success are well understood, interventions and strategies can be developed on an institutional level to improve persistence and completion. There are five recommended steps for institutions to improve student success: a) enact policies and allocate resources aimed at increasing student success, b) use data to understand different student groups and successes and barriers for each, c) engage faculty and staff to design strategies to support student success, d) implement and assess strategies, and e) establish an infrastructure to improve upon existing institutional policies and practices (Mayer et al., 2014).

Faculty members frequently explore alternate modes of teaching to increase student success. Gonzalez (2014) compared student success of three modes of teaching general biology--lecture, blended, and hybrid. The lecture format consisted of approximately 150 minutes of teacher-led information and 165 minutes of laboratory experience each week. The blended

format included 300 minutes per week of integrated lecture and laboratory experience. The hybrid format included lecture material wholly online and 165 minutes of laboratory experience per week. Gonzalez (2014) found students in the blended format exhibited the highest success rate (A, B, or C in the course) over the other two formats while the students in the lecture format exhibited the lowest success rate. Murphy & Stewart (2017) identified a 14% increase in attrition for online students over in-class students. However, they noted that when students continued with the course, online students had a higher overall success rate as measured by receiving A, B, or C for the course. In addition, they noted that 41% of all online students registered for the online format because all in-class formats were full, and 36% of the online students stated they selected the online format because it did not conflict with other courses. Only 5% of the online students stated they preferred the online format because they learn better online than in other formats, and 16% stated they preferred online due to the flexibility of the schedule (Murphy & Stewart, 2017).

Community colleges. Community colleges typically have a mission to provide low cost, high quality, accessible, post-secondary education to a wide range of students. Therefore, they tend to serve a high proportion of non-traditional college students defined as older (>24 years of age), low income, underprepared, minority students (Bahr & Gross, 2016). Forty-six percent of community college students are over the age of 25 years, 30% have dependent children, 52% attend college part-time, 41% enroll in remedial courses, 84% work over 20 hours per week, and 50% make less than $30,000 per year. Due to these demographics, community college students are more likely to enroll in online courses than students attending 4-year institutions, with over half of community college students enrolling in at least one online course (Fishman, 2015).

Although community colleges have provided increased access to higher education for non-traditional students in recent decades, there has not been a comparable increase in completion rate from four-year institutions. More low-income, non-traditional students are entering college, yet more are not persisting to completion (Tinto, 2008). Fifty-six percent of affluent students entering college complete a bachelor's degree within six years, whereas only 26% of low-income students achieve the same goal. Community colleges, in particular, have become a revolving door for non-traditional students (Engstrom & Tinto, 2008). Approximately 50% of freshman students enrolled return for their sophomore year and only 36% of them earn a degree within six years of initial enrollment (Mayer et al., 2014). Many community college students require completion of developmental math and English courses before enrolling in credit-based, degree-seeking courses. Approximately two-thirds of these students fail to complete the requirements and, therefore, never enroll in credit-based courses. In Virginia, only 6% of all first-time, full-time students earn a certificate from a community college in one to two years, and only 12% earn an associate's degree in two years. Older students (>24 years) show a lower success rate, with 6% obtaining an associate's degree in two years, and male students show a lower completion rate (10%) than female students (14%). Further, Black (4%) and Hispanic (8%) students show lower completion rates than White (16%) and Asian (13%) at community colleges in Virginia (Complete College America, 2019).

Online courses. Online courses provide more flexibility and convenience for students to pursue higher education while balancing work and family obligations (Bawa, 2016). However, they also provide fewer opportunities for interactions with faculty and peers and require students to be self-motivated, with high academic-discipline, and the ability to manage academic and life demands (Bettinger, Fox, Loeb, & Taylor, 2017). Students must also overcome technical

barriers such as accessing the internet from rural locations, obtaining a reliable computer, and becoming proficient with online programs as well as learning course material (Gregory & Lampley, 2016). Many studies have shown decreased student success (Bettinger et al., 2017; Huntington-Klein et al., 2017; Xu & Jaggars, 2011a) and increased student attrition of online courses compared with in-person courses (Wladis, Conway, & Hachey, 2017; Xu & Jaggars, 2011a). Faulconer et al. (2018) found no significance in pass rate of online, synchronous video home and classroom, and in-person introductory physics courses (all over 90% pass rate); however, the withdrawal rate was significantly higher for online (3.6%) and synchronous video at home (2.48%) than synchronous video classroom (0.31%) and in-person (0%). Therefore, they concluded that for introductory physics courses, attrition rates were higher for online and synchronous video at home, but if students persist, success rates were not significantly different (Faulconer et al., 2018).

A study of Washington State community colleges found that online courses had a -6.5% effect on students enrolling in another course within the same field and -1.7% effect on earning an associate's degree. With completion rates already of concern at community colleges, a negative impact on student success and degree completion based on enrollment in one online course is of particular concern. Although online courses provide increased access to higher education for students, it may not provide a success route to degree completion (Huntington-Klein et al., 2017). Bettinger et al. (2017) found that online students earned 0.4 points lower than in-person students of the same course and had a higher incidence of withdrawing from college, especially for online students with lower starting grade point averages (Bettinger et al., 2017). Overall, attrition rates for online courses have been determined to be as high as 30-40% (Wladis et al., 2017).

James, Swann, & Datson (2016) found that blended students (enrolled in some online and some face-to-face courses) at 2-year community colleges showed higher retention than students enrolled entirely online and students enrolled completely face-to-face. Therefore, they concluded that the increase in access achieved through online courses and the increase in retention of blended students at community colleges has an overall positive impact on providing access to higher education for the local community (James, Swann, & Datson, 2016). This is particularly important for older, non-traditional college students attempting to balance the demands of work and family with the demands of a college education. Shea & Bidjerano (2018) showed a similar positive impact of blended course program for community college students in New York. They determined that students received the highest benefit for degree completion with a 3:2 ratio of face-to-face and online courses. Students who took 40% of their courses in the online format received the greatest benefit of flexibility that online courses offer without the negative impact of isolation and other barriers resulting in decreased student success in online courses (Shea & Bidjerano, 2018).

Xu & Jaggars have been exploring student success in online learning, particularly at the community college level for over a decade (Jaggars & Xu, 2010; Xu & Jaggars, 2011a; Xu & Jaggars, 2011b; Jaggars, 2011; Xu & Jaggars, 2013a). They tracked a cohort of students from Washington State community colleges from 2004 to 2009 and concluded that students working more hours of employment and representing a demographic of higher academic success, were more likely to enroll in online courses. However, they also showed those students were more likely to withdraw or fail online courses than students enrolled in hybrid and face-to-face courses and less likely to return in subsequent semesters and obtain a degree (Xu & Jaggars, 2011a). A differential success rate has been identified for different populations of students in online

learning environments. Some of these differences (female students outperforming male, white students outperforming black, higher GPA students outperforming lower GPA) are also observed in traditional learning environments, but one demographic (older students outperforming younger students) was found to be contrary to traditional learning environments (Xu & Jaggars, 2013a).

The focus of research in Jaggars (2011) was on student success in online courses within the low-income and underprepared student population of community colleges. The researcher identified many barriers to success for low-income students enrolled in online courses, primarily technological barriers and lack of institutional support. Technological barriers should be addressed through evaluation of financial aid programs and by providing laptop computers to low-income students. In addition, institutions should provide online readiness assessments, online learning skills tutorials, and non-instructional support staff for students to aid in overcoming technological barriers. Lastly, online faculty should receive professional development opportunities to improve online courses and expand online courses to include fully online degree programs for community college students (Jaggars, 2011). Also, implementing four additional areas of improvement to the online learning environment could potentially improve student success: screening, scaffolding, early warning, and wholesale improvement. Screening includes offering online courses as a privilege to those students who show higher potential for success (i.e., students with a GPA greater than 3.0) rather than to all students. Although this may improve student success in online courses, it may reduce enrollment and potentially add more barriers to specific student populations. Scaffolding includes incorporating online learning skills into the online course curriculum to help students gain specific skills for online learning; however, it requires additional faculty support for course re-design. The early

warning includes incorporating identification and intervention of potential problems for online

students to aid in the successful completion of the course. Lastly, wholesale improvement

involves the re-design of many online courses with the assistance of faculty development and

support (Xu & Jaggars, 2013a).

Online courses provide increased access to higher education for many populations of

students, particularly in the community college system. However, many barriers to success need

to be addressed to improve success within the online courses and through degree completion.

Johnson (2015) found that only 11% of online courses in California's community colleges

resulted in greater than 70% pass rate of students as compared with 44% of traditional courses.

The reason for this disparity was determined to be the design of online courses. Most online

courses are developed by individual faculty members based on traditional course curricula with

very little training and support. The author recommends a systems model approach in online

curriculum development through providing professional development for faculty and a support

team to advise and mentor faculty through the design and implementation of new courses and

updating older courses with current best practices (Johnson, 2015). Besides, institutions should

provide better support for distance learners to help them feel more connected than they currently

do and integrated into the culture of the institution for a higher chance of success. Faculty also

need professional development and training from the institution to practice the best techniques of

support for online students (Travers, 2016).

STEM. The top five departments represented in online courses include English, math,

psychology, sociology, and communications. Online math courses show the lowest student

success rate (Huntington-Klein et al., 2017). In addition, social sciences (anthropology,

philosophy, psychology) and applied programs (business, nursing, law) showed lower

performance in online courses than face-to-face courses of the same discipline (Xu & Jaggars, 2013a). Amro et al. (2015) found that face-to-face students' final grades were higher (M=2.98) than online students' final grade (M=2.20) in algebra courses. In addition, they determined the average age for online students to be higher (M= 26.95) than face-to-face students (M=25.14) and more females (69.5%) to enroll in online algebra courses than males (30.5%). Prior success in online courses was found to be a good indication of success in subsequent online STEM courses such that students' first online experiences are crucial to determining future enrollment in online STEM courses (Hachey, Wladis, & Conway, 2014). Non-traditional students majoring in STEM-related fields are more likely to enroll in online courses. In fact, the greater the number of non-traditional student characteristics, the more likely the student is to enroll in online courses. It is believed that online STEM courses may provide an opportunity to increase enrollment of non-white and female students and ultimately diversify the STEM-related workforce (Wladis, Hachey, & Conway, 2015a).

Gatekeeper classes, introductory sciences, developmental math, and English, frequently create a barrier for students pursuing STEM degrees. In particular, completion rates for math (23%) and English (36%) gatekeeper classes are low in community college student populations (Mayer et al., 2014). Xu & Jaggars (2011b) found that English and math gatekeeper courses in the VCCS showed lower completion rates than face-to-face courses. They concluded that community college students typically work, have family obligations, are underprepared for college courses, and are first-generation college students, and, therefore, may not receive the necessary support through an online course environment particularly in gatekeeper courses early in their college careers (Xu & Jaggars, 2011b). Introductory biology acts as the gatekeeper course to satisfy many students' lab science requirements and, may, therefore, create a barrier to

students progressing through their college career path. As with gatekeeper English and math courses, they have high enrollment and, therefore, potentially impact more students (Xu & Jaggars, 2011b).

However, the development of online physical science courses has lagged behind other disciplines and few studies have examined success in online science courses. Varty (2016) examined 96 higher education institutions across the country and identified a total of 149 online, general biology courses offered during the 2015 to 2016 academic year. A significant disproportion of the biology courses was offered at two-year community colleges rather than four-year colleges and universities, with 64% of the four-year institutions examined offering no online, biology options. In addition, the courses were predominantly biology for nonmajors satisfying pre-requisites for students pursuing healthcare fields. Online biology courses for science majors were typically offered in a hybrid format with an online lecture and a face-to-face laboratory experience (Varty, 2016). Varty (2016) concluded that faculty are resistant to developing fully online biology courses for science majors for several reasons, such as comparability of an online to face-to-face laboratory experience, transferability of credits to four-year institutions, and lack of support and resources to develop such a course. Lastly, the student success rate of online STEM courses overall has been the lowest of all online courses (Wladis et al., 2017).

Summary

The theoretical frameworks in which this study was founded, Tinto's (1987) theory of departure and Bean and Eaton's (2001) retention model, provide many reasons for student attrition in higher education and community colleges in particular. Both models propose that students and institutions share responsibility for assuring student success and persistence. For

institutions to increase student success, administrators need to have a thorough understanding of areas of needed improvement. It is well established in the literature that community colleges enroll non-traditional students with many life-demands which frequently impede successful completion of certificates, degrees, and transfers to four-year institutions (Bahr & Gross, 2016; Kinzie & Kuh, 2016; Mayer et al., 2014) and lead to a high rate of attrition. In addition, it is well established that offering online courses continues to grow in community colleges (Huntington-Klein et al., 2017; Moore & Kearsley, 2012; Ortagus, 2017; VCCS, n.d.a) with student success low and attrition high (Bettinger et al., 2017; Huntington-Klein et al., 2017; Wladis et al., 2017) particularly in STEM-related courses (Hachey et al., 2014; Huntington-Klein et al., 2017; Wladis et al., 2017, Xu & Jaggars, 2011b). However, the development of online, physical science courses, especially for science majors, lags behind other disciplines primarily due to concerns over low success rates and quality of online lab science courses (Varty, 2016). Community college students cite specific courses, such as lab science, math, foreign language, and public speaking, as not being conducive to the online learning environment. Most students believe they do not learn as well online; therefore, they prefer to take more challenging courses face-to-face (Jaggars, 2012).

Regardless of student perception, online courses continue to grow, and a gap in the literature exists of student success within the VCCS for online biology courses for students majoring in science. Online courses provide flexibility for community college students with childcare demands, work responsibilities, transportation challenges, and overall time management constraints. Also, older students cite a discomfort or fear of returning to the classroom environment with a preference for online courses (Jaggars, 2012). Science majors are required to take subsequent science courses, either online or in-person; therefore, identifying

student success within the first-semester, online biology course, as well as subsequent biology courses, is an essential contribution to the literature. The goal of this study was to evaluate student success in online biology courses in the VCCS as measured by online attrition, student success, and downstream effects on subsequent biology courses.

CHAPTER THREE: METHODS

Overview

The purpose of this study was to examine student success in online, general biology courses as compared to in-person, general biology courses at Virginia Community Colleges. Three measures of student success were used: course attrition, successful course completion, and successful course completion of a subsequent general biology course (i.e., downstream effect). Successful course completion was indicated by an earned letter grade of A, B, or C. Included in this chapter are the experimental design, research questions and hypothesis statements, participants and settings, instrumentation, procedures, and data analysis.

Design

A quantitative, ex post facto, correlational research design was used to examine student success of general biology students enrolled online versus in-person at Virginia Community Colleges. Ex post facto is defined in Latin as "operating retroactively" (Gall, Gall, & Borg, 2007). In this study, data were collected from the VCCS database of previously enrolled students; therefore, data were analyzed retroactively using a correlational design. An ex post facto, correlational design was used to explore predictive relationships that already exist between the identified groups or among the selected variables (Field, 2018). The rationale for using a correlational design for this study was to identify if a statistically significant relationship exists between student success in online general biology courses and in-person general biology courses. If a significant difference in student success is identified between delivery modes, then VCCS educators may choose to make changes to course design of online or in-person biology courses.

Research Questions

RQ1: How accurately can *course attrition* (receiving W) of first-semester general biology students be predicted by *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

RQ2: How accurately can *successful course completion outcome* (receiving A, B, or C) of first-semester general biology students be predicted by *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

RQ3: How accurately can downstream effects, measured as *successful course completion outcome* (receiving A, B, or C) of second-semester general biology in-person students, be predicted by enrollment in first-semester general biology students *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

Hypotheses

$H_0 1$: There is no significant predictive relationship between *course attrition* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant.

$H_0 2$: There is no significant predictive relationship between successful *course completion* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant.

H₀3: There is no significant predictive relationship between *successful course completion* outcome of second-semester, general biology in-person students, following first-semester *online versus in-person* general biology courses at Virginia Community Colleges, while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant.

Participants and Setting

A stratified convenience sampling method was used in this study. Participants were drawn from archival data provided by the VCCS based on prior enrollment in general biology courses (either online or in-person) for two semesters at one of the 23 Virginia Community Colleges between the years of 2015 to 2019. As of 2017 to 2018 academic year, there were over 234,000 full and part-time students throughout 23 community colleges in the VCCS across Virginia. In the fall of 2017, the student population distribution within the VCCS was approximately 43% nonwhite and 57% white (VCCS, n.d.a). This is a somewhat higher nonwhite population than the overall racial demographics of the state of Virginia, with 32% nonwhite and 68% white (World Population Review, n.d.).

As described by Cohen (1988), power, significance criterion (α), effect size (ES), and sample size (n) are inter-related in determining the optimum experimental design. In social and biological sciences, it is conventional to use a power of 0.8 and a significance criterion of 0.05. A small ES is 0.2, medium is 0.5, and large is 0.8. In addition, a minimum of fifteen cases per IV is required for a binomial logistic regression analysis (Laerd, n.d.; Warner, 2013). By utilizing the VCCS database, a sample size of over 4,000 participants enrolled in first-semester general biology online, over 30,000 participants enrolled in first-semester general biology in-person, and over 10,000 participants enrolled in second-semester general biology in-person were

attained for this study. In addition, a significance criterion of 0.05 was used. The two groups were compared, over a 4-year time frame of students enrolled in general biology, first and second semester, delivered as online or in-person format at VCCS community colleges. The 4-year time frame utilized included the four most recent academic years available through the database with the exception of 2019 to 2020 academic year as the spring semester of 2020 was severely impacted by the coronavirus pandemic. A convenience sampling approach was used by obtaining data from online and in-person general Biology courses from all of the 23 community colleges in Virginia.

Sample population demographics were collected for participants in this study. The student population consisted of 58.7% females and 41.3% males; 54% white and 46% nonwhite; 80.2% students under 24 years and 19.8% greater than or equal to 24 years; 21.4% first-generation college students and 78.6% not first-generation college students; and 45.5% Pell grant-eligible students and 54.4% not Pell grant-eligible students.

Instrumentation

This study utilized archival data obtained from the office of Institutional Effectiveness and Research and Reporting for the Virginia Community College System (VCCS). The data consisted of student demographic information, including age, gender, race, first-generation status, and Pell grant-eligibility status, enrollment history, and course grade history. To ensure anonymity, student names and contact information were not be included in the obtained data set. Archival data are appropriate for this study as it provides a large sample size of online and in-person student performance in general biology courses across community colleges in Virginia. Archival data provide a high degree of reliability and validity with accurate and meaningful results (Gregory & Lampley, 2016). History of course grades were used to compare successful

course completion of online and in-person biology courses. Access to the data was restricted to the researcher and kept in a secure location on a password-protected computer.

Procedures

Institutional Review Board (IRB) approval was obtained from the Assistant Vice Chancellor for Institutional Effectiveness and Research and Reporting at the VCCS to obtain access to the student information system (see Appendix A). A Procedures for Research Requesting the Release of VCCS Data application (see Appendix B) and letter (see Appendix C) were submitted to the Vice Chancellor for review by committee. Once the application was approved and letter of acknowledgement was received (see Appendix D) access to the appropriate database was provided. The VCCS uses a database containing demographic information, course name and title, enrollment history, and course grades. Students were selected based on enrollment in first and second-semester general biology online and in-person over four years (2015 to 2019). Only the first attempt of a course by participants was included in the dataset, all repeat attempts by the same student was removed by the VCCS employee prior to release of the data. Participants were assigned to one of two groups identified as Online and In-person first-semester general biology to address research questions #1 and #2. Participants enrolled in second-semester in-person general biology courses were assigned to one of two groups identified as Online first-semester general biology and In-person first-semester general biology to address research question #3. Demographic information of age, gender, race, first-generation status, and Pell grant-eligibility status at the time of course enrollment was collected and end of course grade was recorded as A, B, C, D, F, or W.

Data Analysis

A binomial logistic regression analysis was used to address all three research questions as stated above. Binomial logistic regression is used as a measure of probability that an observation falls into one of two categories (the odds ratio). It was used to explore the predictor variable of course delivery by modeling the odds of the outcome variable student success for general biology courses when controlling for age, gender, race, first-generation status, and Pell grant-eligibility status. A binomial logistic regression analysis is a nonparametric statistic with categorical or continuous predictor variables and a categorical outcome variable (Rovai, 2003; Warner, 2013). It is used to explore multiple predictor variables while reducing confounding effects by modeling the odds of an outcome variable based on individual predictors (Sperandei, 2014).

Logistic Regression Rationale

In the current study, logistic regression was utilized to measure the probability of the following outcomes: that students withdraw from a general biology course using an online delivery mode compared with a general biology course using an in-person delivery mode (RQ1), that students successfully complete a general biology course using an online delivery mode compared with a general biology course using an in-person delivery mode (RQ2), and that students successfully complete a subsequent general biology course after successfully completing a first-semester, general biology course using an online delivery mode compared with an in-person delivery mode (RQ3). It was selected as the most appropriate statistical choice for this study due to the nature of the dichotomous outcome variable and because logistic regression can control for multiple confounding variables if the sample size is large enough (Field, 2018; Warner, 2013). Moreover, logistic regression has been employed in similar studies

of online and in-person student success studies (Hachey, Wladis, Conway, 2014; Ortagus, 2017; Shea & Bidjerano, 2014; Shea & Bidjerano, 2018; Tompkins, 2013; Wladis, Conway, & Hachey, 2017; Wladis, Hachey, & Conway, 2014; Wladis, Hachey, & Conway, 2015a; Xu & Jaggars, 2011b; Xu & Jaggars, 2013a; Xu & Jaggars, 2013b) as well as other areas of research in higher education (Machin, McNally, & Wyness, 2013; Wei, et al., 2014).

Logistic Regression Analysis

In the present study, the predictor and outcome variables were measured as dichotomous, independent categories. The predictor variable was the dichotomous category of delivery mode (online versus in-person) and the outcome variables (depending on research question) were the dichotomous category of course attrition (RQ1), student success of first-semester general biology (RQ2), and student success of second-semester general biology (RQ2), while holding population demographic variables (age, gender, race, first-generation status, and Pell grant-eligibility status) constant. Continuous predictors may be used in logistic regression; only the outcome variable must be scaled on a nominal level, meaning the criterion variable must be dichotomous (Field, 2018; Warner, 2013). Course attrition was measured as students who withdrew from a class (W, did withdraw) regardless of their grade. Students who withdrew from the course (received W on transcript) were coded with '1' and students who did not withdraw from the course (received A, B, C, D, or F) were coded with '0'. Successful completion of first-semester general biology was determined by students who received A, B, or C grade in Biology 101 and were coded with '1' indicating successful while students who received D or F grade in Biology 101 were coded with '0' indicating unsuccessful. Successful completion of second-semester, in-person general biology was determined by students who received A, B, or C in Biology 102 and were coded with '1' indicating successful while students who received D or F grade in Biology 102 were

coded with '0' indicating unsuccessful. The successful parameters were based on the ability for credits to transfer from a two-year to a four-year institution. For four-year colleges and universities to accept transfer credits for courses taken at two-year community colleges, students must attain the letter grade of A, B, or C (Wladis, Conway & Hachey, 2017).

Course attrition to address RQ1 was measured as withdrawing from the course after the start of the semester or receiving a W for course outcome (Wladis, Conway, & Hinchey, 2017). Students receiving W were be coded as '1' and students receiving any other course outcome were coded as '0'. A logistic regression analysis was used to measure the probability that students withdraw from first-semester, online general biology courses compared with first-semester, in-person general biology courses. Successful course completion of first-semester general biology courses to address RQ2 was measured by end of course grades of A, B, or C. Students receiving grades of A, B, or C were considered successful and coded as '1' whereas students receiving grades of D or F were considered unsuccessful and coded as '0'. This level of success was used based on the criteria for successful credit transfer from VCCS colleges to four-year institutions (Wladis, Conway & Hachey, 2017). A logistic regression analysis was used to measure the probability of successful completion of first-semester general biology courses taken online compared with in-person. In addition, successful course completion of second-semester general biology courses to address RQ3 was measured by end of course grades of A, B, or C. Students receiving grades of A, B, or C were considered successful and coded as '1' whereas students receiving grades of D or F were considered unsuccessful and coded as '0'. A final logistic regression analysis was used to measure the probability of successful completion of in-person, second-semester general biology courses based on the condition of successful completion of online versus in-person first-semester general biology courses. In addition, sample

demographics including age, gender, race, first-generation status, and Pell grant-eligibility status were included in the logistic regression model as control variables to assess the impact of the main predictor variable for each research question while holding the demographic variables constant.

A statistical significance level of 0.05 was used as this is an appropriate significance criterion to use in social and biological sciences (Cohen, 1988; Field, 2018). If a statistical significance of 0.05 is not detected in the regression analysis, then the null hypothesis (H_0) for each research question was failed to be rejected.

Assumptions Testing

The assumptions that must be met with logistic regression analysis include: (a) dichotomous outcome variable that is exhaustive and mutually exclusive; (b) continuous or nominal predictor variables; (c) independence of observation such that there is no relationship between observations in each category or between each category; (d) adequate sample size of at least fifteen cases per predictor variable; (e) linearity between continuous predictor variables and logit transformation of the outcome variable; (f) no excessive multicollinearity between variables; and (g) no outliers that would produce highly influential data points (Field, 2018; Laerd, n.d.; Warner, 2013).

In this study, the outcome variable was dichotomous, exhaustive, and mutually exclusive, meaning that only one outcome per case was possible: withdraw or not withdraw (RQ1); successful completion or unsuccessful completion of first-semester general biology (RQ2); and successful completion or unsuccessful completion of second-semester general biology (RQ3). Predictor variables met the assumption of being either nominal, interval, or ratio level (age, gender, race, first-generation status, Pell eligibility-status, and online versus in-person delivery

modes). The independence of observation and adequate sample size assumptions was met as all participants were only enrolled in one delivery mode category and only the first attempt at a course included. The large VCCS database of archival data provided an adequately large sample size of over 4,000 participants enrolled in general biology online and over 30,000 participants enrolled in general biology in-person. The linear relationship between the predictor variable and the logit transformation of the outcome variable was measured using the Box-Tidwell approach (Tabachnick & Fidell, 2013). The Box-Tidwell approach adds terms of interactions between each predictor and its natural log to the logistic regression model. If one or more of the interactions is statistically significant, the assumption is considered violated (Field, 2018; Tabachnick & Fidell, 2013). Multicollinearity was determined in this study based on the inspection of variance of inflation factor (VIF) variables. Lastly, significant outliers or other influential data points were not of concern as all variables were categorical (Field, 2018; Laerd, n.d.).

CHAPTER FOUR: FINDINGS

Overview

With a rise in online science course offerings, particularly in response to the COVID-19 pandemic, the purpose of this study was to examine student success in online, general biology courses as compared to in-person, general biology courses at Virginia Community Colleges. Three measures of student success were used: course attrition, successful course completion, and successful course completion of a subsequent general biology course (i.e., downstream effect). Successful course completion was measured by an earned letter grade of A, B, or C. Included in this chapter are the research questions, null hypotheses, descriptive statistics, and results. Data were obtained from the Office of Institutional Effectiveness, Research, and Reporting at the Virginia Community College System (VCCS). The data include information from all 23 community colleges in Virginia during four recent academic years of 2015-16 through 2018-19. The academic year of 2019-20 was not included in the study due to the unusual circumstances of spring 2020 semester caused by the pandemic. Each case in the data set included delivery mode, academic performance, and demographic information. All identifying information was removed from the data set by VCCS office personnel.

Research Questions

RQ1: How accurately can *course attrition* (receiving W) of first-semester general biology students be predicted by *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

RQ2: How accurately can *successful course completion outcome* (receiving A, B, or C) of first-semester general biology students be predicted by *online versus in-person* at Virginia

Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

RQ3: How accurately can downstream effects, measured as *successful course completion outcome* (receiving A, B, or C) of second-semester general biology in-person students, be predicted by enrollment in first-semester general biology students *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility-status constant?

Null Hypotheses

H_01: There is no significant predictive relationship between *course attrition* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

H_02: There is no significant predictive relationship between successful *course completion* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

H_03: There is no significant predictive relationship between *successful course completion* outcome of second-semester, general biology in-person students, following first-semester *online versus in-person* general biology courses at Virginia Community Colleges, while holding population demographics of age, gender, race, first-generation status, and Pell grant-eligibility status constant?

Descriptive Statistics

For all 23 community colleges in Virginia during four academic years of 2015-16 through 2018-19, a total of 34,450 students were enrolled in Bio101 either online or in-person and a total of 11,055 of those students enrolled in Bio102 in-person in the subsequent semester following Bio101 online or in-person. Fifty-four cases reported as gender 'undeclared' were determined to be a very rare subset of the population and, therefore, eliminated from further analysis resulting in a total of 34,396 total cases and 11,040 Bio102 cases (Table 2). Research question #1 addressed *course attrition* measured by students receiving a W on their transcripts for Bio101 online and in-person. Research question #2 addressed *successful course completion* of Bio101 measured by students receiving A, B, or C deemed successful and students receiving D or F deemed unsuccessful for Bio101 online and in-person. Research question #3 addressed *successful course completion* of Bio102 in-person following Bio101 online or in-person measured by students receiving A, B, or C deemed successful and students receiving D or F deemed unsuccessful. Successful course completion was based on credit transferability from Virginia community colleges to four-year institutions.

Student demographics such as age, gender, race, first-generation status, and Pell grant eligibility were self-reported on student applications. Descriptive statistics were provided for all demographic data, online and in-person Bio101 students, and Bio102 in-person students after taking Bio101 online or in-person. Most cases were traditional-aged students (80.2%), not first-generation college students (78.6%), and enrolled in Bio101 in-person (88.1%). In addition, there were more female (58.7%) than male (41.3%) students, more white students (54.0%) than non-white students (46%), and fewer Pell-eligible (45.5%) students than those not eligible (54.5%) for Pell grants (Table 2).

For the outcome variables related to Bio101, a small number of students enrolled in Bio101 withdrew from the course (9%) and the majority of the students completed the course successfully (76.2%) defined as receiving a letter grade of A, B, or C. The total sample size for the Bio101 success outcome variable represented all students who did not withdraw from the course (N=31,287). For the Bio102 success outcome variable, the majority of the students completed the course successfully (85.7%) and the sample size represented only those students enrolled in Bio102 in-person after successfully completing Bio101 in-person or online (N=11,040) (Table 2).

Table 2

Descriptive statistics of predictor and outcome variables

Variables

Predictor Variables	Frequency (N)	Percent (%)
Age		
Traditional	27,587	80.2
Non-traditional	6,809	19.8
Gender		
Male	14,215	41.3
Female	20,181	58.7
Race		
White	18,581	54.0
Non-white	15,815	46.0
First-generation		
Yes	7,372	21.4
No	27,024	78.6
Pell-eligible		
Yes	15,648	45.5
No	18,748	54.5
Delivery mode		
Online	4,109	11.9
In-person	30,287	88.1
Outcome Variables	Frequency (N)	Percent (%)
Bio101 Withdraw		
Not withdraw	31,287	91.0
Withdraw	3,109	9.0
Bio101 Success		
Successful	23,840	76.2
Unsuccessful	7,447	23.8
Bio102 Success		
Successful	9,465	85.7
Unsuccessful	1,575	14.3

Results

Binary logistic regression analyses were utilized for all three research questions and all assumptions for this model were met. The outcome variables of course attrition (RQ1), Bio101 success (RQ2), and Bio102 success (RQ3) were mutually exclusive and all predictor variables were dichotomous, nominal variables that were dummy coded. The independence of observation

was met as each case was only enrolled in one delivery mode for Bio101, each case was in the data set once representing the first attempt at the course, and all other variables were also mutually exclusive. The large sample size of 34,396 total cases with the smallest predictor variable (online delivery mode) represented by 4,109 cases and the smallest outcome variable (Bio102 unsuccessful) represented by 1,575 cases (Table 2) met the assumption of adequate sample size. The assumption of multicollinearity between variables was met based on the largest VIF statistic for non-traditional aged students to be 1.087. The cutoff to meet the assumption of multicollinearity is less than 10 (Rovai, Baker, & Ponton, 2013). Lastly, there was no concern for extreme data points or outliers as all variables were binary and categorical.

Hypotheses

H_01: There is no significant predictive relationship between *course attrition* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant?

A binary logistic regression analysis was conducted to determine the predictive relationship between course attrition and delivery mode of Bio101 while holding population demographics of age, gender, race, first-generation status, and Pell-eligibility status constant. The outcome variable, withdraw, was determined by students receiving a W on their transcripts for Bio101. The predictor variables included teaching mode (online vs. in-person) with covariates age, gender, race, first-generation status, and Pell-eligibility status and the outcome variables included withdraw or not withdraw. The logistic regression model was statistically significant, $\chi^2(6) = 326.619$, $p < .001$. The model explained 2.1% (Nagelkerke's R^2) of the variance course withdraw and correctly classified 91% of the cases. Sensitivity was 0%,

specificity was 100%, positive predictive value was 0%, and negative predictive value was 91% (Table 3).

Table 3

Classification table: Bio101 Withdraw

Observed	No	Yes	Percentage Correct
Bio101 did not withdraw	31,287	0	100.0
Bio101 did withdraw	3,109	0	.0
Overall Percentage			91.0

Of the six predictor variables, five were statistically significant: age, gender, first-generation status, Pell-eligibility status, and teaching mode of predicting student withdraw from Bio101. Online students had 1.94 times higher odds of withdrawing from Bio101 courses. Male students, older students, and Pell-eligible students also showed higher odds of withdrawing from Bio101 courses. First-generation college students showed lower odds of withdrawing and there was no significant difference between withdraw for white and non-white students (Table 4).

Table 4

Variables in the Equation: Bio101 Withdraw

Predictor Variables	p	Odds Ratio	95% C.I. for Odds Ratio	
			Lower	Upper
Non-traditional age (> 23 yrs)	.001	1.164	1.063	1.275
Gender = male	<.000	1.209	1.120	1.304
Race = non-white	.928	.997	.924	1.075
First-generation student	.012	.888	.810	.974
Pell eligible	<.000	1.458	1.350	1.574
Online delivery mode	<.000	1.943	1.758	2.147

Based on the logistic regression analysis and an alpha level of 0.05, a significant difference was detected between course attrition of Bio101 online students and Bio101 in-person students. Therefore, $H_0 1$ was rejected, stating no significant predictive relationship between *course attrition* of first-semester, general biology students enrolled in *online versus in-person*

courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant.

H$_0$2: There is no significant predictive relationship between successful *course completion* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant?

A binary logistic regression analysis was conducted to determine the predictive relationship between Bio101 course success and delivery mode of Bio101 while holding population demographics of age, gender, race, first-generation status, and Pell-eligibility status constant. The outcome variable, success, was determined by students receiving a letter grade of A, B, or C on their transcripts for Bio101. The predictor variables included teaching mode (online vs. in-person) with covariates age, gender, race, first-generation status, and Pell-eligibility status and the outcome variables included success or not success. The logistic regression model was statistically significant, $\chi^2(6) = 381.248$, $p<.001$. The model explained 1.8% (Nagelkerke's R^2) of the variance of student success and correctly classified 76.2% of the cases. Sensitivity was 100%, specificity was 0%, positive predictive value was 76.2%, and negative predictive value was 0% (Table 5).

Table 5

Classification table: Bio101 Success

Observed	No	Yes	Percentage Correct
Bio101 Not Successful	0	7,447	.0
Bio101 Successful	0	23,840	100.0
Overall Percentage			76.2

All of the six predictor variables: age, gender, race, first-generation status, Pell-eligibility status, and teaching mode were statistically significant predictors of student success in Bio101.

Online students were less likely to succeed in Bio101 (Odds Ratio = .738) or had 1.35 times higher odds of being unsuccessful. Male students, non-white students, first-generation students, and Pell-eligible students also showed lower odds of success in Bio101 courses. Older students had 1.55 times higher odds of success (Table 6).

Table 6

Variables in the Equation: Bio101 Success

Predictor Variables	p	Odds Ratio	95% C.I. for Odds Ratio	
			Lower	Upper
Non-traditional age (>23 yrs)	<.000	1.556	1.446	1.675
Gender = male	<.000	.751	.712	.792
Race = non-white	<.000	.808	.766	.853
First-generation student	.012	.922	.864	.982
Pell eligible	<.000	.802	.759	.846
Online delivery mode	<.000	.738	.678	.803

Based on the logistic regression analysis and an alpha level of 0.05, a significant difference was detected between successful course completion of Bio101 online students and Bio101 in-person students. Therefore, **$H_0 2$** was rejected, stating no significant predictive relationship between successful *course completion* of first-semester, general biology students enrolled in *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant.

$H_0 3$: There is no significant predictive relationship between *successful course completion* outcome of second-semester, general biology in-person students, following first-semester *online versus in-person* general biology courses at Virginia Community Colleges, while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant?

A binary logistic regression analysis was conducted to determine the predictive relationship between Bio102 in-person student success and delivery mode of Bio101 while holding population demographics of age, gender, race, first-generation status, and Pell-eligibility status constant. The outcome variable, success, was determined by students receiving a letter grade of A, B, or C on their transcripts for Bio102. The predictor variables included teaching mode of Bio101 (online vs. in-person) with covariates age, gender, race, first-generation status, and Pell-eligibility status and the outcome variables included Bio102 success or not success. The logistic regression model was statistically significant, $\chi^2(6) = 100.894$, $p < .001$. The model explained 1.6% (Nagelkerke's R^2) of the variance of student success and correctly classified 85.7% of the cases. Sensitivity was 100%, specificity was 0%, positive predictive value was 85.7%, and negative predictive value was 0% (Table 7).

Table 7

Classification table: Bio102 Success

Observed	No	Yes	Percentage Correct
Bio102 Not Successful	0	1,575	.0
Bio102 Successful	0	9,465	100.0
Overall Percentage			85.7

Of the six predictor variables, four were statistically significant: age, gender, race, and Pell-eligibility status of predicting student success in Bio102 in-person classes. Teaching mode of Bio101 and first-generation college student status were not significant in predicting student success in Bio102. Older students had 1.89 times higher odds of being successful in Bio102 than younger students. Males students, non-white students, and Pell-eligible students all had lower odds of success in Bio102 (Table 8).

Table 8

Variables in the Equation: Bio102 Success

Predictor Variables	p	Odds Ratio	95% C.I. for Odds Ratio	
			Lower	Upper
Non-traditional age (>23 yrs)	<.000	1.888	1.557	2.289
Gender = male	<.000	.797	.715	.888
Race = non-white	.002	.845	.758	.942
First-generation student	.263	.927	.811	1.059
Pell eligible	<.000	.738	.661	.824
Online delivery mode	.654	1.106	.711	1.721

Based on the logistic regression analysis and an alpha level of 0.05, no significant difference was detected between successful course completion of Bio102 in-person after successfully completing Bio101 online versus in-person. Although, the Omnibus test showed a significant difference in the model, it was not attributed to delivery mode. Therefore, **H₀3** failed to be rejected, stating no significant predictive relationship between *successful course completion* outcome of second-semester, general biology in-person students, following first-semester *online versus in-person* general biology courses at Virginia Community Colleges, while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant.

CHAPTER FIVE: CONCLUSIONS

Overview

Community colleges across the country are known to have low student completion rates. In Virginia, only 12% of first-time, full-time students earn an associate's degree within two years and only 6% of students over the age of 25 years graduate within two years (Complete College America, 2019). Therefore, institutions need to identify programs, courses, and delivery formats that create student success barriers. In this study, focus area was delivery format (online versus in-person) of general biology courses at Virginia community colleges. Included in this chapter is the discussion section covering the findings of each research question compared to other studies in the literature and the overall theoretical framework, the implications of these findings, limitations of the study, and recommendations for future research.

Discussion

This study aimed to examine student success in online, general biology courses compared to in-person, general biology courses at Virginia community colleges. First and second-semester general biology courses were examined, and three research questions were used to assess student success based on course attrition and successful course completion. As detailed below, each research question explored one aspect of student success in general biology courses at Virginia community colleges.

RQ1: How accurately can *course attrition* (receiving W) of first-semester general biology students be predicted by *online versus in-person* courses at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant?

This research question's focus was to determine if delivery mode of first-semester general biology could predict the likelihood of student withdrawal. It was determined that online students showed a significantly greater probability of withdrawing from online general biology than in-person general biology. In addition, non-traditional students (> 23 years of age), male students, and Pell-eligible students all showed a significantly greater probability of withdrawing from general biology. First-generation college students showed a significantly lower probability of withdrawing. The difference in withdrawals was greatest between online and in-person students suggesting that delivery mode was the strongest predictor of student withdrawal from general biology courses. These findings of increased withdraw from online courses are well supported in the literature (Faulconer, Griffith, Wood, Acharyya, & Roberts, 2018; Gregory & Lampley, 2016; Hachey, & Conway, 2015a; Hachey, Wladis, & Conway, 2014; Johnson, Mejia, & Cook, 2015; Wladis, Conway, & Hachey, 2017; Wladis, Murphy & Stewart, 2017; Xu & Jaggars, 2011a). Wladis, Conway, & Hachey (2017) found that attrition rates could be as high as 30 to 40% from online courses, particularly in STEM-related disciplines. General biology is considered a gatekeeper course for students pursuing many areas of study and can potentially impact a large number of students (Xu & Jaggars, 2011b). Based on the current study, approximately 1,000 students enrolled in online general biology per academic year in community colleges across Virginia; therefore, addressing the increased risk of withdrawing from online courses has the potential impact student success and overall completion rates substantially.

Over the past few decades, online classes have become an important part of higher education (Martin, Budhrani, Kumar, & Ritzhaupt, 2019), with 44.7% of all online students enrolled in community colleges (Allen & Seaman, 2017). However, only 5% of online students choose online courses because they state they learn better, and 16% choose online courses

because of the online format's inherent flexibility. The remaining online students state that they choose online courses because in-person courses are full or conflict with other courses (Murphy & Stewart, 2017). With this in mind, community colleges have a higher proportion of the student body comprised of non-traditional students than four-year institutions (Bahr & Gross, 2016) and, therefore, benefit from online courses' flexibility. However, community college students already show a high risk of withdrawal based on the inverse relationship between institutional selectivity and student departure (Tinto, 1987) and many non-traditional students. Non-traditional college students are typically older, part-time, nonresidential, work full-time, are financially independent, and are single parents with dependent children (Wyatt, 2011). These factors reduce social interactions and influence with classmates causing integration into the institution more challenging and, therefore, increases the risk of attrition (Bean & Metzner, 1985). With this overall increased risk of attrition for community college students and the increased risk of withdrawing from online general biology courses as outlined in this study, it is essential to recognize the contribution that attrition from online courses may play in the overall high rate of attrition for community college students. Community college students frequently need the flexibility offered through the online format; however, improvements must be made to reduce attrition from these courses.

RQ2: How accurately can *successful course completion outcome* (receiving A, B, or C) of first-semester general biology students be predicted by *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant?

The focus of this research question was to determine if the delivery mode of first-semester general biology could predict successful course outcome in Bio101. Successful course

outcome was based on a student receiving a letter grade of A, B, or C for the course. The transferability of credits determined this parameter from two-year to four-year institutions. Four-year colleges and universities do not accept transfer credits for courses taken at two-year community colleges unless the student receives the letter grade of A, B, or C (Wladis, Conway & Hachey, 2017). It was determined that of the students who did not withdraw from Bio101, online students were significantly less likely to succeed than in-person students. In addition, younger students (< 24 years), male students, non-white students, first-generation students, and Pell-eligible students also showed lower odds of success in Bio101 courses.

Student success in online courses has mixed results in the literature. As supported by the current study, much of the research shows a reduced student success rate in online courses (Bettinger, Fox, Loeb, & Taylor, 2017; Huntington-Klein, Cowan, & Goldhaber, 2017; Johnson, Mejia, & Cook, 2015; Wladis, Hachey, & Conway, 2015a; Wladis, Hachey, & Conway, 2015b; Xu & Jaggars, 2011a). However, some research shows that when students persist in online courses, they have a higher success rate than in-person courses (Murphy & Stewart, 2017) even in STEM, lab sciences courses such as physics (Faulconer, Griffith, Wood, Acharyya, & Roberts, 2018). Assuming that up to 1,000 students per year at Virginia community colleges are enrolling in online, first-semester, general biology, and those students may have a lower success rate than in-person students, the impact for overall student success toward completion may be substantial. As stated previously, general biology is a gatekeeper course (Xu & Jaggars, 2011b) and is frequently students first introduction to lab sciences. When students are not successful in gatekeeper courses, their path to completion is impeded. As stated by Tinto (2013), gaining and maintaining momentum in the college journey is a crucial factor contributing to student success. When gatekeeper courses are not completed successfully, students may lose momentum and,

therefore, reduce the probability of degree completion and transferability to four-year institutions. Although online biology courses have lagged behind other online courses (Varty, 2016), online course offerings are a growing and expected mode of instruction, particularly in community colleges (Mitchell, 2017). If student success in online courses continues to be lower than in-person courses, as the number of students enrolled in online courses continues to grow, the overall student success and completion rate from community colleges will not improve.

RQ3: How accurately can downstream effects, measured as *successful course completion outcome* (receiving A, B, or C) of second-semester general biology in-person students, be predicted by enrollment in first-semester general biology students *online versus in-person* at Virginia Community Colleges while holding population demographics of age, gender, race, first-generation status, and Pell grant eligibility status constant?

This research question aimed to determine if delivery mode of first-semester general biology (online versus in-person) could predict successful course outcome of in-person second-semester general biology. This was defined as the *downstream effects* of first-semester delivery mode on a second semester sequenced course. Successful course outcome was based on a student receiving a letter grade of A, B, or C for the course. As described above, this parameter was determined by the transferability of credits from two-year to four-year institutions where the letter grade of A, B, or C is required (Wladis, Conway & Hachey, 2017). It was determined that of the students who completed Bio101 successfully, teaching mode did not significantly impact the successful completion of Bio102 in-person. First-generation college student status also did not have a significant impact on the successful completion of Bio102 in-person. Whereas, male students, non-white students, and Pell-eligible students all had significantly lower odds of successful completion and older students had increased odds of successful course completion of

Bio102 in-person. Therefore, the significance of the model as shown by the Omnibus test is likely explained by the significance of other variables in the equation such as age, gender, race, and Pell-eligibility status, rather than delivery mode of Bio101.

Successful course completion in prior online courses has been shown to predict the probability of successful course outcomes in subsequent online courses. This is known as the downstream effect. Students who withdrew or received a letter grade of D or F in one prior online course, had a lower success rate in subsequent online courses than students who never enrolled in previous online courses. The examination of downstream effects is one approach to identifying community college students at the highest risk, particularly in STEM courses (Hachey, Wladis, & Conway, 2014). In a similar but somewhat different approach, the current study examined the impact of teaching mode in a prior course to the success of a subsequent in-person course, of which very little information was found in the literature. The importance of downstream effects is noted in the Hachey, Wladis, & Conway (2014) study and should be applied here in which teaching mode of the prior sequenced course did not have a negative impact on the subsequent in-person course.

Implications

Online courses have become an important mode of teaching for much of higher education. The Virginia Community College System (VCCS) developed *College Everywhere VA* to offer the flexibility of online courses to students "no matter where you are." Currently, the VCCS offers over 10,000 online courses through 23 community colleges across the state with new courses being added daily (VCCS, n.d.c). Therefore, particularly with the current pandemic situation, the demand for online courses is expected to continue to grow. With this in mind, it is important to recognize areas that impact student success for improvements in future course

developments. This study determined that students withdraw at a higher rate from online than in-person biology courses and that students are less successful in online than in-person biology courses. As described in Tinto's (1987) theory of departure, student success is directly linked to students transitioning and integrating into the community of college life. Online courses' isolation may likely be a contributing factor of increased difficulty in transitioning and reduced integration into college life and, therefore, increased withdraw and decreased success. Many other factors, such as self-efficacy, motivation, and coping mechanisms as described by Bean & Eaton's (2001) retention model and technology limitations, may all be exacerbated by the online environment. As the online environment appears to be here to stay for the foreseeable future, it is college and university educators' responsibility to close the achievement gap between online and in-person courses. As stated previously, the development of online lab science courses is lagging behind other online courses; however, science faculty and staff are working to improve the online environment and offer dynamic virtual and hands-on lab experiences. As the courses improve and efforts to reach students to help them integrate into the college community continue, student success in these courses is expected to improve.

Limitations

Research questions #1 and 2 have a relatively high internal validity considering the number of confounding variables in the experiment. Both research questions examined teaching mode as an aspect of student success and both included five additional covariates controlled by the model. However, other confounding variables not considered, such as GPA, number of hours worked, number of dependents, or number of hours devoted to studying may also influence the model's outcome, and therefore, reduce internal validity. Research question #3 has a somewhat lower internal validity due to the same factors described above and the limitations of the design.

Impact of delivery mode of Bio101 on student success of Bio102 in-person was examined; however, self-selection of delivery mode for Bio101 and Bio102 was not considered. Therefore, students who may have self-selected Bio101 and Bio102 online courses were not included in the analysis since only Bio102 in-person students were included. In addition, although the sample size was large for research question #3 (N = 11,040), it included approximately one-third of the total sample size included in the study (N = 34,396) due to approximately two-thirds of students enrolled in Bio101 did not enroll in Bio102 in-person.

External validity is expected to be relatively high for all research questions in this study. Since the sample population for this study was collected from biology courses across the VCCS and the sample population was very large (over 34,000 students), the results and conclusions are applicable to individual community colleges in Virginia. It is safe to assume that student success (measured by attrition and course outcome) of online Bio101 students would be lower than in-person Bio101 students at all of the community college campuses in Virginia. In addition, as long as student demographics are similar between institutions, it is expected that the results and conclusions of this study are applicable to other community colleges across the country. However, it would be expected that student population demographics would differ between community college students and students of 4-year institutions resulting in a less reliable application. Although some generalizations can be made regarding student success in online versus in-person courses across disciplines, it is recommended to limit the application primarily to general biology and other lab sciences. Applying the results and conclusions of this study to other disciplines is cautioned as online lab experiences are unique to the lab sciences. Lastly, this study identified a predictive relationship between general biology teaching mode and student success through a correlational research design. However, it should be noted that teaching mode

is only a possible causal factor and a true experimental research design is needed to definitively identify causation of student success in general biology courses.

Recommendations for Future Research

It is hoped that the findings of this study will provide more depth to the literature regarding student success in online lab science courses, and therefore, useful in the development of future online courses. The following recommendations for further study address this area of interest.

1. First and foremost, it is recommended that studies examining student success of online lab science courses be continued regardless of the accumulation of information available in the literature. Technology is rapidly changing and courses are regularly improving; therefore, it is important to continue to monitor the achievement gap between online and in-person lab science courses.

2. A study comparing student success in online lab science courses between 2-year community colleges and 4-year institutions is recommended. If transition and integration contribute to decreased success in online courses, then students of 4-year institutions would be expected to have a narrowed achievement gap between online and in-person courses compared to community college students.

3. Lastly, downstream effects should be examined more closely. The impact of the teaching mode of Bio101 on student success of Bio102 online; the impact of success of Bio101 online on student success of Bio102 online; and the impact of success of Bio101 in-person on student success of Bio102 in-person would each offer more insight to student success in general biology courses.

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Institutional Review Board (IRB) application

<div style="background:#666;color:#fff;text-align:right;padding:4px">Date: 8-17-2020</div>

IRB #: IRB-FY20-21-50
Title: Student Success of Online vs. In-person Biology Courses at Virginia Community Colleges **Creation Date:** 7-28-2020 **End Date:**
Status: Approved
Principal Investigator: Jennifer Scott **Review Board:** Research Ethics Office **Sponsor:**

Study History

Submission Type Initial	Review Type Exempt	Decision No Human Subjects Research

Key Study Contacts

Member Jeffrey Savage	Role Co-Principal Investigator	Contact jsavage2@liberty.edu
Member Jeffrey Savage	Role Co-Principal Investigator	Contact jsavage2@liberty.edu
Member Jennifer Scott	Role Principal Investigator	Contact jscott38@liberty.edu
Member Jennifer Scott	Role Primary Contact	Contact jscott38@liberty.edu

Initial Submission

Application for the Use of Human Research Participants

Before proceeding to the IRB application, please review and acknowledge the below information:

Administrative Withdrawal Notice

This section describes the IRB's administrative withdrawal policy. Please review this section carefully.

Your study may be administratively withdrawn if any of the following conditions are met:

- Inactive for greater than 60 days and less than 10% of the app has been completed
- Duplicate submissions
- Upon request of the PI (or faculty sponsor for student submissions)
- Inactive for 90 days or more (does not apply to conditional approvals, the IRB will contact PI prior to withdrawal)

✔ I have read and understand the above information.

Study Submission & Certification

This section describes how to submit and certify your application. Please review this section carefully. Failure to understand this process may cause delays.

Submission

- Once you click complete submission, all study personnel will need to certify the submission before it is sent to the IRB for review.
- Instructions for submitting and certifying an application are available in the IRB's Cayuse How-tos document.

Certification

- Your study has not been successfully submitted to the IRB office until it has been certified by all study personnel.
- If you do not receive a "submission received by the IRB office" email, your study has not been received.
- Please check your junk folder before contacting the IRB.

✔ I have read and understand the above information.

Moving through the Cayuse Stages

In Cayuse, your IRB submission will move through different stages. We have provided a quick overview of each stage below.

In Draft

- The In Draft stage means that the study is with the study team (you). In this stage, the study team can make edits to the application.
- When the IRB returns a submission to the study team, the submission will move back to the In-Draft stage to allow for editing.

Awaiting Authorization

- Each time a study is submitted, it will move from In-Draft to Awaiting Authorization.
- During this stage, the submission must be certified by all study personnel listed on the application (PI, Co-PI, Faculty Sponsor). This ensures that every member of the study team is satisfied with the edits.
- Please note, the IRB has not received your submission until all study personnel have clicked "certify" on the submission details page.

Pre-Review

- When your application is submitted and certified by all study personnel, your study will move into the Pre-Review stage.
- Pre-Review means the IRB has received your submission. The IRB review occurs during the Pre-Review stage.
- Once received, an IRB analyst will conduct a cursory review of your application to ensure we have all the information and documents necessary to complete a preliminary review.
- If additional information or documents are needed to facilitate our review, your submission will be returned to you to request these
- changes. Your study will be assigned to an analyst once it is ready
- for review. Preliminary and any subsequent reviews may take 15–20 business days to complete.

Under Review

- Studies will move into the "Under Review" stage when the analyst has completed his or her their review and the study is ready for IRB approval.

✔ I have read and understand the above information.

Finding Help

The IRB has several resources available to assist you with the application process. Please review the below information, or contact our office if you need assistance.

Help Button Text (?)

- Some questions within the application may have help text available.
- Please click on the question mark to the right of these questions to find additional guidance.

Need Help? Visit our website, www.liberty.edu/irb, to find:

- Cayuse How-Tos
- FAQs
- Supporting document templates

Contact Us:

- irb@liberty.edu
- 434-592-5530
- Office Hours: M-F; 8:00AM-4:30PM

✔ I have read and understand the above information.

Acknowledgement

Please acknowledge that you have reviewed and understand the above information. You can refer back to this information at any time.

I acknowledge that I have read and understand the above information. Take me to the IRB
✔
application.

What type of project are you seeking approval for?

Please make the appropriate selection below.

Research

- Research is any undertaking in which a faculty member, staff member, or student collects information on living humans as part of a planned, designed activity with the intent of contributing relevant information to a body of knowledge within a discipline.

✔ Archival or Secondary Data Use Research ONLY

- Archival data is information previously collected for a purpose other than the proposed research. Examples include student grades and patient medical records.
- Secondary data is data that was previously collected for the purpose of research. For example, a researcher may choose to utilize survey data that was collected as part of an earlier study.

Doctor of Nursing Practice (DNP) Scholarly Project

- This option is specific to doctor of nursing practice (DNP) students' evidence-based practice scholarly projects.

Please indicate the primary purpose of this project:

Why is this project being proposed?

✔ Doctoral Research

*Note: Students must enter themselves as PI and their faculty sponsor under Co-PI/Faculty Sponsor.

Have you passed your dissertation proposal defense?

Doctoral candidates may not submit their project for IRB review until they have successfully passed their proposal defense.

✔ Yes

No

N/A

Masters Research

Undergraduate Research

Faculty Research

Class Project

Other

Study Personnel

Please fill in all associated personnel below.

Please note: All study personnel must complete CITI training prior to receiving IRB approval.

- IRB Training Information
- CITI Training Website

Primary Contact

The individual who will receive and respond to communication from the IRB should be listed as the primary contact. For student projects, the primary contact will be the student researcher(s). For faculty projects, the primary contact may be the researcher or a student(s), administrative assistant, etc. assisting the faculty member. The same individual may be listed as the primary contact and the principal investigator.

Name: Jennifer Scott
Organization: Graduate Education
Address: 1971 University Blvd , Lynchburg, VA 24515-0000
Phone:
Email: jscott38@liberty.edu

Principal Investigator (PI)

The principal investigator (PI) is the individual who will conduct the research or serve as the lead researcher on a project involving more than one investigator.

Name: Jennifer Scott
Organization: Graduate Education
Address: 1971 University Blvd , Lynchburg, VA 24515-0000
Phone:
Email: jscott38@liberty.edu Co-

Investigator(s)

Co-investigators are researchers who serve alongside the principal investigator and share in the data collection and analysis tasks.

Name: Jeffrey Savage
Organization: Graduate Education
Address: 1971 University Blvd , Lynchburg, VA 24515-0000
Phone:
Email: jsavage2@liberty.edu

Faculty Sponsor

Projects with students serving as the PI must list a faculty sponsor, typically a dissertation or thesis chairperson/mentor.

Name: Jeffrey Savage

Organization: Graduate Education
Address: 1971 University Blvd , Lynchburg, VA 24515-0000
Phone:
Email: jsavage2@liberty.edu
Will the research team include any non-affiliated, non-LU co-investigators?

For example, faculty from other institutions without Liberty University login credentials. Note: These individuals will not be able to access the IRB application in Cayuse, however, the information provided below allows the LU IRB to verify the training and credentials of all associated study personnel. Yes

✔ No

Conflicts of Interest

This section will obtain information about potential conflicts of interest.

Do you or any study personnel hold a position of influence or academic/professional authority over the participants?

For example, are you the participants supervisor, pastor, therapist, teacher, principal, or district/school administrator? Yes

✔ No

Do you or any study personnel have a financial conflict of interest?

For example, do you or an immediate family member receive income or other payments, own investments in, or have a relationship with a non-profit organization that could benefit from this research? Yes

✔ No

Funding Information

This section will request additional information about any funding sources.

Is your project funded?

Yes

✔ No

Study Dates

Please provide your estimated study dates.

Start Date

08/15/2020

End Date

05/15/2021

Use of Liberty University Participants

Please make the appropriate selection below:

I do not plan to use LU students, staff, and/or faculty as participants.

✔

● Note: Use of LU students, faculty, or staff also includes the use of any existing data.

I plan to use a single LU department or group.
- You will need to submit proof of permission from the department chair, coach, or dean to use LU personnel from a single department.

I plan to use multiple LU departments or groups.

- If you are including faculty, students, or staff from multiple departments or groups (i.e., all sophomores or LU Online) and you have received documentation of permission, please attach it to your application. Otherwise, the IRB will seek administrative approval on your behalf.

Purpose

Please provide additional details about the purpose of this project.

Write an original, brief, non-technical description of the <u>purpose</u> of your project.

Include in your description your research hypothesis/question, a narrative that explains the major constructs of your study, and how the data will advance your research hypothesis or question. This section should be easy to read for someone not familiar with your academic discipline.

The purpose of this study is to compare student success of two modes of course delivery (online vs. in-person) for general biology courses at Virginia community colleges. Student success will be measured by student withdraw from first semester biology courses (Bio101), course completion success (based on letter grade received) in first semester biology courses (Bio101), and course completion success (based on letter grade received) in second semester biology courses (Bio102).

My research questions are as follows:
RQ1: Will course attrition of first-semester general biology students enrolled online be significantly different than students enrolled in-person?
RQ2: Will successful course outcome of first-semester general biology students enrolled online be significantly different than students enrolled in-person?
RQ3: Will the downstream effects, measured as successful course outcome of second semester general biology in-person students , following first semester general biology students enrolled online be significantly different from students following first semester general biology enrolled in-person?

I am requesting the use of archival data from two community colleges in the Virginia Community College System during the academic years 2015-16 through 2018-19 to explore the research questions stated above. Gaining a better understanding of student success in online general

biology courses is an important contribution to all of higher education particularly during this time of rapid growth of online learning seen as a result of the pandemic. With a better understanding of student success in online general biology courses, faculty and higher education administrators will be better informed to make decisions regarding the development of online curricula.

Investigational Methods

Please indicate whether your project involves any of the following:

Does this project involve the use of an investigational new drug (IND) or an approved drug for an unapproved Use?

Yes

✔ No

Does this project involve the use of an investigational medical device (IDE) or an approved medical device for an unapproved Use?

Yes

✔ No

Use of Archival Data

This section will collect additional information about your proposed use of archival data.

Please describe your intended use of the archival data.

For example, what are you hoping to discover by using and interpreting this data?

I hope to determine if there is a difference in student success (both through attrition and course outcome) in online versus in-person general biology courses in Virginia community colleges. I plan to use recent academic years (2015-16 through 2018-19) to explore student success with the most current teaching practices in both delivery modes. In addition, I hope to determine if the different delivery modes (online and in-person) have an impact on student success in subsequent general biology courses (i.e. the downstream effect).

Please provide the list of data fields you intend to use for your analysis and/or describe the original instruments used to collect the data.

I plan to use student course outcomes (A, B, C, D, F, W, and I) for first and second semester general biology as well as student demographic information such as age, race, gender, and GPA. All names and contact information will be stripped from the data set.

Please name the organization(s) from which you are seeking archival data.

Virginia Community College System

Please describe the steps you will take to secure the archival data.

For example, where will the data be stored and who will have access to it?

I will store all archival data on my personal computer which is a password-protected laptop kept within my home.

Is the archival data publicly accessible?

Yes

✔ No

How will you obtain access to the data?

For example, an organizational representative will provide the data to you.

I will work with Dr. Catherine Finnegan , Assistant Vice Chancellor for Institutional Effectiveness, Research and Reporting, Virginia Community College System. I met (virtually) with Dr. Finnegan to discuss my topic and incorporated her suggestions. I then submitted a request for data application and once IRB approval is complete, I will contact Dr. Finnegan again to finalize the request.

Will you receive the raw data stripped of identifying information?

For example, will the data be free of any names, addresses, phone numbers, email addresses, student IDs, medical record numbers, social security numbers, birth dates, etc.?

✔ Yes

State who will strip/redact the data.

This person should have regular access to the data and should be a neutral party not involved in the study.

The office of Institutional Effectiveness, Research and Reporting at the Virginia Community College System personnel will be responsible for redacting the data.

No

Can the names or identities of the participants be deduced from the raw data?

Yes

✔ No

Please place your initials in the box.

I will not attempt to deduce the identity of the participants in this project.

JCS

Please submit documentation of permission to access/use the archival data.

This documentation should state the following:

1. You have permission to access/use the data.
2. Whether the data will be stripped of any private, identifiable information prior to you receiving it.

JScott_Permission_Letter.docx   Sample documents: Permission (Request Letter) ,
Permission (Example Letter) JScott_Permission_Request.docx

Human Subjects Training Documentation

Note: This upload is only required for non-affiliated, non-LU personnel. If you are affiliated with LU, we are able to view your CITI training report.

External Investigator Agreement

Note: This upload is only required for non-affiliated, non-LU personnel. If you are affiliated with LU, you are able to provide certification within the Cayuse system.

Proof of Permission to Use LU Participants, Data, or Groups

Note: If you are not using LU participants, data, or groups, you do not need to include an attachment here.

DNP Permission

Note: If you are not in the Doctor of Nursing Practice Program (School of Nursing), you do not need to include an attachment here.

Sample documents: [Permission (Request Letter)](#) , [Permission (Example Letter)](#)

Recruitment

Note: If you are strictly using archival data, you may not need to include an attachment here.

Sample documents: [Recruitment (Letter/Email)](#) , [Recruitment (Follow-up)](#) , [Recruitment (Flyer)](#)

Parental Consent

Note: If your study does not involve minors, you will not need to provide an attachment here.

Sample documents: [Parental Consent](#)

Archival Data Permission

Note: If you are not using archival data, you will not need to provide an attachment here.

[JScott_Permission_Letter.docx](#) Sample documents: [Permission (Request Letter)](#) , [Permission (Example Letter)](#)

[JScott_Permission_Request.docx](#)

Data Collection Instruments

Note: If you are strictly using archival data, you may not need to provide an attachment here.

Site Permission

Note: If you do not require external permission(s) to conduct your study, you may not need to provide an attachment here.

[JScott_Permission_Letter.docx](#)   Sample documents: [Permission (Request Letter)](#) , [Permission (Example Letter)](#)

[JScott_Permission_Request.docx](#)

Child Assent

Note: If your study does not involve minors, you will not need to provide an attachment here.

Sample documents: [Child Assent](#)

Consent Templates

Note: If you are strictly using archival data, you may not need to provide an attachment here.

Sample documents: [Consent](#) , [Consent (Medical)](#)

Debriefing

Note: If your study does not involve deception, you will not need to provide an attachment here.

Sample documents: [Debriefing](#)

APPENDIX B

VIRGINIA COMMUNITY COLLEGE SYSTEM
PROCEDURES for RESEARCH
REQUESTING THE RELEASE OF VCCS DATA

The Virginia Community College System (VCCS) advocates the benefits of research and promotes the professional growth and development of its faculty and staff. As such it supports the conduct of research that benefits teaching and learning at the college level, operations at the college or system level, and greater understanding of student behavior. However, at all times, the confidentiality and protection of the VCCS, its students, and staff are primary.

All VCCS-related research requires VCCS approval. All proposed research must lead to worthwhile educational benefits for students and/or personnel of the VCCS and must be compatible with the mission and goals of the VCCS. Projects proposing solutions to problems or improvements to programs will receive preferential consideration. This document (Procedures for Research Requiring the Release of VCCS Data) covers research involving the use of VCCS data including data previously gathered for another purpose.

Details related to submitting a research proposal and the subsequent review and approval process follow. Note that **requests for student- and college-identifiable data will not be approved.** Student data and college data will have all identifiable attributes removed and the VCCS will create unique identifiers, if necessary.

Procedures for Obtaining Approval to Conduct Research using VCCS Data

This document outlines procedures required of those seeking to conduct research using VCCS data about its students, programs, or facilities. No research may be conducted until this research request has been approved by the VCCS Research Review Team (RRT) and the Data Release Research contract has been signed and returned to the Assistant Vice Chancellor for Institutional Effectiveness for the VCCS.

Research Review Team
The VCCS RRT is charged with reviewing and approving or disapproving proposals for the acquisition and use of VCCS data as outlined herein. The RRT is also charged with ensuring the safety and integrity of the VCCS and the ethical use of VCCS data. The RRT may request an interview with the researcher to gather information beyond that submitted in the written proposal. It may also suggest revisions to the proposal prior to a final decision on the proposal's acceptability.

Research Review Process: Once a research proposal is received, it will be distributed electronically to all members of the RRT. Each RRT member will review the research proposal. Within ten days, the RRT will meet via conference call to review the proposal and make a determination as to approval or non-approval of the research proposal.

Once the RRT has made its determination, the Director of Institutional Research will notify the researcher via email. If the proposal is accepted, the notification will include:
- Procedures to be followed by the researcher for implementing the project/study
- Special conditions or constraints, if any, which may apply to the research project, etc.
- How data will be provided (SAS dataset or flat file); and, how data will be destroyed.

There is no appeal process for denied proposals. To be reconsidered, the researcher must submit a new proposal.

Requirements for using VCCS data
1. Data and information requested must be necessary for the research project or study.
2. All research must adhere to commonly accepted research practices. In addition, when analysis results in subsets of data of very few (five or fewer) data points, the researcher should not use the data in that cell.
3. In accordance with state and federal law, VCCS is limited in its ability to share personally identifiable faculty, staff, and student information. Personally identifiable faculty, staff, and student information will not be released. Rather, such data will be deleted to eliminate the possibility of identifying a specific faculty, staff, or student.
4. Data at all times will be the property of the VCCS. Data integrity must be maintained.
5. All research must be completed within one-year from receipt of data. If additional time is needed, evidence of need must be demonstrated to the VCCS office via completion of the Request for Extension of Research agreement form at the back of this document.
6. All data must be kept in a secure, limited-access location and must be destroyed after completing the research or within the contractual timeframe agreed to between the researcher and the VCCS.

Use of Research Results
Results of the research project must be submitted to the VCCS office of Academic Services and Research (ASR). In addition, ASR must be notified promptly of all future publications and/or studies in which the results of, or data from, the research project are used, **and** the VCCS must be allowed by the researcher to make non-commercial use of the project results for the benefit of the VCCS.

Researcher Contract to be signed by Researcher and Advisor:
I (researcher) **agree to** abide by the conditions of the **Procedures for Research Requiring the Release of VCCS Data** set forth above in the section titled "Requirements for using VCCS data". I further acknowledge that (a) Sources of data used in this research will be explicitly acknowledged within the research report (e.g., SCHEV, National Clearinghouse, VCCS, etc.); (b) Required approval for use and acquisition of such data has been obtained; (c) Research Proposal and Contact Information Sheet are attached; (d) a change in the scope of the approved research requires the submission and approval of a new proposal; and, (e) if any conditions in this contract are not met, or are broken at any stage of the project, the VCCS reserves the right to deny future access to all its data and to revoke permission for use of all data previously obtained.

Researcher Name: _____
Title of Study: _____
Researcher Signature: _____**Date:** _____
Advisor Signature: _____**Date:** _____
VCCS Review Team Approval: Yes: _____**No:** _____ **Date:** _____
VCCS Approval: _____ **Date:** _____

Research Proposal
Outline and Requirements

Use the format and discussion points, below, to prepare the **Research Proposal** to conduct VCCS-related research. Proposals should be submitted electronically to the Director of Institutional Research at least four weeks prior to the time the research is expected to begin to allow time for review of the proposal.

Research Proposal Format

I. <u>**Title of Study**</u>

II. <u>**Statement of the Problem**</u>
   A. Discuss the purpose of the research, and state the question(s) to be answered or hypotheses to be tested.
   B. Define cohort(s) and data elements requested.
   C. Briefly summarize relevant theory and previous related research (one-page or less).
   D. Justify the study (explain its importance and describe the intended use of the findings).
   E. Describe the benefits of the study to the VCCS.

III. <u>**Design of the Study**</u>
   A. Describe the methods to be used in analyses of data and describe how data will be described in any reports or presentations resulting from this research.
   B. Provide a time schedule for implementation of the study.

IV. <u>**Use and Users of Results**</u>
   A. Discuss the expected uses and users of the results of the study including expected publications.

Checklist of Research Request Submission Materials
Submit the following electronically to the email address listed below.
- One copy of the Research Proposal following required format described above.
- One copy of Researcher 's Vita (brief)
- One copy of the Institutional Review Board/Protection of Human Subjects approval (or exemption, if appropriate) as required for university and/or dissertation research.
- One completed and signed Researcher Contract.
- One completed Contact Information Sheet.

CONTACT INFORMATION SHEET
VCCS-DATA RELEASE RESEARCH REQUEST

Contact Information

  Researcher:

                                                                 Email:
  Cell phone: _____   Office phone: _____   _____

Researcher Information

  Student: _____   Faculty: _____   Other: _____

  If Proposed Research is in partial completion of a degree, indicate type of degree:

  Ph.D. _____   Ed. D. _____   M.A./M.S. _____   Undergrad. _____   Other: _____

Educational Affiliation

  University/College: _____

  Academic Dept.:   _____

  City, State: _____

Organizational Affiliation

  Organization Name: _____

  City, State: _____

Submit Completed Research Proposal Package to:
Dr. Catherine Finnegan.
Assistant Vice Chancellor for Institutional Effectiveness
Virginia Community College System
101 No. 14th Street
Richmond, VA 23219
804-819-1665
cfinnegan@vccs.edu

REQUEST FOR EXTENSION OF RESEARCH

VCCS-DATA RELEASE

Researcher Name: _____

Research Title: _____

Date: _____

Reason for Request for Extension of Research:

_____
_____

_____
_____

_____
_____

_____
_____

Researcher Signature: _____
_____

Revised Research Extended. New Completion Due Date:
_____

VCCS Approval: ___ _____ **Date:** __ _____

APPENDIX C

Letter of Request for Data

August 10, 2020

Dr. Catherine Finnegan
Assistant Vice Chancellor for Institutional Effectiveness
Research and Reporting
Virginia Community College System
300 Arboretum Place, Suite 200
Richmond, VA 23236

Dear Dr. Finnegan:

As a graduate student in the Department of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy degree in Higher Education Administration & Education Leadership. The title of my research project is Student Success of Online vs. In-person Biology Courses at Virginia Community Colleges and the purpose of my research is to compare student success of two modes of delivery (online vs. in-person) for general biology courses.

I am writing to request your permission to access and utilize institutional student records from the VCCS database to access course outcomes and demographic information such as race, age, gender, and GPA for general biology courses for the academic years between 2015-16 through 2018-19 from Northern Virginia Community College and Germanna Community College. All identifying information such as name and contact information will be stripped from the dataset prior to release.

The data will be used to compare student success in online and in-person Biology 101 courses as well as the downstream effects of student success in Bio102 courses. This is a particularly pertinent topic at this time with much of our higher education courses being delivered in an online format.

Thank you for considering my request. If you choose to grant permission, respond by email to jscott38@liberty.edu. A permission letter document is attached for your convenience.

Sincerely,

Jennifer C. Scott
Doctoral candidate, Department of Education
Liberty University

APPENDIX D

Letter of Approval of Data Release

August 14, 2020

Liberty University IRB Officer
1971 University Blvd
Lynchburg, VA 24515

To whom it may concern:
Ms. Jennifer G. Scott has requested student level record data to be analyzed for her dissertation research. As part of practice in providing data to external researchers, we de-identify all records, including removing personal identifiable information (PII). We provide the researchers with random study identifiers for the records. We also request that researchers destroy their records as soon as they have completed their studies.

Sincerely,

Dr. Catherine Finnegan
Assistant Vice Chancellor for Research and Reporting