ABSTRACT

INGLE, KENNETH. Exploring the Impacts on Student Success of Providing Community College Students Laptop Computers: A Propensity Score Matching Approach (Under the direction of Dr. James Bartlett).

The future of the workforce requires post-secondary education and the ability to effectively use technology. Technology has become an integral part of education, business, and daily life. Yet, there remains a digital divide for many individuals. Increasingly, community colleges are using technology in the classroom and as part of the processes required to complete college. However, many students do not have access to the technology resources they need to complete college and compete in today's workforce. The pandemic increased the amount of technology used in higher education and cast a spotlight on the digital divide.

This study explores the impact of loaning a laptop computer to students at a North Carolina community college. This study is important because it is necessary to understand the impact of providing technology to students in helping to close the digital divide and improve student outcomes. Currently, there is limited research into the impact of providing technology resources to community college students. Much of the research to date has focused on K-12 one-to-one programs or technology access programs in the four-year space. Research in the K-12 space has shown that one-to-one programs often have a positive impact on student engagement and academic outcomes. In community colleges, literature has explored the impact of student support services on student outcomes in areas such as last dollar promise programs.

The major research questions of this study examine the impact on performance, retention, and completion for those students who chose to participate in the laptop loan program compared to students who chose not to participate. Research results could help impact the development of

similar programs, inform funding opportunities to increase technology access, and help close the digital divide.

The population for this study consisted of students from a medium to large suburban community college in North Carolina. The college annually serves roughly 20,000 students across a range of curricula, technical, workforce, and transfer programs. The data for this study includes students who were enrolled between the spring of 2020 and the fall of 2022. Students varied in age, gender, race/ethnicity, program, economic status, and other areas. Students self-selected into the laptop loan program and either chose to participate or not participate while enrolled in at least one curriculum course at the college.

The study utilizes propensity score matching to study the impact on outcomes of providing a loaner laptop computer to students. Treatment and control groups were created by analyzing multiple matching models and then determining the strongest match. Logistic regression results indicate the strongest overall match on predictors: gender, age, identifying as Black, Hispanic, or White, receiving Pell, enrolled in a transfer program, enrollment status (full-time or part-time), and enrolled in a summer course. The model was statistically reliable in predicting membership in the treatment and control groups.

The findings of the study indicate that students who participate in the laptop loan program retain at a higher rate, attempt more credits, complete more credits, and take more course sections than students who do not. However, students who participate in the program had a lower GPA than students who did not participate in the program. A limitation of the study is that enough time has not passed to reliably observe the impact of participation on completion of a degree, diploma, or certificate. Future research is needed to determine if results hold true at other community colleges as well as the impact of the program on awards earned long-term.

Exploring the Impacts on Student Success of Providing Community College Students Laptop Computers: A Propensity Score Matching Approach

by
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DEDICATION

I would like to dedicate this dissertation to my loving wife, Amy, for her support and encouragement throughout this entire experience. Without your love, patience, and encouragement this would not have been possible. I am so thankful to have you in my life and to walk this amazing journey with you.

I would also like to dedicate this work to my children, Conner and Adelyn. Every day you would not only encourage me, but would motivate me to show you the importance of education and the opportunity to always learn. Finally, I would like to dedicate this dissertation to my parents. Mom and Dad, thank you for always encouraging me to pursue my educational goals and supporting me through everything.

BIOGRAPHY

Kenneth (Ken) Ingle is a resident of Charlotte, North Carolina where he has lived for almost 30 years. He completed his undergraduate studies at the University of North Carolina at Charlotte where he earned a Bachelor of Science in Business Administration with a concentration in Management Information Systems. Ken continued his studies at Bellevue University in Bellevue, Nebraska, where he completed his Master of Science in Management Information Systems.

Ken currently serves at the Chief Officer of Information Services for Rowan-Cabarrus Community College in Salisbury, North Carolina where he leads Institutional Effectiveness, Planning, and Research as well as Information Technology for the college. He has worked in higher education for more than 17 years and is passionate about helping student achieve their educational goals.

Ken is actively involved with local, state, and national efforts to improve higher education. He is a member of the Aspen College Excellence Program, Rising President's Fellowship (cohort 7) and he currently serves on the Educause CIO advisory committee. He is a member and past president of the North Carolina Community College System Chief Information Officer Association, board member of the Rowan County Chamber of Commerce, and member of Cabarrus Rotary. Ken also serves on several committees and initiatives for the North Carolina Community College System. Ken strives to serve the community and advocate for students in his work.

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CHAPTER 1

INTRODUCTION

Within the next 10 years, 70% of jobs will require some post-secondary education (Lanahan, 2022). Reviewing occupation growth shows that 18 of the 30 fastest-growing occupations require some post-secondary education (Khine, 2019). Amid this labor landscape, there is a greater need than ever for colleges to produce a high-quality, college-educated workforce. To meet the nation's educational needs, higher education must expand its reach to support success for students from all backgrounds, regardless of socio-economic status.

Since 1980 the United States has been underproducing graduates with post-secondary skills. The United States ranks outside of the top ten globally for degree completion in 25-34 year old's, and nationally enrollment continues to decline (Bouchrika, 2022; *Reclaiming the American Dream, Community Colleges, and the Nation's Future*, 2012). Between 2018 and 2019, before the pandemic, college enrollment shrunk by 1.8% (Bouchrika, 2022). While post-secondary attainment is shrinking, income inequality is expanding, with middle-income households shrinking and the wealth gap between upper and middle/lower-income families growing (Mitchell, 2020). Low-income and underserved individuals are disproportionately impacted by education and income gaps. Only 10 percent of families in the bottom income quartile earn a bachelor's degree by the age 26 (Wyner, 2014). Underserved students have also been negatively impacted by the education gap, with 26% of Black or African American individuals and 23% of Hispanic individuals having obtained a bachelor's degree, compared to 45% of white adults (Nietzel, 2022).

Community colleges play a critical role in closing the education and workforce readiness gap (Evans et al., 2020). Community colleges offer low-cost education to more than 13 million students annually (Evans et al., 2020; Wyner, 2014). Community college education has been shown to increase earnings potential by 30 percent over someone with only a high school diploma (Evans et al., 2020; Wyner, 2014). While nearly half of all undergraduate students in the United States are enrolled in a community college, completion, transfer, and retention rates remain low, with less than 50 percent of students completing after 6 years (Evans et al., 2020; *Reclaiming the American Dream, Community Colleges, and the Nation's Future*, 2012). Community colleges serve the most significant share of low-income and underserved post-secondary students in the United States, yet are funded at a rate often lower than four-year colleges and universities (Levesque, 2018; *Reclaiming the American Dream, Community Colleges, and the Nation's Future*, 2012). To improve performance, retention, and completion rates research has identified a need for greater interventions beyond financial support (Evans et al., 2020).

Over the past several years higher education has experienced a digital transformation resulting in the pervasive use of technology. Campuses are increasingly a blended environment of online, technology-enabled instruction combined with traditional in-class experiences (Grajek, 2021). Technology enabled education has transitioned from a projector and computer in the classroom to fully online learning, artificial intelligence-driven education resources, virtual reality, and hybrid learning environments that blend synchronous and asynchronous learning experiences divorced from a specific location and flexible for the learner (Marcus, 2020).

As online education has grown and the use of technology in the classroom expanded, the need for students to have access to a personal computer has continued to expand. As Educause noted in the Top 10 IT Issues of 2022, rapid technology transformation occurs regardless of preference or readiness for change (Grajek, 2021). The American Association of Community

Colleges has identified access to state-of-the-art technology as critical to instructional innovation and excellence in education (*Reclaiming the American Dream, Community Colleges, and the Nation's Future*, 2012). Online training is increasingly popular for employed workers, aligning with the workforce education programs offered by community colleges (*Exploring the Digital Nation: America's Emerging Online Experience*, 2013). While access to technology has grown, many low-income and underrepresented students continue to face challenges accessing the technology needed to complete their program. As the use of technology in the classroom has grown, so has the need to support the understanding, maintaining, and when necessary, repair of technology used for school. Even when students have access to technology, their devices are often old or in need of repair (C. Brown & Haupt, 2018). In one study, 16 to 19 percent of students reported facing a technology barrier (Jaggars et al., 2021). Seventeen percent of adults in the United States are dependent on a cell phone and may not have access to a computer (Jaggars et al., 2021). The digital divide is still challenging for many current and potential students.

Adding to existing challenges, in the spring of 2020, the world began to experience challenges associated with the COVID-19 pandemic. The pandemic disrupted education across the globe forcing colleges to re-evaluate how they deliver instruction while health lockdowns started. Many community colleges transitioned most of their courses online and required students to continue their education remotely as opposed to on-campus (Grajek, 2021). A requirement for a personal computer has expanded even further during the COVID-19 pandemic. The pandemic forced even the most technology-averse faculty members to utilize technology extensively in their courses (Grajek, 2021). Students were forced to complete classes using technologies such as Zoom and to access campus services via the Internet. The pandemic has highlighted digital inequity and changed the long-term use of technology in higher education (Grajek, 2021).

Statement of Problem

One of the most significant challenges facing higher education is ensuring that students have the resources necessary to complete their education (Goldrick-Rab, 2018). Resources can include basic needs such as food and housing, or more education specific needs (Goldrick-Rab, 2018). One of the most prevalent resources required into today's education landscape is access to technology resources (Moore, 2018). Over the last number of years, education has continued to adopt technology-enabled solutions in the classroom.

Technology has become pervasive in daily life. Technology is used for personal banking, connecting to friends, shopping, and many other activities. Technology is transforming industries like healthcare, banking, automotive, services, and even agriculture (N. T. Lee, 2018; Loubier, 2021). Technology is also the foundation for new industries and industry-enabling innovations such as social media, online streaming, artificial intelligence, and machine learning (N. T. Lee, 2020). In 2000 there 740 million cell phone subscriptions worldwide compared to more than 8 billion today (Hillyer, 2020). Technology innovation has also disrupted the job market. Innovations like artificial intelligence are creating an environment where technology can do much of the work better than individual people in industries including dermatologists, insurance claims adjusters, lawyers, seismic testers in oil fields, sports journalists and financial reporters, crew members on guided-missile destroyers, hiring managers, psychological testers, and more (Rainie, 2017). The growth of artificial intelligence and automation in many routine and mechanized tasks has expanded the need for employees in fields like software development and data science (S. Brown & Loprest, 2018).

The workforce has also increasingly supported remote, technology-enabled work for many jobs. The total number of remote workers doubles every 15 years before 2020 (Iacurci, 2022). To hold a remote work job, workers must understand and have access to the technology necessary to complete the work. The pandemic only increased the requirement for workers to have access to and expertise in technology usage. During the peak of the pandemic, workers completed more than 60% of their workdays from home (Iacurci, 2022). While many workers have returned to the office as the pandemic has waned, experts predict remote work will remain popular and have long-lasting impacts on the workforce (Iacurci, 2022).

Technology has become a core part of how businesses function and how people search for and apply for jobs. The Pew Research Center found that more than 79% of job seekers primarily use the Internet to perform their job search (A. Smith, 2015). Of those job seekers, 34% indicated that the resources they found online were the most critical elements of their job search (A. Smith, 2015). The job seeker needs to understand how to create a resume using tools like Microsoft Word, navigate the applicant tracking platforms, and use synchronous online meeting platforms like Zoom for the interview process.

Students must have the technical skills and access necessary to be competitive in the workforce of today and the future. Yet, while technology is widely used and available in modern society, there still exists a digital divide for many students. These requirements exist where low-income and underserved populations have significantly less access to the technology and the connectivity required to be competitive (Moore, 2018). To equip themselves for the modern and future workplace, students need access to technology that enables the acquisition of essential skills and experience with the tools used in the workplace.

Many primary education systems and schools have implemented one-to-one device programs to support students. In the United States, K-12 schools provide at least one computer for every five students (Herold, 2016). There has also been significant growth in four-year universities requiring students to own a laptop computer for coursework (Reisdorf et al., 2020). Each year over 8 billion dollars is spent on technology in education and spending will likely continue to grow (Herold, 2016).

Even as technology has become globally more available, low-income households continue to face challenges owning and accessing technology. Community colleges serve a high number of low-income and underserved students compared to other post-secondary education options. Students have reported that using technology for educational purposes can positively impact educational outcomes. Yet, many students do not have access to the technology they need to succeed (Anderson & Horn, 2012).

More than 41% of low-income individuals do not own a home desktop or laptop computer and 24% do not own a smart phone (Vogels, 2021). In many cases where a family does own a computer, the system is shared between multiple individuals in the household. Forced to use a shared device, a student may not be able to utilize the system to complete their coursework effectively. Just under 25% of adults do not own a smartphone if their household income is less than $30,000 per year (Vogels, 2021). Even when a low-income household owns a computer, they are less likely to have broadband available at home, often depending on libraries, schools, or other shared spaces for connectivity (*Exploring the Digital Nation: America's Emerging Online Experience*, 2013). Households with a lower education level are also less likely to own a computer (*Exploring the Digital Nation: America's Emerging Online Experience*, 2013). Issues with access to technology exist in a landscape where over 90 percent of students indicate laptops are very important for completing their course work (Educause, 2019).

The COVID-19 pandemic has further expanded and accelerated the use of technology in higher education but also set a spotlight on ongoing issues with the digital divide (Klein, 2021). The onset of the pandemic created significant challenges for many students. During the pandemic more than 37% of community college students indicated they were having trouble paying for college (Center for Community College Student Engagement, 2021). In North Carolina a survey showed that 79% of respondents' classes were moved online due to the pandemic (Urquhart, 2020). Most higher education institutions were forced to move classes online in a short amount of time so that students could stay safe while continuing their coursework. During this transition, students desired to choose between face-to-face and online course formats, yet colleges had no choice but to transition to online learning (McKenzie, 2021). More than 29% of the students who remained after this transition did not have reliable access to the internet and other technology necessary to complete coursework (Center for Community College Student Engagement, 2021). This challenge existed in an environment where many students faced extreme financial stress. A survey of North Carolina community college students showed that up to 63% of students could not gain access to $500 within 30 days to cover unexpected expenses (Urquhart, 2020). Faculty found that even when students had access to a computer, it was often not in acceptable working condition to complete all coursework (McKenzie, 2021). For low-income students laptops may have broken keys, limited connectivity, or they may be required to use a cell phone to complete their work (McKenzie, 2021). Repairing broken computers, or obtaining assistance with using technology that may be new or unfamiliar can be expensive when available.

Challenges with access to technology exist in a landscape where many students already need help to succeed. Community colleges are open-door institutions that provide a quality higher education to millions of students every year. Increasing a community's educational attainment benefits the individual and strengthens the community with lower unemployment, decreased crime, and a stronger local economy (Carnevale et al., 2013).

The cost to attend a community college is significantly lower than most four-year colleges and universities, reducing the financial burden for many students to attend. When students need financial assistance, there are frequently resources available to help cover the cost. Yet, many community college students still struggle to succeed (Evans et al., 2020). While financial assistance programs often positively impact student enrollment, they alone have not been shown to have a significant influence on success and completion rates (Evans et al., 2020).

Community college students fail to retain at alarming rates with even higher dropout rates for underserved and low-income students. Less than 40% of low-income community college students graduate within six years (Levesque, 2018). These challenges exist in a landscape where 46% of community college students are attending part-time and community colleges serve the greatest number of low-income and underserved students in higher education (Irwin et al., 2021).

Community colleges must address barriers beyond the financial need to close the post-secondary attainment gap. Many students are working, taking care of family, struggle with food insecurity, face transportation issues, lack the technology resources they need to succeed, or face a myriad of other challenges to completing their education. Wraparound services are critical to the success of low-income and underserved students. Often students may not know how to access these services, or the right services may not be available (Kolenovic et al., 2013).

Providing low-income students with a free loaner laptop for use while enrolled in college is a wraparound service with the potential to impact student outcomes positively. Research has indicated that intrusive support services can have a positive impact on student success (Kolenovic et al., 2013). The specific problem this study addresses is there is a lack of understanding how a laptop loaner program impacts student outcomes. This study will fill that gap by exploring the outcomes of students who are provided a loaner laptop, with ongoing support for the device, in comparison to students who have not received a laptop. If students do not have access to and support for the technology required to complete their college education, then they will be less likely to stay in college, perform adequately in their courses, and graduate, resulting in the further growth in income inequality.

Purpose Statement

The purpose of this study is to evaluate the impact of loaning a computer at no cost to students while enrolled in community college. Specifically, the study will examine the performance [grade-point average], retention, and completion rates increase among students who receive the technology compared to students who do not.

The study will examine the laptop loan program at Wolfpack Community College. Wolfpack's laptop loan program is available at no charge for any enrolled student, providing a laptop to the student for as long as needed so long as the student maintains enrollment at the college. The laptop provided is a Windows 10 laptop with Microsoft Office and other program specific software pre-installed. The program also provides support for participating students during the checkout and setup process, throughout the term as needed, and in the event of a problem with the device.

Student demographics including, but not limited to, age, gender, ethnicity, enrollment status, and financial aid status for students who participated in the laptop loan program will be compared with students who did not participate in the laptop loan program. The study will focus on examining students segmented into two primary groups, those who received a loaner laptop, and those who did not receive a loaner laptop.

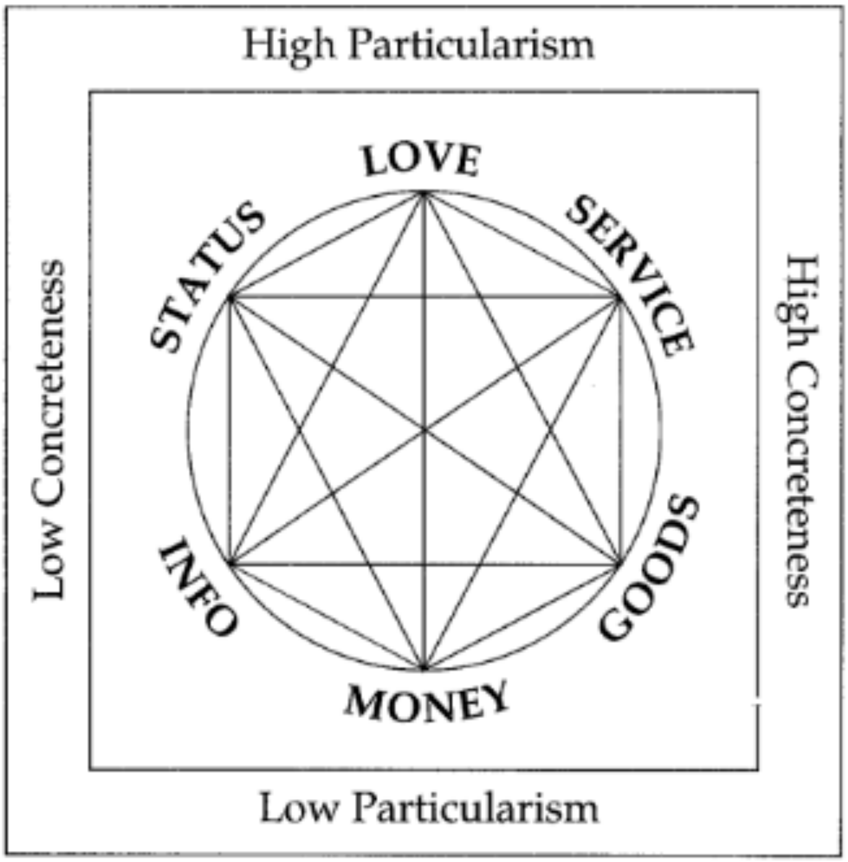
Theoretical Framework

This study uses Resource Theory as a theoretical framework. Resource Theory, initially developed by Foa and Foa, studies the impact of interchanging resources, such as money, for services or information (1980). Resource Theory lends itself well to this study as technology has become pervasive in higher education and a student's ability to use and access technology both on campus and at home to accomplish their desired outcomes represents an integral component of the education experience.

Resource Theory builds on existing social exchange theory. Social exchange theory focused on the exchange of like resources, such as economic resources for economic resources (Dorsch et al., 2017). Resource Theory instead focuses on how an individual will manage resources, which may not be like resources, to accomplish a goal (Dorsch et al., 2017). Figure 2 illustrates the foundation of Resource Theory, the general types of resources and the overall relationship between resources (U. G. Foa et al., 1993).

Figure 1

Illustration of relationship between resources and types of resources central to Resource Theory (U. G. Foa et al., 1993)



Resource Theory does not assume that all resources hold the same value for an individual looking to accomplish a goal, but that some resources are more valuable than other resources in the pursuit of a goal or outcome (E. B. Foa & Foa, 1980). In recent years Resource Theory has been used to study consumer behavior (Dorsch et al., 2017). From this work researchers have expanded their understanding of the characteristics inherent in resource exchange and developed additional resource theories that have contributed to a deeper understanding of the larger concept (Dorsch et al., 2017).

Students must navigate the process to obtain a laptop through the laptop loan program and then have a base familiarity with the operations of a laptop computer to use the system for the completion of coursework. While support resources are made available through the program, ease of use is still foundational to the experience the student will have in the program. Student must understand and effectively use the loaner laptop, or resource, to complete coursework and ultimately achieve the goal of completing their educational program (Dorsch et al., 2017).

For the purposes of this study, resource need directly relates to the requirement for access to a computer to complete required coursework and processes for navigating the college experience. Both online and in-person classes frequently require access to a computer and an Internet connection. Additionally, most colleges have moved many administrative processes such as registration, financial aid management, and online payment.

Access to technology is critical as higher education continues to adopt technology-enhanced tools in the classroom and requires technology to manage the educational process. The study strives to show that community college students who participate in the loaner program perform better and retain at higher rates than students who do not participate in the program. This assertion is based on the staples of Foa and Foa's theory that access to technology resources and associated support services will result in students using that resource to accomplish their academic goals (1980).

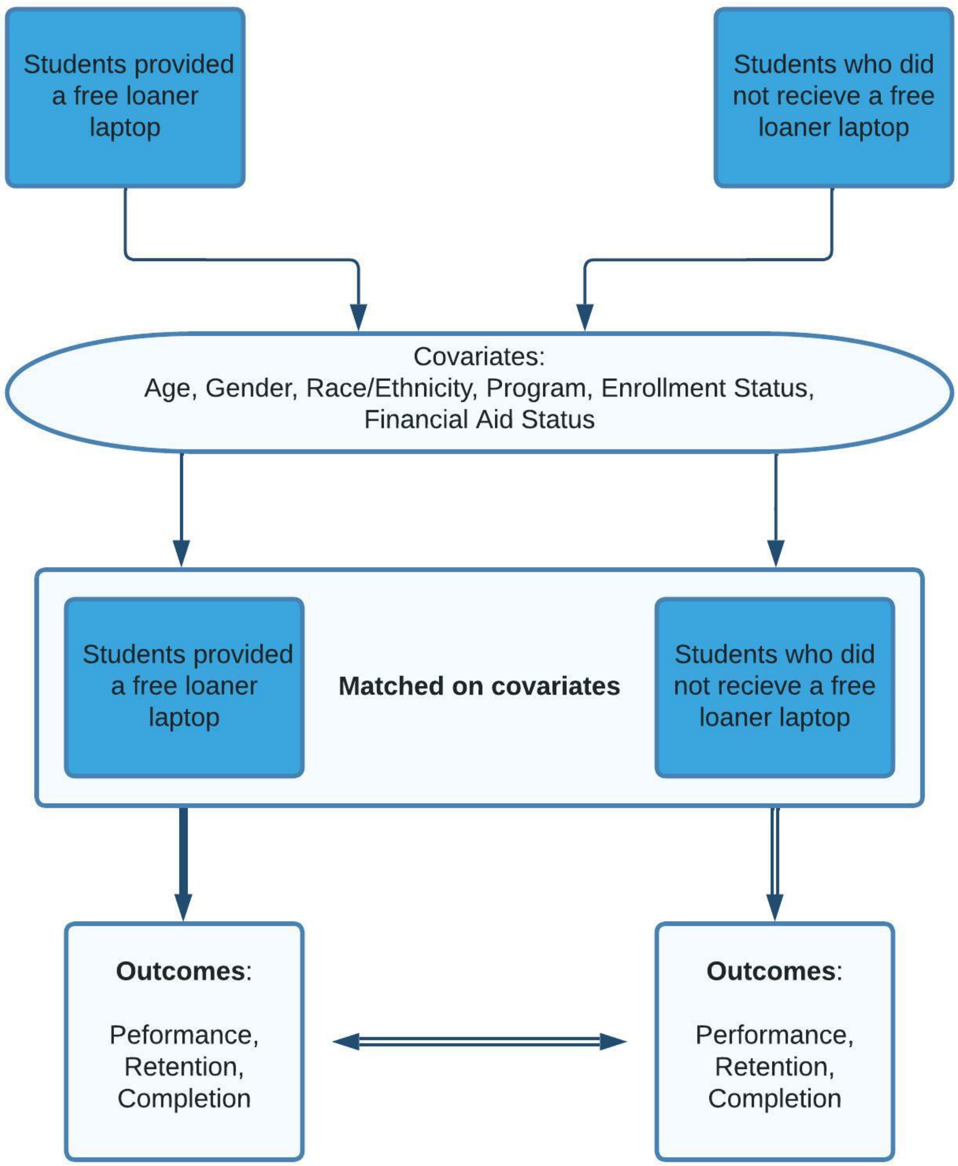
Conceptual Framework

Determining if providing community college students with a loaner laptop will improve student success is an area where research is necessary. Many community college student households are less likely to own a computer or have access to the Internet and as a group, have a lower level of educational attainment (Vogels, 2021). Access to technology is critical for community college students. Research into this topic could help improve student support services and create a stronger case for colleges to invest in technology resources for students.

The conceptual framework for this study details the use of propensity score matching to examine the success rates for community college students who are provided a free loaner laptop compared to community college students who do not participate in the free laptop loan program. The study utilizes a series of co-variates shared between students who participate in the program with students who do not participate in the program. As shown in Figure 1, the conceptual framework includes the population, the treatment variable (being provided a free loaner laptop through the device loan program or not participating in the program), covariates (age, gender, ethnicity, financial status, and others), the propensity score matching process, and the outcome variables.

Figure 2

Conceptual framework describing population of students studied, covariates, propensity score matching, and outcomes studied.



Research Questions

This study explores the performance, retention, and completion impact of providing a computer to community college students. Based on the purpose of the study, the research questions are as follows:

1. How do students who are provided a laptop perform [GPA] compared to those who are not?
2. How do students who are provided a laptop retain from one semester to the following semester compared to students who are not?
3. How do students who are provided a laptop complete a program of study by earning a degree, diploma, or certificate compared to students who are not provided a laptop?

Significance of Study

As education becomes increasingly dependent on technology for teaching and learning, it is important to understand the impact of access to technology on the success rates of community college students. There are many benefits that could result from the outcomes of this research. Providing free loaner laptops to students could result in stronger performance as well as higher retention and completion rates for students who have historically struggled to succeed. Technology is such an integral part of the modern higher education experience that increasing access could also result in a greater feeling of belonging for students who otherwise would not have had easy access to the technology.

Additionally, providing laptops that may be used away from the campus to students could expose other family members to technology and the potential for higher education. It has long been held that education is the gateway to greater economic mobility, yet far too often families are still being left behind (Busteed, 2020). Giving support to students through wrap-around services like the laptop loan program could encourage other family members to pursue higher education.

Effective student support services have been shown to have a strong impact on overall student success. Combining the classroom environment with services to support the student outside of the classroom provides a stronger total learning experience for the student (Busby & Aaron, 2021). Strong support services can help connect students to other students who have similar experiences and create a greater sense of belonging in the college (Bratton, 2019). One of the most significant student support services, financial aid, has proven to help students enroll, persist, and graduate (Boatman & Long, 2016). Support services that connect students to internships, educate on financial wellness, assist with family needs, and address similar student challenges have also been shown to help students focus on school and make greater progress towards their goals (Bratton, 2019). Multiple examples show that wrap-around services, like a laptop loan program, have the potential to positively impact student outcomes. The Wolfpack laptop loan program does not merely provide a device, but supports the device and the student's use of the device throughout their participation in the program.

The research could also prove beneficial for other community colleges exploring similar technology access programs. While many K-12 school districts implemented one-to-one laptop or tablet programs over the last number of years, community colleges have been slower to adopt the same types of programs. Frequently funding has been a barrier for community colleges where resources are often constrained. The onset of the pandemic forced most of higher education to transition completely online and many colleges have continued to have a more significant online presence as the pandemic progresses. Providing students with access to a laptop computer that may be used away from the college campus could prove a valuable tool for college recruitment, retention, and completion. Research that demonstrates the performance and completion benefits associated with a laptop program could help colleges pursue additional funding and create similar programs.

Low-income students have higher rates of technology inadequacy and lower rates of broadband connectivity than students from a higher income (Jaggars et al., 2021). Community colleges serve a greater number of low-income students than any other type of higher education. The research could prove a resource for continued lobbying to expand broadband connectivity to low-income and underserved populations as well as a resource for organizations looking to pursue grants and other funding opportunities to expand access to technology for students who need access. During the pandemic, many colleges and universities loaned laptops and internet hotspots to students (Jaggars et al., 2021). Pursuing long-term funding resources will be essential to maintaining increased access.

Many students need to access support services for their college experience but do not know how, or have taken advantage of the services available (Kolenovic et al., 2013). Over the past 10 years community colleges and higher education in general has experienced a decline in college enrollment (Busteed, 2020). Results from the research will provide data on the overall impact of wrap around services to students and a model for understanding the outcomes associated with the service.

Limitations

Limitations represent elements that cannot be controlled by the researcher. The study evaluates the impact of computers provided to community college students as part of a device loan program. Some students may have already owned a computer or Internet accessible device to complete their academic work. The study cannot account for the capability of, or access to, devices currently available to students who either received or did not receive devices as part of the loan program.

The study does not evaluate factors that may impact success or retention of students outside of the computer loan program. During the study the world experienced a global pandemic that has impacted traditional education processes and delivery methods. While the study does speak to the potential influence of the global pandemic on the educational process, the study does not specifically research or address the global pandemic on the success of the program. Finally, this study limits student records analyzed to those students who are identified as degree seeking. The researcher has no mechanism to confirm if the students have accurately identified as degree seeking.

Delimitations

There are various delimitations inherent in the research study. The study is being performed with data from a single suburban community college in North Carolina and does not represent all community colleges. Study participants are from students enrolled at the community college between 2020 and 2022. The study is limited to students who either received a device from the college's loan program or chose not to participate in the college program and does not explore students who may have received a device from another source or similar program. Additionally, the research focuses solely on access to a college loaned computer, and does not account for Internet access or the quality of Internet connectivity for the student.

Definitions

Retention: For this study, retention is defined as continued enrollment at the same college as measured by the number of courses taken, number of credits attempted, and number of credits earned by a student.

Completion: For this study, completion is defined as the completion of a degree, diploma, or certificate.

Academic Performance: For this study, academic performance is measured by the student's grade point average.

Laptop / Computer: A Microsoft Windows class laptop computer with integrated keyboard, mouse, screen, and wireless / WiFi capabilities. At a minimum the computer is running Microsoft Windows 10 or higher with 4 GB of RAM and an Intel i3 class or greater processor.

Digital Divide: The "gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities" (Jaggars et al., 2021).

Low-Income: Individuals with a household income of less than $30,000 per year as defined by the federal financial aid program.

Propensity Score: "The covariates identified in the logistic regression before PSM are combined into a single summary score whose value ranges between 0.0 and 1.0. A variety of estimation techniques have been used to determine propensity scores; the appropriate technique depends on the number of study groups being examined" (B. J. Frye, 2014a).

Propensity Score Matching: "PSM examines grouped data and the dependent variable is categorical instead of quantitative. Covariate variables are the independent variables with the highest degree of influence on the dependent variable. The use of logistic regression permits the researcher to identify the covariate by using multiple quantitative independent variables to predict the probability of group membership, a dependent variable" (B. J. Frye, 2014a).

Summary

There is a greater need than ever for community college students to have access to technology. Community colleges are a vital resource providing access to higher education for a diverse group of students that would not otherwise have the opportunity to earn a post-secondary education. Over time the use of technology in the classroom has continued to expand and requires that students, regardless of financial status, have access to a laptop to complete college processes and their coursework. Despite this need, many students face significant challenges accessing the technology and broadband necessary to complete their education and compete in the labor market successfully. This study examines the relationship between access to a computer and student success. Student retention rates, grade point averages, and completion rates were used to make this determination.

This chapter began with an introduction of the study, describing important factors of the study including: the nature of the digital divide, student challenges in higher education, the growth of technology in higher education, and the impact COVID-19 has had on colleges. A statement of the problem and purpose statement were provided with a theoretical framework describing the foundation of the research. The research questions, limitations, and delimitations were detailed with the overall significance of the study discussed. The chapter was concluded with a definition of terms and chapter summary.

CHAPTER 2

LITERATURE REVIEW

This chapter provides a detailed review of literature and research on access to resources, technology, and the impact of technology in education. The chapter begins with a review of the community college and enrollment trends in community college education. The chapter then reviews research on retention and overall student success. Examining the impact of technology, the chapter discusses the digital divide, the use of computers in education, the skills necessary to utilize technology effectively, and supporting student technology needs. Finally, the chapter discusses literature related to the use of technology in higher education during the global COVID-19 pandemic and the theoretical foundation for the study. The chapter ends with a review of the impact access to resources has on success in education and a summary of the research reviewed.

Community Colleges

For more than 100 years, community colleges have served as a gateway for students to earn a post-secondary education. Community colleges focus on providing access to higher education for students who may otherwise not have the opportunity to attend college. These students are often underprepared, low-income, or from an underrepresented community (Schneider, 2022). From humble beginnings at the first community college in Joliet, Illinois, community colleges now serve students throughout the United States (Kasper, 2002). The expansion of community colleges across the country has been staggering, with 1,050 community colleges as of 2020 (Edenfield & McBrayer, 2021). Over time the community college has evolved from an extension of high school to an eclectic institution with opportunities ranging from dual enrollment high school courses to workforce education programs customized for local industry partners (Kasper, 2002).

Community colleges are designed as open-access institutions, providing educational opportunities to anyone who applies (Kasper, 2002). The programs and courses offered at the community college are intended to be flexible, with the opportunity to attend classes at different times, locations, and for less money than traditional four-year colleges (Edenfield & McBrayer, 2021). The average cost to attend a community college in 2022 is $3,800, serving as one of the most affordable options available for higher education (Community College Research Center, 2022). This cost is nearly a third of the average public four-year college. Over the past several years, college costs have continued to rise, with 43% of four-year college students requiring a student loan compared to only 15% of community college students (Community College Research Center, 2022). As college affordability has declined, community colleges remain a low-cost option for students (Spica & Biddix, 2021). The continued affordability of community college, coupled with the flexibility offered, has encouraged access to higher education for students who may otherwise not have the opportunity to obtain a post-secondary education (Kasper, 2002). Today more than 40% of post-secondary students attend community colleges, with more than 800,000 associate degrees awarded each year (Edenfield & McBrayer, 2021).

Community College Enrollment

Over time the enrollment landscape for community colleges has continued to evolve. In the early years, community colleges served as an extension of high school (Kasper, 2002). As community colleges expanded, so did enrollments and the programs available. From inception to 1980, community college enrollment grew to over 4.3 million students (Kasper, 2002). As of 2021 there are more than 4.8 million community college students in the United States, representing 29% of total undergraduates (Community College Research Center, 2022). Today community college students range from dual-enrollment high school programs to working adults looking to improve their skills or change careers.

The flexibility of the community college has resulted in a greater number of adult, non-traditional, commuter, and first-generation students (Edenfield & McBrayer, 2021). Community colleges serve a more comprehensive range of students than traditionally seen in four-year colleges and universities (Schneider, 2022). Increasingly community colleges serve low-income and historically underserved students. 67% of community college students or their families make less than $50,000 per year with 37% earning less than $20,000 per year (Community College Research Center, 2022). From 2012 to 2017 enrollment for non-white students declined while the number of Hispanic students has continued to increase, representing over 24% of total community college enrollments (*Community College Enrollment Crisis? Historical Trends in Community College Enrollment*, 2019).

While community colleges have expanded tremendously since their founding in 1909, the last few years have seen a decline in community college enrollment that is anticipated to continue (*Community College Enrollment Crisis? Historical Trends in Community College Enrollment*, 2019). Since the start of the COVID-19 pandemic, college enrollments, both community and four-year colleges, have declined by more than 1 million students (Thomas, 2022). When compared to four-year colleges, community colleges serve a greater number of low-income and historically underserved students. When exploring demographics across the community college landscape, there is a disproportionate impact on low-income and underserved students when enrollment declines. Low-income students represent more than 60% of community college enrollments, and historically marginalized groups represent 55% of students enrolled in community colleges (Community College Research Center, 2022).

Multiple factors impact student enrollment, especially among low-income and historically marginalized students. Unemployment has maintained near-record low levels of less than 4%, and businesses are struggling to find enough workers to fill vacancies (Thomas, 2022). During the pandemic, the wages for high-school students working 15-20 hours per week increased to $15 per hour in many locations reducing motivation to enroll in college (Thomas, 2022). There is also growing concern about the shrinking number of high school graduates nationwide (Baugus, 2020). The students who register while employed often take fewer courses and have reduced schedule flexibility to complete their coursework (Goldrick-Rab, 2018). As a result more than 64% of community college students attend part-time (*2022 Community College Statistics - Data and Trends*, 2021).

Low-income students face challenges not experienced by higher-earning students. Food and housing insecurity, lack of family support, childcare challenges, and basic financial need are all barriers low-income students must overcome (Goldrick-Rab, 2018). There has also been rapid growth in online courses. Where in 2019, 36.4% of students were enrolled in distance education courses, 2020 saw the number jump to 69.5% as the pandemic impacted higher education (National Center for Educational Statistics, 2021). The increasing role of technology in education requires additional skills, resources, and access that frequently are a more significant challenge for low-income and underserved students.

Retention and Completion Challenges

While community college access has dramatically increased over time, retention and completion rates remain alarmingly low. Between the fall of 2020 and 2021, just over 61% of students who first enrolled in 2020 remained enrolled, and only 52% remained at the same college (Community College Research Center, 2022). When exploring these challenges from an equity perspective, the results are even worse, with African American retention rates 10% lower than those of other students (Spica & Biddix, 2021). Retention challenges impact low-income students more acutely than any other higher education sector, with low-income first-generation students representing roughly 30% of total higher education enrollment (Ceyhan et al., 2019).

When exploring retention and completion challenges for college students, common traits become evident and are often unique when compared to four-year college students. Many community college students are low-income with significant financial barriers, require developmental education, struggle to balance work schedules, and lack focus in their program or major (Chen & Hu, 2021). Many of these students face food insecurity and other life challenges (Schneider, 2022). These challenges directly impact the student's success and how they approach higher education. In many cases, these students may take fewer classes, have lower performance, or leave college before completing a program (Spica & Biddix, 2021). Many community college students are first-generation students who do not have a family history of higher education attendance or completion (Ceyhan et al., 2019). Ceyhan (2019) reported that first-generation students are four times more likely to drop out of college than their peers who have family members that attended college and are not low-income. These students face daily challenges that must be solved, yet negatively impacting their ability to focus on completing a post-secondary program (Mechur Karp, 2016).

One of community college students' most common challenges is access to adequate financial resources to complete college. The American Association of Community Colleges (AACC) found that as of 2022, 72% of community college students are solely responsible for the costs of their education compared to 61% of four-year students (*DataPoints: Paying for College on Their Own*, 2022). While the cost of community college is lower compared to many four-year colleges and universities, the cost of education is still a barrier for many students. Nationally 59% of community college students completed the FAFSA (Free Application for Federal Student Aid), a lower rate than any other sector (Community College Research Center, 2022). The financial challenges community college students face often have the greatest impact on underserved communities who attend community college at a higher rate than four-year colleges or universities. Often the income earned by students working part or full-time while attending school does not cover the cost of attendance and basic living needs (Goldrick-Rab, 2018). More than 57% of community college students receive financial aid to help support the cost of attending college (Baugus, 2020). Unfortunately, financial aid frequently does not cover the full cost of attendance and affordability remains a challenge for community college students. Affordability plays a significant role in a student's ability to complete college (Spica & Biddix, 2021).

Another distinction between community college and four-year students is their readiness to attend college academically. A 2016 survey completed by the Center for Community College Student Engagement found that while 86% of community college students believe they are academically prepared for college-level work, in reality 67% of students must take developmental education courses when they enter community college (*DataPoints: Ready–or Not?*, 2016). This is nearly double the number of students needing developmental courses at four-year colleges (Community College Research Center, 2022). Students who need developmental courses to be college ready often take longer to complete or fail to complete all together. After 8 years only 28% of community college students who require developmental education will earn a degree (Jaggars & Stacey, 2014).

Community colleges serve a large number of adult students. Frequently these students are juggling work commitments that may impact retention and completion. Community colleges can help working adults develop new skills or earn credits towards a degree (Lanahan, 2021). Work has been identified as one of the most significant barriers to completing a degree and staying in college for many community college students (A. A. Smith, 2019). For working students, there were several work factors that contributed to challenges in retention and completion. When surveyed, 61% of students who identified work as a primary challenge indicated the number of hours worked did not leave enough time for studying (A. A. Smith, 2019). Other students indicated that work schedules conflicting with classes and resources and schedules not being flexible enough to support college were primary barriers to continuing their education (A. A. Smith, 2019). Student support services play a critical role in helping students who are balancing work and school (Lanahan, 2021). Access to the technology required to complete their coursework is a significant barrier for many working students (Lanahan, 2021). Childcare is another barrier that must be overcome for many students (Lanahan, 2021). The balance of time, resources, work, and family creates significant challenges for adult and working students attempting to complete their education.

Retention concerns are not limited to a student's first year of college. Almost 20% of students will attend multiple years and earn more than 75% of credits towards a degree yet fail to complete their program and subsequently leave college (Chen & Hu, 2021). This occurs in the midst of a labor market desperate for skilled workers requiring a post-secondary education and a higher education system that cannot produce enough graduates to meet the demand (White, 2022). Students who attend full-time complete at a much higher rate than those who attend part-time, yet many community college students are forced to attend part-time due to outside circumstances (Juszkiewicz, 2020). Part-time students are nearly 30% less likely to complete their degree after six years at the same institution compared to full-time students (Juszkiewicz, 2020). After six years of enrollment, less than 40% of community college students earned a certificate or degree (Levesque, 2018). Completion rates for low-income and underserved students are even lower (Carrasco, 2022; Juszkiewicz, 2020).

Many of the challenges faced by low-income and underserved students lead to a feeling that they don't belong, and these students struggle to find their place in the college community. Lack of belonging is most acutely experienced by historically minoritized students (Schneider, 2022). These students often come from underfunded secondary schools, which leaves them unprepared for the rigor required by college work (White, 2022). As a result, these students are frequently required to take remedial courses that historically result in poor performance (Weiss et al., 2019). Community college students requiring remedial education take an average of 2.9 remedial courses within three years of enrolling, with 60% of all students requiring remedial courses (Community College Research Center, 2022). Belonging and institutional attachment has been shown to have a solid link to college retention and completion.

Exploring the reasons for dropping out and lack of completion from an equity perspective highlights additional non-academic challenges faced by students (Baugus, 2020). Without the resources required to complete community college, income and equity gaps will continue to grow.

The Digital Divide

Access to appropriate resources plays a critical role in education. With the growth of online and technology-enabled education, understanding the current state of the digital divide is vitally important. The digital divide is “the gap between those who have and do not have access to computers and the Internet” (Muller, 2022).

Technology has continued to become a central aspect of daily life for many people around the country. Banking, travel, shopping, and many other activities have moved primarily online. Today more than 74% of adults in the United States own a laptop or desktop computer (Alsop, n.d.). When one broadens the perspective to include tablets and smartphones, 92% of households in the United States own a device (*Bureau of Labor Statistics Data*, n.d.). While this may seem like a large number, there remain significant inequities in computer ownership and access to connectivity among low-income, rural, and underserved populations.

Low-income and underserved populations are significantly less likely to own a laptop or desktop computer. The American Community Survey report, administered by the United States Census Bureau, shows that while total household desktop or laptop computer ownership is 77%, Black or African American and Hispanic households are 64% and 67.9% respectively (Martin, 2021). When accounting for income, 50.9% of households earning less than $25,000 per year do not own a laptop or desktop computer (Martin, 2021). Expanding the income range to less than $50,000 annually increases ownership to only 69.1% (Martin, 2021).

Table 1

Desktop or laptop ownership by race/ethnicity and household income

Group	Desktop or Laptop Computer
Race / Ethnicity	
White	81.1%
Black	64.0%
Asian	88.9%
Hispanic (of any race)	67.9%
Household Income	
Less than $25,999	50.9%
$25,000 - $49,000	69.1%
$50,000 - $99,999	84.2%
$100,000 - $149,999	92.8%
$150,000 and more	96.1%

Note. US Census Bureau, 2018 American Community Survey, 1-year estimates.

The digital divide is not limited to device access or ownership. Connectivity remains a challenge for many communities and individuals around the United States. Globally more than 3 billion people still lack access to the Internet (Muller, 2022). In the United States, more than 20 million people do not have a home Internet connection (Winslow, 2019).

Lack of access to technology results in a wide range of negative impacts that most directly impact low-income and underserved populations. Without technology and Internet connectivity, individuals struggle to access healthcare services, employment opportunities, and educational resources (Muller, 2022). Only 44% of households with an income below $30,000 per year have broadband (Winslow, 2019). Cost is a significant barrier to home internet access for low-income individuals, with an average cost of more than $60 per month for broadband access (Wood, 2021).

Community colleges serve a disproportionately large number of low-income and underserved students who are most dramatically impacted by the digital divide. Many community college students face significant financial challenges which affect their ability to purchase a computer or other education materials (Weiss et al., 2019). In many cases, students may have access to a smartphone or another device in the home, but often this device is not sufficient to complete the work required or must be shared between multiple individuals in the family (C. Brown & Haupt, 2018). Students may be required to write papers or perform other tasks on a smartphone where the screen is small, and yet access to a full computer is still necessary to effectively finish the course work (Wood, 2021). Additionally, students who do not have high-speed Internet are at a disadvantage compared to students who do have high-speed Internet access to complete their coursework (Wood, 2021). As more classes move online, proper access to personal computers and high-speed Internet is vital to student engagement and success (Werang & Leba, 2022).

Computers in Education

Colleges have provided access to technology on campus for many years in an effort to expand access to technology for all students. These computers are often found in labs, classrooms, and campus libraries. As early as 1920, classes were being offered over the radio, with the first personal computers starting to enter the classroom by the mid-1980's (*The Evolution of Technology in the Classroom*, n.d.). For the first number of years, computers were available via the campus library and dedicated computer labs (Turnbull et al., 2021). Over time the availability of computers expanded, with computers added to many individual classrooms and workspaces.

The first work to expand access to computers for all students began in the K-12 space. As the availability of computers in the classroom increased, the use of technology in the classroom did not grow at the same rate (Bebell & Kay, 2010). Administrators recognized that greater use and improved outcomes would not occur until all students had access to a computer without the need for the computer to be a shared resource (Bebell & Kay, 2010). Educational leaders believed that if each student had access to a computer, they would be able to utilize the technology regardless of location or time to complete their school work (Heubeck, 2022).

The early 1990s saw the first efforts to provide a laptop to individual students in the K-12 environment (Penuel, 2006). Now commonly referred to as one-to-one programs, the idea was to give a laptop to every K-12 student and to integrate technology into the learning experience (Penuel, 2006). Education leaders believed that increasing the use of computers would help students learn new skills and improve overall classroom efficiency (Bebell & Kay, 2010). The adoption of the Elementary and Secondary Education Act of 2001 bolstered the desire to increase the use of technology in education by requiring schools to prioritize utilizing technology in the delivery of instruction (Davies & West, 2018). It was also believed that one-to-one programs could improve equitable outcomes by decreasing gaps between white students, students of color, and low-income students (Penuel, 2006). The goal of reducing equity gaps and a desire to increase access to technology led to significant investments in laptops for students that continue today (Bebell & Kay, 2010).

Educational leaders also recognized the need to provide professional development to teachers on the use of technology in the classroom. If teachers felt the technology could enhance the learning experience, they were more likely to use the new technology and encourage students to use the computers (Bebell & Kay, 2010). The technology needed to be integrated into the curriculum to provide the most significant impact for students (Warschauer et al., 2004). Where one-to-one programs started as an opportunity to improve access, they have now become a vital part of the education process as the primary tools for accessing and completing assignments, tests, and reviewing course materials (Heubeck, 2022). Over time the introduction of one-to-one programs in the K-12 environment has shown a positive impact on learning outcomes, classroom behavior, student engagement, and even the amount of time students spend on homework at home (Bebell & Kay, 2010).

Like K-12 education, higher education leaders recognized the value of providing access to technology. Colleges and universities have served as pioneers in the development and use of technology. As early as the 1960's colleges started teaching the BASIC programming language on early computers (Atchison, 2021). One of the earliest global computer networks, PLATO, was developed at the University of Illinois and provided communication and education services to connected universities around the world (Bates & Bates, 2015). The early 1990s saw the introduction of the world wide web and the earliest stages of modern online learning. WebCT, which eventually became Blackboard, was introduced as a web-based learning platform during the early 90's (Bates & Bates, 2015). The growth of online education and the adoption of technology in higher education has continued to accelerate, fostering a highly competitive landscape where institutions strive to stay on the cutting edge (Bates & Bates, 2015; *Technology in Education - Higher Education*, n.d.).

As online learning has expanded, so has the need to ensure students have access to technology. Not only must students have access to technology to complete their coursework, but the labor market increasingly demands that students have familiarity with the technology required to succeed in the job market (C. Brown & Haupt, 2018). Online learning also forces faculty to utilize new teaching methods for instruction that previously occurred in person. Hands-on activities must be redesigned for a digital world where a significant portion of the engagement is asynchronous (Turnbull et al., 2021). As early as 1998, numerous universities began requiring students to purchase a laptop (Gates, 1998). Some universities raised tuition as much as $3,000 per year to support the cost of purchasing laptops for incoming students (Gates, 1998). While raising the cost of tuition or fees is an option for many four-year universities, this approach negatively impacts accessibility for low-income students.

Community colleges have also embraced the use of technology in the classroom to support learning. Like universities, online education has expanded significantly over more than twenty years in community colleges. Student computers are effective tools for online learning, note-taking, media consumption, assignment completion, and collaboration (McKenzie, 2021). Community colleges serve a more significant proportion of low-income students and are not in a position to add a high cost to tuition to cover the cost of a computer for every student (McKenzie, 2021). Many community college students resort to using mobile devices, such as a smart phone, to complete coursework (C. Brown & Haupt, 2018). When considering the number of low-income students served by community colleges and the number of low-income individuals who own a computer, it is no surprise that community college students utilize and appreciate computer labs on campus (C. Brown & Haupt, 2018; Martin, 2021). In recent years community colleges have worked to develop programs that increase student laptop availability.

According to one survey the average time per day a laptop was used inside and outside of class for schools was 8.8 hours (Kay & Lauricella, 2011). Students found that laptops increased collaboration and engagement in their class activities (Kay & Lauricella, 2011). Community colleges grapple with increasing access to technology while maintaining affordability for students and institutions. Community colleges must be mindful of the cost of attending college as many students struggle to cover the total cost of attendance (Weiss et al., 2019). Many students who do already own a computer find that the device is not suitable for completing their coursework (C. Brown & Haupt, 2018). Historically, community colleges have provided access through computer labs on campus to bridge the gap for students who otherwise do not own a computer. More recently, institutions have started offering device loan programs and reduced-cost laptop programs to help increase access to technology outside of campus for students (McKenzie, 2021). When the pandemic began, these special access programs accelerated, with many institutions purchasing computers for students to use at home so that each student could continue their course work (McKenzie, 2021).

Technology Skills

The digital divide in higher education is not limited to access but also incorporates the skills necessary to effectively utilize the technology available (*Understanding the Digital Divide in Education*, n.d.). While many colleges have worked to increase access to technology, they must also work to ensure all students and faculty have the skills necessary to take advantage of the technology and support the technology that is being used by the student.

While technology is seemingly ubiquitous in society, nearly 20% of students have reported struggling to learn the educational technology used in their courses (Wood, 2021). Many community college students enter college with more vital technology skills than traditional four-year students yet still frequently lack all the technical skills necessary to succeed in the classroom. This is largely due to the fact that community college students, who are often non-traditional students, have learned skills in the workforce before starting in the community college yet may not know how to use the technology specific to college (Caruso, 2007).

The struggle to ensure students have technology skills also extends into the workforce, where employers still experience challenges with recent graduates not having the technical skills needed to complete the required work (Elliott et al., 2018). Ensuring students have the technical skills necessary to support their classroom work will also positively impact their labor market skills (Vigdor et al., 2014). Skills necessary for today's labor market include office software, programming, and pc maintenance (Vigdor et al., 2014).

To close the technology skills gap, colleges must also ensure that faculty and staff have the technical skills necessary to support students. Faculty often have access to advanced technology but must understand the difference between assisting students in an online class with their technology needs versus students taking a traditional seated class (Polly et al., 2021; Turnbull et al., 2021). Faculty must become proficient in both the pedagogical and technological uses of technology in the classroom environment to effectively support students (Coles et al., 2020; Turnbull et al., 2021). Faculty members must have resources to help them understand how technology can enable student learning and what methods of technology utilization will resonate most effectively with students (Coles et al., 2020). Training efforts for faculty must address the specific needs of their program and fit within the framework of faculty schedules and other responsibilities (Polly et al., 2021). Creating faculty training that has clear goals, aligns pedagogy and programming with the correct technology, and gives multi-modal options for faculty learning will increase faculty participation and enhance faculty's ability to support student technology needs (Coles et al., 2020).

Many colleges have recognized that although students today may have grown up with technology, they often lack familiarity with the educational technology necessary to succeed (Biddle, 2021). Students may own a smartphone or interact with social media, yet not have experience using a learning management platform or managing content through office applications (Biddle, 2021). While students may sometimes lack all of the skills necessary to effectively use the technology, students increasingly expect that technology is integrated into their classroom and general education experience (Coles et al., 2020).

The realization that students need assistance with technology specific to their educational program has led many institutions to explore options for developing these skills. Numerous factors can impact a student's exposure to technology and the development of technology skills. Socio-economic factors have been identified as a significant predictor of technology exposure (Biddle, 2021). The skills gap exists amid substantial growth in online and technology-enabled education. Between 2012 and 2019, there was a 36% increase in online and hybrid students (Diaz-Infante et al., 2022). To close the skill gap, colleges have begun developing programs to help build students' technology skills. Penn State University developed a "Tech Academy" that taught first-year students skills for using word processing systems, learning management systems, and other technology frequently used in the classroom experience (Biddle, 2021). Developing these technology training programs help to increase student engagement and reduce barriers to success for students.

Student Technology Access and Support

Students also need assistance supporting the devices they either own or use as part of the education experience. If the student already owns a device, it may be old, shared with the household, or generally unsuitable for use in an education setting (C. Brown & Haupt, 2018). If the student uses a device provided by the college, they may not have the experience or skills necessary to maintain the device. In a recent survey, 18% of participants indicated that merely getting the technology to work was one of their greatest frustrations while pursuing their education (Diaz-Infante et al., 2022). Historically students also access technology through campus computer labs and other on-campus spaces with dedicated technology. This frequently results in students reverting to the technology they know, such as a smartphone, and attempting to complete work on a less-than-ideal platform (Wood, 2021).

Colleges must adapt technology support to the specific needs of the student and recognize how to provide technology without impacting overall college affordability (Spica & Biddix, 2021; Turnbull et al., 2021). Many students delay the purchase of required materials due to the high cost of education, and adding an additional technology cost could negatively impact equitable access (Spica & Biddix, 2021). A 2014 study in northern California found that providing a computer to low-income community college students increased the probability of the student taking a transferrable course (Fairlie & Grunberg, 2014).

Student engagement is also a significant driver of student success (Werang & Leba, 2022). Increasingly higher education is moving online and requires that students be dependent on technology to complete coursework, register for classes, participate in activities, and generally engage with the college (Diaz-Infante et al., 2022). Traditionally online education has focused on using the learning management system and remains the most popular tool for faculty (Coles et al., 2020). However, online and technology-enabled learning continues to evolve. College programs are now starting to use simulations, massive online courses, and non-academic technologies from companies like Google (Diaz-Infante et al., 2022).

These changes enhance the quality of the technology experience but also require additional support to ensure students have technology that is capable, and that the student can manage the systems. Expanding the use of advanced technology has the potential to address inequities in access for those students who otherwise could not afford the technology

(Warschauer et al., 2004). However, many community college and four-year students do not have access to these systems off-campus and do not have the knowledge to manage the devices and software. Without access to technology, and support for the management of the technology, inequities in higher education could become worse (C. Brown & Haupt, 2018; Warschauer et al., 2004). Providing access to devices for students who otherwise would not have access to technology can enhance engagement, foster a sense of belonging, and prepare students for the workforce (Gierdowski, 2019; Warschauer et al., 2004; Werang & Leba, 2022).

Supporting students' technology requires a multi-faceted approach that recognizes the distinct challenges faced by low-income and underserved students while also building a network to extend support throughout their student experience (Diaz-Infante et al., 2022; Turnbull et al., 2021). Once students have access to technology, many report having trouble learning how to effectively use and manage the technology (Wood, 2021). Merely having the technology available for students is not sufficient (Schneider, 2022). Successful colleges make non-academic support services a core part of the student experience (Mechur Karp, 2016; Schneider, 2022). Research has shown there is a strong connection between effective support services and student success (Balkcum, 2014). The continued growth of online education also forces institutions to recognize that a student may never step on campus to receive support. As a result, colleges must create services that are easy to use and accessible regardless of location (Diaz-Infante et al., 2022).

COVID-19 Impact on Technology and Education

At the start of 2020, the world began to face the reality of the global COVID-19 pandemic (O’Donnell et al., 2020). The COVID-19 pandemic has resulted in higher education experiencing numerous challenges that have impacted students’ ability to complete college. The pandemic has negatively impacted enrollment, shocked the global economy, affected college affordability, seen the rapid transition of students to an online first model, and magnified inequities that disadvantaged underserved and low-income students (Finkel, 2021).

The pandemic has caused tremendous challenges for students and families. At the start of the pandemic, more than ten million people lost their job, and more than twenty million households experienced food insecurity (Center on Budget and Policy Priorities, 2022). While over time government assistance helped to stem the economic tide and some workers were able to find work, the ongoing pandemic, supply chain challenges, and rising inflation continued to create challenges for individuals and families (Center on Budget and Policy Priorities, 2022).

Low-income and underserved communities were the hardest hit during the pandemic (O’Donnell et al., 2020). More than 25% of adults reported having trouble covering basic expenses, with Black and Latino adults reporting even higher at 44% and 38% (O’Donnell et al., 2020). Employment disruption most significantly impacted low-wage jobs at a loss of 4.5%, more than double any other job sector (O’Donnell et al., 2020).

The pandemic resulted in massive disruption to higher education. Many colleges were forced to move most of the coursework online and shut down on-campus operations. These disruptions acted as an accelerator toward technology-enabled education and online learning. Uncertainty created by the pandemic also impacted the number of courses being taken by students, with many taking fewer courses or choosing employment over college (Finkel, 2021). Students who did attend college missed the opportunity to engage with faculty and receive feedback in-person (McKenzie, 2021).

A growing body of literature has explored the impact of the pandemic on education and the part that technology played in responding to the challenges of the pandemic. The pandemic highlighted equity challenges with access to the resources necessary to complete a college program (Finkel, 2021). Many students lacked the Internet access and technology required for their coursework. With most curricula transitioning online, students were not able to come to the campus to access tools they did not already have at home (McKenzie, 2021; Muller, 2022; Wood, 2021). Additionally, institutions recognized that faculty and students needed training and assistance with transitioning to an online first format for coursework (Turnbull et al., 2021). The University at California-Berkely found that 14% of undergraduate students did not have the technical skills necessary for online learning (Wood, 2021). Colleges made significant investments in tools like Zoom to support online learning during the pandemic (Turnbull et al., 2021). Faculty and students needed assistance with online learning tools, access to technology, and ongoing technical support to be successful (Turnbull et al., 2021).

As government lockdowns began, many institutions started exploring laptop loan programs to help students continue their coursework while off campus (Finkel, 2021). An Inside Higher Ed survey found that more than 20% of participating students struggled with connectivity, software, or hardware issues when the pandemic forced their courses online (McKenzie, 2021). Students were required to share a family computer, complete work on a smartphone or use an otherwise underpowered, old, or broken device (Calarco, 2018; McKenzie, 2021). Thirteen percent of adults with an income below $30,000 per year did not have access to a desktop computer, laptop, tablet, or smartphone (Wood, 2021). College programs that provided a laptop to students would presumably address these technical challenges.

The approach to a laptop giveaway or loan program took different forms at different locations. Ivy Tech in Indiana had a raffle on their Facebook page, some colleges looked to adjust their cost of attendance by making laptops required, while other colleges contracted with external vendors to provide laptops for students (McKenzie, 2021). The University of California, Davis, purchased more than 600 laptops and reached out to 10,000 financial aid students notifying them of the availability of a loaner laptop (McKenzie, 2021). Numerous community colleges and four-year institutions around the country developed similar programs to assist students who otherwise would not have had access to a stable computer. Lehman College, a part of the CUNY system, provided loaner laptops to students with one student commenting:

> "I cannot think of the appropriate way to say this, but thank you. Thank you so much. You saved my life, the entire academic term, my graduation for next year, and all my future prospects. You are lifesavers indeed." (Lutolf, 2020)

Resource Theory

Resource theory operates as the theoretical foundation for this study. For the development of the study, it was important to select a theory that illustrates the potential of connection between obtaining a resource, in this case a laptop, and successfully retaining and completing a community college education.

When exploring the impact of technology on the community college experience, researchers have access to multiple theories. One frequently utilized theory in higher education research related to technology is the Technology Acceptance Model (TAM). The Technology Acceptance Model focuses on the usefulness and ease of use of a specific technology for students (Davis, 1989). Other theories, such as Connectivism and Tinto's Theory of Student Departure, are less frequently used but explore areas including why students leave college, how technology shapes the way we learn, and how technology can be used to enhance the learning experience (Goldie, 2016; Milem & Berger, 1997). Although these theories provide valuable insights into the role of technology in community college education, they tend to focus more on the impact and resulting behaviors of students rather than on the connection to specific outcomes. This study aims to explore whether access to technology and corresponding support services will result in better outcomes for students. As a result, Resource Theory was selected for this study to explore the potential direct connection between technology resources, in this case, a laptop, and student outcomes.

Resource theory provides a foundation for determining how an individual will manage resources to attain a desired outcome (Dorsch et al., 2017). Building upon the study of social exchange theory, Foa and Foa developed social resource theory to study the impact of the interchange between money and service or information resources (1980). Foa and Foa identified six resource classes that may be transacted: love, status, information, money, goods, and services (1980).

Actions result in the transfer of resources and subsequently impact social behavior (E. B. Foa & Foa, 1980). Resources may be tangible in nature, such as a computer, or intangible, such as knowledge (Dorsch et al., 2017). Resource characteristics impact the implications of resource theory with inherent characteristics such as stickiness, fungibility, divisibility and depletion, as well as situational characteristics such as assembly, valence, and availability (Dorsch et al., 2017). From this foundation, additional resource theories were developed speaking to business, psychology, and social psychology behavior (Dorsch et al., 2017).

When exploring the impact of providing a laptop to low-income and underserved students, with the goal of improving student outcomes, Resource-Based Theory of the Firm provides the foundation. Resource-Based Theory of the Firm (RBT) explores how a resource is used to accomplish a goal (Dorsch et al., 2017). Initially developed to explore how an organization may gain a competitive advantage in the market, the framework may also be used to examine how being provided with a computer may impact student outcomes (Dorsch et al., 2017). Application of the theory within the study can be used to examine the value of the device, but the services associated with the device through the loan program.

One to One Computer Resources and Student Outcomes

While research has established the background and growth of providing technology in the educational setting, there has been limited research completed on the student success outcomes associated with providing technology resources in the community college context. One-to-one programs have existed in the K-12 space for a number of years and have had a greater number of studies exploring the connection between providing technology resources and positive student outcomes. In the K-12 space one-to-one programs have been seen as a way to address equity gaps for children who may otherwise not have access to technology (Power et al., 2020). School systems and local leaders who direct funding have made significant investments in devices for students. An EdWeek Research Center survey found that 85% of parents who responded felt that their school district had enough devices to provide one for all students (Stone, 2022). A technology leader in Bellevue school district in Washington stated:

> “Teachers no longer have to fight for labs and carts, nor do they have to book time for shared devices, Now the access is just assumed.” (Stone, 2022)

In Texas, the Technology Immersion Pilot (TIP) invested $20 million in a technology program for high need middle schools. This competitive grant provided 21 schools with laptops, software, and other technology support resources for every student and teacher between grades 6 and 8 (Shapley et al., 2010). The program compared student outcomes in math and reading between the 21 schools who were awarded the grant, and 21 schools who did not receive the grant. After four years, access to technology and the use of technology indicated a positive impact on both reading and math performance (Shapley et al., 2010).

A similar study in California explored the impact on English and language arts performance for fourth-grade students who were provided access to a laptop one-to-one program. Nationally fourth-grade student achievement in English and language arts is decreasing (Suhr et al., 2010). Results from the study showed stronger performance in English and language arts for students who participated in the one-to-one program versus students participating in a traditional program (Suhr et al., 2010).

In Florida, researchers found that participation in a one-to-one program increased engagement for rural students (Power et al., 2020). Similarly, in North Carolina researchers studied the impact of one-to-one initiatives on students with special needs in 18 high schools (Corn et al., 2012). Findings showed improvements in student organization, confidence, and communication as a result of the one-to-one program (Corn et al., 2012). In New York researchers examined results from a low-income, urban New York City school participating in the Microsoft Anytime, Anywhere Learning program (Mouza, 2008). In this study, 94% of participants were Hispanic and qualified for free lunch (Mouza, 2008). Researchers found that students were more engaged and found new ways to use technology in their learning experience (Mouza, 2008). Additionally, researchers found that students participating in the program improved math and writing skills compared to students who did not participate in the program (Mouza, 2008).

While focused on K-12 education, these studies are part of a growing body of research that demonstrate a link between access to technology resources and improved student outcomes regardless of geographic location. These studies also demonstrate the ability of technology to improve equitable outcomes by demonstrating outcome gains for low-income and historically minoritized student populations.

Community colleges face unique challenges that distinguish a one-to-one computer experience for students compared to K-12 schools and four-year colleges. As discussed previously in the review of literature, community college students frequently work while also attending college, need more developmental education to be prepared for college, have limited access to technology resources, and often attend with greater financial challenges to help pay college expenses. All of these, and other factors, not only impact educational outcomes but also how technology is used to help improve student education outcomes.

Community colleges frequently receive lower funding compared to other types of institutions while educating some of the most vulnerable and underprepared students (Melguizo et al., 2017). Where four-year colleges will frequently add fees or tuition increases to compel a laptop purchase by students, and many K-12 systems have adopted a full one-to-one device approach for all grade levels, community college students are frequently struggling to pay for basic life expenses much less purchase a computer (Urquhart, 2020). As a result, many community college students either lack access to a computer, are forced to visit the college to use a computer or must share a computer with other members of their household. The Center for Equity in Learning found that 24% of low-income students have access to only one device at home and that 14% of low-income students only have access to a smartphone (Moore, 2018). Students who rely on financial aid to assist with at least 50% of their college cost are 6.2 more likely to not own a laptop computer (Reisdorf et al., 2020). Prior to the pandemic a growing number of community colleges were creating device loan or reduced cost purchase programs. During the pandemic these device support programs began to expand as federal funding became available to support students displaced into a remote learning environment (Urquhart & Hahn, 2020).

While some research studies have been completed exploring the benefits of technology in community colleges, there still exists a gap in research on the direct impact of technology and the corresponding support services on college retention and success. In 2017 Michigan State University implemented a laptop requirement for all students and began a study to examine the characteristics of students who did and did not have a laptop as well as the resulting academic performance from the program implementation (Reisdorf et al., 2020). Researchers found that students who did not already own a laptop were primarily low-income and underserved populations without a family history of educational attainment (Reisdorf et al., 2020). Cost was identified as the most significant barrier to laptop ownership for the students who did not have a laptop prior to the start of the requirement (Reisdorf et al., 2020). While the study did not examine the potential impact to performance for students who did own a laptop, results showed that students who did not own a laptop had a lower GPA and overall negative impact on student performance (Reisdorf et al., 2020).

The results observed at Michigan State University align with larger scale feedback around the importance of devices to the modern education experience. Educause found that 90% of students in a 2018 student study indicated laptops are extremely important for their coursework (Gierdowski, 2019). Of the community college survey participants 85% reported using laptops for all or most of their coursework (Gierdowski, 2019).

Non-Academic Resources and Outcomes

While limited research exists on providing laptops as a resource to impact educational performance, retention, and success in the higher education context, the exploration of other higher education support resources illustrates the connection to Resource Theory.

Promise programs are a financial resource that looks to close the financial gap between financial aid and the total cost of attending college. In 2010, Tennessee passed the Complete College Tennessee Act which looked to address higher education challenges and improve articulation, create outcomes-based funding, and strengthen remedial education (J. F. Smith & Bowyer, 2016). Following this legislation, the state created the Tennessee Promise program. The Tennessee Promise program provides free postsecondary education through the associate's degree level (J. F. Smith & Bowyer, 2016). Applicants to the program were required to attend a community college, complete eight hours of community service, and attend two mandatory meetings with mentors (J. F. Smith & Bowyer, 2016). Initial results showed an increase in college enrollment of 4.6 percent and a FASFA completion increase of 7.7% between 2014 and 2015 (J. F. Smith & Bowyer, 2016). The first two cohorts of the program completed with a graduation rate of 35%-36% within 3 years compared to the national average of 32.6% (J. Lee et al., 2022).

In 2015 Oregon implemented Oregon Promise, a last-dollar tuition assistance program similar to the Tennessee Promise program (J. Lee et al., 2022). The Oregon program covered tuition for qualifying students who had a 2.5 or better high school GPA, filed a FAFSA, lived in Oregon for at least 1 year, immediately enrolled in college, attended a first-year experience course, as well as other similar requirements (J. Lee et al., 2022). Where Tennessee Promise was restricted to full-time students, Oregon Promise was also available for part-time students looking to attend college (J. Lee et al., 2022). Following the start of the program in-state community college enrollment increased by four to five percentage points (J. Lee et al., 2022).

Tennessee and Oregon are not alone in the development of college promise programs that support student financial needs. Programs have been developed in New York, Arkansas, Oklahoma, Wisconsin, Michigan, Connecticut, and Pennsylvania (Bell, 2021). The program in Kalamazoo Michigan resulted in more credits attempted, higher persistence, and increases in credential attainment (Bell, 2021). Similarly, programs in Pennsylvania and Wisconsin increased enrollment, persistence, and credential attainment (Bell, 2021).

Financial support programs are not the only examples of non-academic assistance that show the potential impact of resources on outcomes. As early as 1996, community colleges created orientation courses, or student success courses, to help students acclimate to the higher education environment (Crisp & Taggart, 2013). These courses are designed to help students develop study skills, identify learning styles, develop strategies for success, understand college health and wellbeing, prepare for career alignment, and identify other resources to help with their college journey (Crisp & Taggart, 2013). These courses sat outside of the typical program curriculum and over the years have gained popularity (Crisp & Taggart, 2013). Results from these programs have shown a connection to positive student outcomes. Students who have completed a student success course are more likely to stay in college, complete a credential, or transfer to a four-year university (Crisp & Taggart, 2013).

Resource Theory examines how a resource will be used to achieve a desired goal (Dorsch et al., 2017). While the literature on device loan programs and student outcomes in the higher education context is limited, the literature reviewed in K-12 one-to-one laptop programs and higher education support service programs demonstrates the connection between resources and outcome achievement.

Summary

Technology has increasingly become an integral component to completing a community college education. Without access to the required technology resources and skills to effectively use the technology, student success could be negatively impacted. This chapter discussed the history of community colleges and the changing landscape of community college enrollment over time. The chapter also reviewed community college students' retention and completion challenges. The chapter highlighted the equity gaps faced by low-income and underserved students when exploring college enrollment, retention, and completion.

Chapter 2 then reviewed the current landscape of the digital divide in an increasingly digital world. The discussion of the digital divide highlighted the significant gap in computer ownership and Internet access for low-income individuals compared to all other income brackets. The chapter then reviewed the literature on the use of computers in education, the importance of students and faculty having the skills necessary to use the technology, and the importance of supporting, not merely providing the technology.

The chapter concluded with a discussion of the pandemic's impact on the use of technology in higher education, the theoretical foundation, Resource Theory, for the study, and applications of theory to evaluate outcomes in both one-to-one computer programs and other non-academic support programs.

CHAPTER 3

METHODS

This study uses propensity score matching (PSM) to measure the impact of a laptop loan program on student performance, retention, and completion for two groups of students at Wolfpack Community College (pseudonym). The first cohort, Group A, includes students who participate in the Wolfpack student laptop loan program. The second cohort, Group B, comprises students who did not participate in the Wolfpack laptop loan program. The data examined focuses on outcomes related to performance, retention, and completion.

Methodology Selection

When working to measure the effect of an intervention on a group, the most effective mechanism for the study is a randomized experiment (Yanovitzky et al., 2008). For a randomized experiment to be successful, the researcher must provide a treatment to a randomly selected group and withhold treatment from a like, randomly selected group (Yanovitzky et al., 2008). When studying education, it is often impossible to create experimental designs and random trials due to the ethical considerations that arise when providing treatment to one group of students without providing the same treatment to another group of students (Titus, 2007).

Higher education studies frequently utilize data that may be impacted by selection bias, or other threats to validity in a study (Titus, 2007). For this study, individuals in the laptop loan program can self-select to participate in the program. As a result, the researcher is not able to randomly assign individuals to the program, and results may be biased by self-selection into the program (Yanovitzky et al., 2008). Treatment groups may differ from one another due to the likelihood of being assigned to a treatment group as a result of other factors (Rosenbaum & Rubin, 1983).

To overcome the inability to create a true random control study, other statistical methods for results analysis were explored. Historically, methods such as standard multiple regression, ANCOVA, structural equation modeling, matching, and the instrumental variable approach have been utilized by researchers (Lane et al., 2012; Yanovitzky et al., 2008). While valuable in many circumstances, these methods frequently fall short when performing observational studies where randomized controls are unavailable. Structural equation modeling is unable to account for all background variables, while the instrument variable approach requires the researcher to identify what variables impact the outcome and must assume that there are no other confounding variables that may also have an impact (Lane et al., 2012; Yanovitzky et al., 2008). Similarly, standard multiple regression must assume that the relationship between the outcome and covariates follows a linear or logistic function (Yanovitzky et al., 2008). Standard multiple regression also faces a challenge where the more covariates that exist in a model, the fewer degrees of freedom available for analysis (Yanovitzky et al., 2008).

Propensity score matching overcomes many of the pitfall associated with other methods by creating a balancing score that allows for the direct comparison between control and treatment groups (Rosenbaum & Rubin, 1983).

Propensity Score Matching

Propensity score matching provides a mechanism for comparing groups by simulating an experimental design, and testing what would happen to a group both receiving a treatment and not receiving a specific treatment (B. E. Frye & Bartlett, 2017). Propensity score matching was first introduced in 1983 by Paul Rosenbaum and Donald Rubin, who were researchers at the University of Wisconsin and the University of Chicago (Rosenbaum & Rubin, 1983). Grounded in Rubin’s counterfactual framework, propensity score matching is a statistical approach that balances participants between treatment groups by determining the probability of a participant being assigned to a specific group (Lane et al., 2012). Propensity score matching was developed to overcome the shortcomings of other research methods when an experimental design must be simulated. Propensity score matching “assures groups with different levels of treatment are balanced on all covariates” (Yanovitzky et al., 2008).

Propensity score matching was initially utilized in the fields of medicine, statistics, and economics. More recently propensity score matching has been used to study education (Lane et al., 2012). Propensity score matching has been recognized by the United States Department of Education as an accepted and recommended method for educational research (Lane et al., 2012). While the Department of Education has acknowledged propensity score matching, there is still greater opportunity to use the method in the education field (Lane et al., 2012).

Propensity score matching offers many benefits over other research methods. First, propensity score matching eases complications that occur when performing regression analysis on a large number of covariates (Yanovitzky et al., 2008). Propensity score matching allows the researcher to compare groups with a relatively small number of matching variables to determine the effect of a treatment (Titus, 2007). Propensity score matching also accounts for covariates that do not have a linear or logistic relationship with the outcome and accounts for selection bias by adjusting for effects on multiple outcomes, while still able to be used with other statistical methods for results interpretation (Yanovitzky et al., 2008).

Research Design

This study utilizes propensity score matching to explore the relationship between participation in the Wolfpack laptop loan program and performance, retention, and completion. In the study, propensity score matching uses data from the college student population at large, including both participants and non-participants in the program, to create nearly equivalent experimental and control groups that overcome the risks of selection bias, ethical concerns, and lack of random selection (B. E. Frye & Bartlett, 2017; Yanovitzky et al., 2008).

To start the analysis process, the data will first be screened using standard statistical analysis methods (B. E. Frye & Bartlett, 2017). The researcher must complete frequency analysis, check for multivariate and univariate outliers, screen for missing data resulting in listwise deletions, and check for multi-collinearity (B. E. Frye & Bartlett, 2017; Rojewski et al., 2010).

After completing the initial screening process, the independent variables for the study will be identified and code (Rojewski et al., 2010). This study evaluates results for participants in the Wolfpack laptop loan program compared to students who did not participate in the program. Outcomes to be measured for this study are:

1. Grade point average as measured by a continuous variable on a scale of 0.0 to 4.0
2. Retention as measured by the continued enrollment in the college, number of courses taken, number of credits attempted, and number of credits earned
3. Completion of a degree, diploma, or certificate

Once the identification of independent variables has been completed, the next step is to identify significant covariates using stepwise logistic regression (B. E. Frye & Bartlett, 2017). Logistic regression will be used to determine the variables that create membership in the treatment and control group (B. J. Frye, 2014b).

Following the identification and removal of outliers, the distribution of propensity score estimation values will be examined (B. E. Frye & Bartlett, 2017). For this study, propensity score represents the probability of participating in the Wolfpack laptop loan program and improving

GPA, retaining, and completing a degree, diploma, or certificate (Rojewski et al., 2010). There are various estimation methods available and no clear consensus on which method is best (Titus, 2007). Nearest neighbor matching will be used to determine the variance of the model based on prior use from other studies on education (B. E. Frye & Bartlett, 2017; Rojewski et al., 2010). Standardized bias values will be examined for each covariate. Values below 0.1 for each covariate will indicate good balance, while any value above 0.1 will result in additional matching attempts to create the strongest match.

Through completion of propensity score matching, data will be analyzed with the impact of bias reduced to the greatest degree possible since a randomized control trial is not available (Staffa & Zurakowski, 2018). Finally, t-tests and chi-square methods will be used to determine which, if any, covariates impact either the treatment group or control group (B. E. Frye & Bartlett, 2017; B. J. Frye, 2014b). All students who registered for a course between the spring of 2020 and fall of 2022 who participated in the laptop loan program at Wolfpack Community college will be examined.

Institutional Description

Wolfpack Community College (pseudonym) is a sub-urban community college in western North Carolina. Wolfpack Community College is part of the 58 college, North Carolina Community College System. Wolfpack Community College was founded in 1963 as Wolfpack Technical College, focused on providing technical programs to a rural North Carolina county. Over time the college expanded the programs available, and the area served, expanding from a single county to two county service area. In 1988 the college’s board voted to change the college from Wolfpack Technical College to Wolfpack Community College. Wolfpack is a college accredited by the Southern Association of Community Colleges Commission on Colleges

(SACSCOC) offering associates degrees, diplomas, and certificates across multiple campuses in a multi-county service area.

Wolfpack enrolls roughly 20,000 students per year across credit and non-credit programs with an average annual FTE of over 6,500. Wolfpack offers more than 40 programs across multiple disciplines, including business, technology, health, public services, and engineering technologies. Curriculum programs represent the majority of Wolfpack's FTE. Curriculum students are 64% female and 36% male. Students served represent a variety of ages, with 73% of students under the age of 25, and race / ethnicities with the three largest groups of students identifying as 53% White, 20% Black or African American, and 16% Hispanic. Of students who start at Wolfpack Community College, 52% are unemployed and 67% of new students receive some type of financial aid.

Participants

This study examines student success measure results, including grade point average (GPA), retention, and completion for two primary groups of participants, those who participated in the Wolfpack Community College laptop loan program and those who did not participate in the laptop program.

Participation in the Wolfpack laptop loan program was completely voluntary and requires participants to have registered for at least one, credit-bearing course any semester from the spring of 2020 to the fall of 2022. Students who participated in the program were provided a Windows 10 laptop with Microsoft Office and any program-specific software required to complete their coursework. When a student joined the loan program, they were required to visit the information technology support desk to check out the computer, receive brief instructions on how to use the computer, and complete the necessary paperwork to participate. Students were provided support as needed for any technical challenges, usage assistance, or other technology-related support needed during the term. If the student had any trouble with the device they could return the device to the help desk for another device. The program was offered to Wolfpack Community College students at no cost.

All remaining students who did not participate in the Wolfpack laptop loan program and were registered for at least one credit-bearing course any semester between spring of 2020 to fall of 2022 were included in the data. To successfully complete the propensity score matching, additional variables were collected for each participant including age, gender, race/ethnicity, financial aid status, enrollment, and course performance.

Data Sources

North Carolina community colleges are required to use Ellucian Colleague as their primary student information system for all credit bearing courses. All student demographic data including birth date, race / ethnicity, and gender were collected during the student's application process and stored in the Ellucian Colleague system at the college. Student performance data with calculated grade point average (GPA), enrollment status, and completion status were managed in the college's Ellucian Colleague system. Financial aid status was determined through the Free Application for Federal Student Aid (FAFSA) application process and managed through the Ellucian Colleague system. All demographic, performance, enrollment, and financial aid status data was exported from the college's Ellucian Colleague system into an excel format that could be used in the SPSS statistical analysis software.

Participation in the Wolfpack laptop loan program was monitored within Wolfpack Community College's information technology department. Participation data in the program (student id, laptop check out date, and laptop check out term) were collected from the information technology departments tracking system. The data were placed into an excel spreadsheet for import and analysis with SPSS.

Variables

This study explores the student success measures impact of providing laptop computers to community college students compared to students who did not participate in the laptop computer program. Table 2 provides a summary of all variables used and the coding method used for each variable included.

Independent Variables

This study examines the relationship between academic performance, retention and completion for students who received a laptop as part of the laptop loan program versus those students who did not participate in the laptop loan program. If the student participated in the laptop loan program, they were coded with a 1. If the student did not participate in the laptop loan program, they were coded with a 0.

Dependent Variables

This study evaluates the student performance, retention, and completion for students who participated in the loaner laptop program versus students who did not participate in the program.

Performance. Performance is measured using the student's grade point average (GPA) and retrieved from the college's student information system. GPA is coded on a numeric scale between 0.0 and 4.0.

Retention. The student's retention is measured as continued enrollment in the same institution from one academic term to the next (fall and spring). If the student retained the result was coded as a 1, if the student did not retain the result was coded as a 0.

Completion. Students who completed a degree, diploma, or certificate between the spring of 2020 and fall of 2022. Students who completed were coded with a 1 where students who did not complete were coded with a 0.

Credits Attempted. The total number of credits attempted by the student between the spring of 2020 and fall of 2022.

Credits Earned. The total number of credits successfully completed by the student between the spring of 2020 and fall of 2022.

Sections Taken. The total number of sections taken by a student between the spring of 2020 and fall of 2022.

Course Pass Rate. The calculated average pass rate for all courses taken by the student between the spring of 2020 and fall of 2022.

Covariate Variables

The study utilized the variables of age, gender, race / ethnicity, enrollment status, and financial aid status to create matching groups for the propensity score matching process.

Age. Students were categorized into two age categories with students under the age of 25 at time of admittance to the college coded as 1, and students 25 years of age and older at time of admittance to the college coded as a 0.

Gender. Female students were coded as 1 and male students were coded as 0.

Race / ethnicity. All students with a race / ethnicity other than white are coded with a 1, with white students coded with a 0.

Enrollment status. Enrollment status is defined as a student attending at least one curriculum course during a given term included in the study. Students attending at least one credit bearing course in a term coded with a 1, and those not attending at least one credit bearing course in a given term coded with a 0.

Enrollment type. Students who were enrolled in a full-time load for 3 or more fall or spring terms are identified as full-time students and coded with a 0. Students who did not attend full-time 3 or more fall or spring terms are identified as part-time students and coded with a 1.

Financial aid status. Students who qualify to receive federal student financial aid were coded with a 1. Students who did not qualify to receive federal student financial aid were coded with a 0.

Transfer program. Students who are enrolled in an identified transfer program at the college. Students enrolled in a transfer program were coded with a 1. Student who were not enrolled in a transfer program were coded with a 0.

Enrolled in summer. Students who have enrolled in at least one summer term during their time attending the college. Students who met the summer enrollment criteria are coded with a 1. Students who did not enroll in at least one summer term were coded with a 0.

Table 2

Variables used in the study

Variable Name	Definition	Coding
Participating in the Wolfpack laptop loan program	Students who have participated in the Wolfpack laptop loan program	1 = Participated in program 0 = Did not participate
Performance	Cumulative academic grade point average	Scale = 0.00 to 4.00
Retention	Retained from one academic term to the following academic term (fall and spring)	1 = Retained 0 = Not retained
Completion	Completion of a degree, diploma, or certificate	1 = Completed 0 = Not completed
Age	Age of student at the time of enrollment	1 = Less than 25 0 = 25 or older
Gender	Student gender	1 = Female 0 = Male
Race / Ethnicity	Non-white includes all race / ethnicities except white	1 = Non-white 0 = White
Enrollment Status	Enrolled in at least 1 credit bearing course during a given term	1 = Enrolled 0 = Not enrolled
Enrollment Type	Part-time or full-time student status	1 = Part-time 0 = Full-time
Financial Aid Status	Eligible for federal financial aid	1 = Eligible 0 = Not eligible
Transfer Program	Enrolled in a transfer program	1 = In transfer program 0 = Not in transfer program

Table 2 (continued).

Enrolled in Summer	Enrolled in at least 1 summer term	1 = Enrolled in summer 0 = Not enrolled in summer
Credits Attempted	Total number of credits attempted between spring of 2020 and fall of 2022	Scale = 0.00 to 100.00
Credits Earned	Total number of credits earned between spring of 2020 and fall of 2022	Scale = 0.00 to 100.00
Sections Taken	Total number of sections taken between spring of 2020 and fall of 2022	Scale = 0.00 to 100.00
Course Pass Rate	Average pass rate of all courses taken between spring of 2020 and fall of 2022	Percentage = 0.00% to 100.00%

Data Analysis

This study compares the performance, retention, and completion between students who participated in the Wolfpack laptop loan program and students who did not participate in the laptop loan program. Data was analyzed using the Statistical Package for Social Sciences (SPSS) after export from the Ellucian Colleague student information system and the Wolfpack information technology laptop loan participant tracking system. All data were screened for outliers, multicollinearity, missing values, normality, and errors.

Propensity score matching was utilized to compare student performance, retention, and completion with participation in the laptop loan program. Students were grouped by term and year for tracking of retention across terms starting in the spring of 2020. Students participating in the laptop loan program were matched with students who did not participate starting with the spring of 2020 cohort of students. SPSS was used to analyze all variables, producing descriptive statistics. Propensity score matching was completed, and the quality of matching was evaluated for the study. T-tests were used to determine if the covariates impacted student performance, retention, and completion.

Validity

This study accounted for multiple co-variates including age, gender, race / ethnicity, enrollment status, and financial aid status to validate the relationship between student who participated in the Wolfpack laptop loan program as well as students who did not participate in the program and student performance, retention, and graduation rates. Propensity score matching was utilized to determine if there was any significant difference between the treatment group, students who participated in the laptop loan program, and control group, students who did not participate in the program.

Summary

This chapter reviewed the research method, propensity score matching, utilized for this study and detailed the research design for the study. Propensity score matching is a statistical research method used to simulate an experimental research design by creating a treatment and control group for the purposes of evaluating the impact of the treatment on the sample population (B. E. Frye & Bartlett, 2017). The chapter provides information on the process for utilizing propensity score matching in this study.

The chapter then reviews the data collection methods and data sources for the study. Data was retrieved from Wolfpack Community College, a sub-urban, multi-county community college located in western North Carolina. Students included in the study attended the college between the spring of 2020 and the fall of 2022 and participated in the laptop loan program. Propensity score matching was used to include students from the same time frame who did not participate in the laptop loan program. Multiple covariates were analyzed with descriptive statistics and t-tests to determine the impact of laptop loan program participation on student performance, retention, and completion.

CHAPTER 4

RESULTS

This study utilized propensity score matching to compare outcomes for students who participated in the Wolfpack laptop loan program to students who did not participate in the program between the spring of 2020 and fall of 2022. The outcomes explored include cumulative GPA, completion status, pass rate in courses taken, and the total number of credits completed. Propensity score matching allowed the researcher to create a balanced control (non-laptop participant) and treatment (laptop participant) group from the student population at Wolfpack Community College.

Chapter 4 details the results of the study, including an overview of propensity score matching and the overall study, description of the data analysis, finding and outcome details, and a conclusion.

This study uses propensity score matching (PSM) to model the effect of loaning laptop computers to community college students. This was accomplished by calculating a propensity score for each covariate to develop similar treatment and control groups. A propensity score is the “conditional probability of a person being in one condition rather than another given a set of observed covariates used to predict a person’s condition” (Rosenbaum & Rubin, 1984). For the purposes of this study, the propensity scores for students who participated in the laptop loan program, treatment group, were matched with students who were enrolled at Wolfpack Community College during the same timeframe but did not participate in the laptop loan program, control group.

Data Analysis

Data analysis began with a review of enrollment data from Wolfpack Community College, including laptop participant data, for students enrolled between the spring of 2020 and fall of 2022. Data was checked for missing values and outliers utilizing frequency analysis. Review of the data showed no missing data and no significant outliers. The initial data set included 18,739 records with 528 laptop participants representing 2.8% of all students. A student was considered a laptop program participant if they had participated in the loan program during any term of enrollment between spring of 2020 and fall of 2022.

To prepare for data analysis, some existing variables were recoded into new dichotomous variables. Additionally, some new variables were calculated based on existing variables into either continuous or categorical, dichotomous variables. Table 3 provides a list of variables recoded or calculated during the data preparation portion of the study.

Continuous variables recoded into categorical variables included Race/Ethnicity and credit hours attempted for each term.

Coded with a value of 0, for not a member of the race or ethnic group or 1 for a member of the race or ethnic group the race/ethnicity values recoded into new variables include American Indian or Alaskan Native, Asian, Black, Hispanic (any race), Native Hawaiian or Pacific Islander, White (non-Hispanic), Two or more races, and Unknown / not reported.

Term status was calculated to indicate if a student was enrolled full-time or part-time for the given term. If the credit hours attempted for each term were greater than 11, the new variable was given a value of 1, indicating full-time enrollment for that term.

New categorical variables were calculated based on the value of other related variables. Calculated, categorical variables included transfer program, non-traditional student, and enrollment status.

Transfer program was calculated by analyzing the first program area for the student. If the students first program area was a transfer program, then the transfer program variable was coded with 1, whereas if the student was not in a transfer program the value was coded with 0.

Non-traditional student was calculated by calculating the age of the student during their first term and coding any student over the age of 24 as non-traditional with a value of 1 and any traditional age student with a value of 0.

Enrollment status was calculated by adding the total number of fall and spring terms where a student had a term status value of 1, indicating full-time enrollment for the term. If the total number of terms enrolled full-time were greater than 3, then the student was considered a full-time student and coded with a value of 1. If the total number of fall and spring terms enrolled full-time was less than or equal to 3, the student was coded with a 0, indicating part-time enrollment.

Table 3

Variables Recoded and Calculated

Variable Name	Type	Coding
American Indian or Alaskan Native	Categorical	1 = Member of group 0 = Not a member of group
Asian	Categorical	1 = Member of group 0 = Not a member of group
Black	Categorical	1 = Member of group 0 = Not a member of group
Hispanic (any race)	Categorical	1 = Member of group 0 = Not a member of group
Native Hawaiian or Pacific Islander	Categorical	1 = Member of group 0 = Not a member of group
White (non-Hispanic)	Categorical	1 = Member of group 0 = Not a member of group
Two or more races	Categorical	1 = Member of group 0 = Not a member of group
Unknown / not reported	Categorical	1 = Member of group 0 = Not a member of group
Transfer program	Categorical	1 = First enrolled in a transfer program 0 = Not enrolled in a transfer program
Non-traditional student	Categorical	1 = Over the age of 24 at first term 0 = Under 24 at first term
Enrollment status	Categorical	1 = Full-time for more than 3 terms 0 = Part-time more than 3 terms
Age at first term	Continuous	Scale = 0 to 100
Total retention terms	Continuous	Scale = 0 to 5

During initial data analysis the data was scoped to only include students with a program level of associate degree, resulting in 12,332 records (65.8% of total enrollment) and 405 laptop program participants.

Initial examination of the covariates included in the model indicated that the laptop participant group differed from the control group. Table 4 provides an overview of the covariates prior to propensity score matching and Figure 2 provides a visual representation of the balance between individual variables in the model prior to propensity score matching. Females in the control group (78.5%, n = 7,497) outnumbered those who participated in the laptop loan program (62.9%, n = 318). Male students in the control group (37.1%, n = 4,427) also outnumbered those who participated in the laptop loan program (21.5%, n = 87). Black students in the control group (22.5%, n = 2,687) were less representative than those who participated in the laptop loan program (44.9%, n = 182). White students in the control group (52.7%, n = 6,289) outnumbered those who participated in the laptop loan program (33.8%, n = 137). Most students who participated in the laptop loan program received Pell (64.0%, n = 259) while less than half of the control group received Pell (36.6%, n = 4,363). Students participating in the laptop loan program were more likely to be non-traditional age students (57.8%, n = 234) compared to the control group (37.9%, n = 4,518). Table 4 provides demographic information for students in the study from both the treatment and control groups.

Table 4

Descriptive Statistics for Treatment and Control Groups

Group Name	Treatment (n=405)		Control (n = 11,927)		Delta
Covariates	*n*	%	*n*	%	
Participant in Laptop Loan Program	405	3.30%	0	0%	-3.30%
Female	318	62.90%	7,497	78.50%	15.60%
Male	87	21.50%	4,427	37.10%	15.60%
American Indian or Alaskan Native	1	0.20%	42	0.40%	0.20%
Asian	3	0.70%	240	2.00%	1.30%
Black	182	44.90%	2,687	22.50%	-22.40%
Hispanic (any race)	56	13.80%	1,862	15.60%	1.80%
Native Hawaiian or Pacific Islander	1	0%	16	0.10%	0.10%
White (non-Hispanic)	137	33.80%	6,289	52.70%	18.90%
Two or more races	15	3.70%	375	3.10%	-0.60%
Unknown / not reported	10	2.50%	416	3.50%	1.00%
Received Pell	259	64.00%	4,363	36.60%	-27.40%
Over age 24 / non-traditional	234	57.80%	4,518	37.90%	-19.90%
Enrolled in a transfer program	210	51.90%	6,590	55.30%	3.40%
Full-time Student	53	13.10%	1,143	9.60%	-3.50%
Part-time Student	352	86.90%	10,784	90.40%	3.50%

The outcome variables used for the study were examined prior to propensity score matching to provide insight into outcomes for the entire population and for comparison when exploring post-match outcomes. Tables 5 through 9 provide chi-square and t-test analysis for outcome variables prior to matching.

Table 5

Results of t tests analysis of select outcome variables by laptop loan program participation before propensity score matching.

		Group						
		Laptop Participant		Control				
Variable	*df*	Mean	*SD*	Mean	*SD*	*t*	*p*	*d*
Credits attempted	426.31	28.30	21.09	23.04	18.89	-4.95	**.009	-.277
Credits earned	427.46	17.60	18.30	15.53	16.81	-2.25	**.002	-.123
Total sections taken	426.08	9.09	6.92	7.37	6.17	-4.93	**.003	-.277
Total Terms Retained	428.96	1.65	1.55	1.19	1.47	-5.85	*.029	-.311
Cumulative GPA	431.63	2.17	1.38	2.39	1.38	3.18	.403	.162
Course pass rate	433.70	54.40%	38.23%	60.87%	39.43%	3.35	.087	.164

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

Table 6

Chi-square analysis of associate degree completion (before matching)

	Group				Delta
	Laptop Program Participant		Control		
Associate degree completion	*N*	%	*N*	%	%
Completed	52	12.8%	2,168	18.2%	-5.4%
Did not complete	353	87.2%	9,759	81.8%	5.4%
Total	405	100%	11,927	100%	

Note: Chi-square = 7.560, df = 1, p = .006

Table 7

Chi-square analysis of diploma completion (before matching)

	Group				Delta
	Laptop Program Participant		Control		
Diploma completion	*N*	%	*N*	%	%
Completed	12	3.0%	172	1.4%	1.6%
Did not complete	393	97.0%	11,755	98.6%	-1.6%
Total	405	100%	11,927	100%	

Note: Chi-square = .6.164, df = 1, p = .013

Table 8

Chi-square analysis of certificate completion (before matching)

	Group				Delta
	Laptop Program Participant		Control		
Certificate completion	*N*	%	*N*	%	%
Completed	52	12.8%	1,116	9.4%	3.4%
Did not complete	453	87.2%	10,811	90.6%	-3.4%
Total	405	100%	11,927	100%	

Note: Chi-square = 5.541, df = 1, p = .019

Table 9

Chi-square analysis for completion of any award (before matching)

	Group				Delta
	Laptop Program Participant		Control		
Completion of any award	*N*	%	*N*	%	%
Completed	92	22.7%	3,031	25.4%	-2.7%
Did not complete	313	77.3%	8,896	74.6%	2.7%
Total	405	100%	11,927	100%	

Note: Chi-square = 1.506, df = 1, p = .220

After initial data exploration, the propensity score matching procedure and data analysis began. Data analysis was completed with SPSS version 29 using the propensity score matching function, regression analysis, frequency analysis, and crosstab functions. Crosstab analysis was completed with the independent variables / covariates as rows and participation in the laptop loan program as the column. This allowed for the researcher to analyze descriptive statistics for the independent variables broken down by participation in the laptop loan program. Each crosstab analysis also included chi-square analysis to examine the relationship between the independent variable and laptop loan program participation. Figure 3 provides a visual representation of the balance for individual co-variates prior to propensity score matching and table 10 provides chi-square results for treatment and control groups prior to propensity score matching.

Figure 3

Balance of Model Independent Variables Prior to Propensity Score Matching

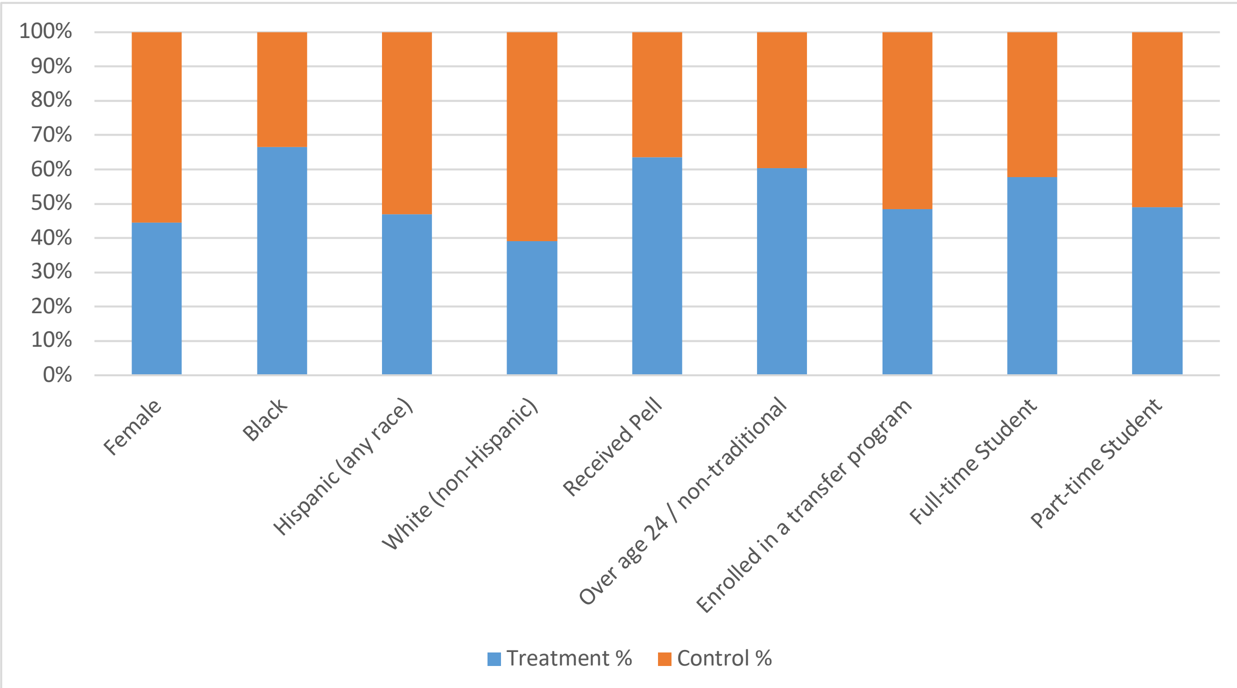


Table 10

Chi-Square results for Treatment and Control Groups (Before Matching)

Group Name	Chi-square	*df*	*p*
Gender	41.313	1	.000
Black	110.220	1	.000
Hispanic (any race)	.954	1	.000
White (non-Hispanic)	56.158	1	.000
Received Pell	125.124	1	.000
Enrolled in a transfer program	1.832	1	.176
Enrollment status (FT / PT)	5.489	1	.019
Enrolled in Summer	8.948	1	.003

After reviewing the frequencies and descriptive statistics for the full data set multiple matches were completed to determine the strongest match for analysis. For each match attempt the model summary and the omnibus tests of model coefficients were reviewed to determine model fit and significance. Match tolerance was set to .01 for each attempt to create the strongest model fit. Nearest neighbor matching was used as the matching algorithm with the "with replacement" option selected for building the treatment and control matched groups. Using the propensity score matching function in SPSS resulted in the creation of the final matched groups. While the selected model is not completely balanced on each independent variable, the overall model is strong. Multiple models were created and tested to determine the strongest model fit. The consistent outcome of each model is that the overall results remained consistent, despite minor variations in outcome values, statistical significance, and model strength.

Covariates were selected for the model by performing a logistic regression on the variables and analyzing the Nagelkerke R-squared, chi-squared, beta coefficients, and independent variables with a p value $\leq .05$. The covariates of gender, age, Pell status, Black, Hispanic (any race), White, enrollment status, enrolled in a transfer program, and enrolled in summer provided the strongest match, significance, and model fit. The independent variables gender, age, and Pell status explain the variance in the model (chi-squared = 257.547, $p < .001$; Nagelkerke R Squared= .083). The model correctly classified 96.7% of the cases and explained 8.3% of the variance in the dependent variables. Regression coefficients are presented in Table 11.

Table 11

Results of Logistic Regression Covariates in the Model

Covariates	Beta	S.E.	Wald	*df*	Sig.	Exp(B)
Gender	.468	.126	***13.741	1	.000	1.597
Age	.029	.005	***37.773	1	.000	1.030
Pell status	.926	.108	***73.951	1	.000	2.525
Black	.632	.203	**9.692	1	.002	1.881
White, non-Hispanic	-.260	.206	1.595	1	.207	.771
Hispanic (any race)	.145	.232	.391	1	.532	1.156
Transfer program	-.076	.106	.514	1	.473	.927
Full-time, part-time status	-.285	.158	3.247	1	.072	.752
Enrolled in Summer	.103	.107	.926	1	.336	1.109
Constant	-4.832	.300	258.643	1	.000	.008

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$, chi-squared = 257.547, Nagelkerke R squared = .083, 96.7 Predicted correctly

Propensity values produced during the matching process that were greater than 0 were selected for the post-match treatment and control groups. Following the matching process, the treatment and control group had a total of 806 records, with 403 laptop loan program participants and 403 students who did not participate in the laptop loan program. The match produced a sample of students in both the treatment and control groups that were not significantly different. Due to the success of the matching process, differences in outcomes between the two groups may be attributed to participation in the laptop loan program as opposed to differences in students' demographics or other pre-treatment factors.

Table 12 details post-match descriptive statistics for both the treatment and control group, figure 4 visually represents the balance between model covariates post-match, and table 13 provides a post-match chi-square analysis.

Table 12

Post-Match Descriptive Statistics for Treatment and Control Groups

Group Name	Treatment (n=403)		Control (n = 403)		Delta
Covariates	*n*	%	*n*	%	
Participant in Laptop Loan Program	403	50.0%	403	50.0%	0.00%
Female	316	78.4%	301	74.7%	-3.70%
Male	87	21.6%	102	25.3%	3.70%
American Indian or Alaskan Native	1	0.2%	2	0.5%	0.30%
Asian	3	1.2%	5	0.7%	-0.50%
Black	180	31.3%	126	44.7%	13.40%
Hispanic (any race)	56	13.9%	7	1.7%	-12.20%
Native Hawaiian or Pacific Islander	1	0.2%	0	0.0%	-0.20%
White (non-Hispanic)	137	34.0%	258	64.0%	30.00%
Two or more races	15	3.7%	3	0.7%	-3.00%
Unknown / not reported	10	2.5%	2	0.5%	-2.00%
Received Pell	257	63.8%	154	38.2%	-25.60%
Over age 24 / non-traditional	232	57.6%	403	100.0%	42.40%
Enrolled in a transfer program	210	52.1%	140	34.7%	-17.40%
Full-time Student	51	12.7%	47	11.7%	-1.00%
Part-time Student	352	87.3%	356	88.3%	1.00%

Figure 4

Balance of Model Independent Variables Following Propensity Score Matching

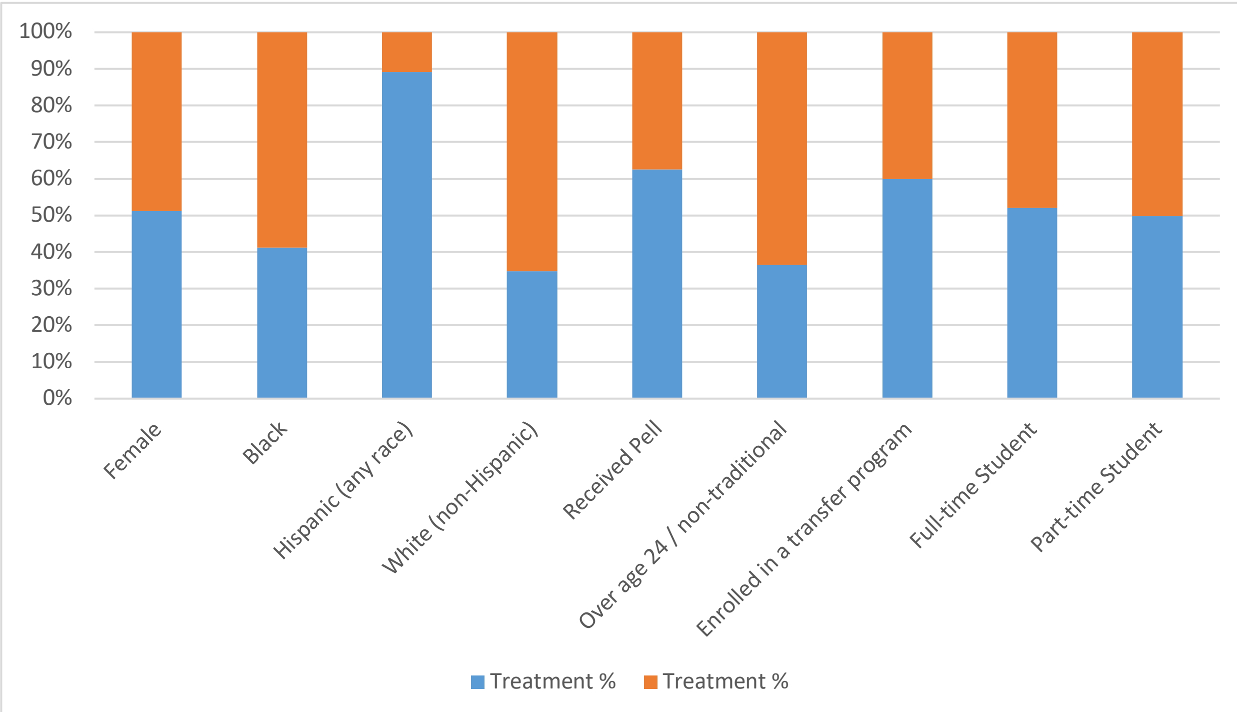


Table 13

Chi-Square results for Treatment and Control Groups (After Matching)

Group Name	Chi-square	*df*	*p*
Gender	1.555	1	.212
Black	74.688	1	<.001
Hispanic (any race)	41.324	1	.001
White (non-Hispanic)	15.361	1	.001
Received Pell	52.671	1	.001
Enrolled in a transfer program	24.746	1	.001
Enrollment status (FT / PT)	.186	1	.666
Enrolled in Summer	21.746	1	.001

Outcomes

To analyze the relationship between laptop loan participation and cumulative grade point average (GPA), completion, pass rate, and credits earned, independent sample t-tests were performed on the outcome variables. A total of 806 student were assigned through propensity score matching to either the treatment group (n = 403), consisting of those who participated in the laptop loan program, or the control group (n = 403), consisting of randomly assigned students who did not participate in the laptop loan program.

The t test indicated that credits earned, cumulative GPA, credits attempted, retention, and total sections taken were statistically significant ($p < .001$) and explained by the model. The course pass rate did not meet the threshold of statistical significance with a significance of .627.

Results from the independent samples t test indicated that students who participated in the Wolfpack laptop loan program earned more credits (M = 17.55, SD = 18.32, N = 403) than students who did not participate in the laptop loan program (M = 13.47, SD = 14.69, N = 403). Students who participated in the laptop loan program attempted on average over 9 more credits (M = 28.22, SD = 21.11, N = 403) compared to students who did not participate in the laptop loan program (M = 18.63, SD = 15.83, N = 403). Similarly, the total number of sections taken by laptop loan program participants (M = 9.06, SD = 6.93, N = 403) was higher than for students who did not participate in the laptop loan program (M = 5.87, SD = 5.10, N = 403). Finally, students who participated in the laptop loan program retained (M = 1.63, SD = 1.53, N = 403) at a higher rate than students who did not participate in the laptop loan program (M = 1.01, SD = 1.30, N = 403).

Students who participated in the laptop loan program had a lower cumulative GPA (*M* = 2.16, *SD* = 1.38, *N* = 403) than students who did not participate in the laptop loan program (*M* = 2.86, *SD* = 1.05, *N* = 403).

Table 14 shows the *t* test results for credits earned, cumulative GPA, credits attempted, total sections taken, and course pass rate.

Table 14

Results of t tests analysis of select outcome variables by laptop loan program participation post propensity score matching.

		Group						
		Laptop Participant		Control				
Variable	*df*	Mean	*SD*	Mean	*SD*	*t*	*p*	*d*
Credits attempted	745.6	28.22	21.11	18.63	15.83	-7.296	***.000	-.514
Credits earned	767.8	17.55	18.32	13.47	14.69	-3.490	***.000	-.25
Total sections taken	738.8	9.06	6.93	5.87	5.10	-7.465	***.000	-.526
Total Terms Retained	783.0	1.63	1.53	1.01	1.30	-6.25	***<.001	-.440
Cumulative GPA	748.3	2.16	1.38	2.86	1.05	8.015	***.000	.565
Course pass rate	804	54.36%	38.31%	66.21%	38.17%	4.399	.627	.310

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

Chi-square analysis was performed on each award type, and the completion of any award to evaluate the potential impact of participation in the laptop loan program on completion.

The results for the variable associate degree completion showed statistical significance (*p* = .001) and a review of results show a lower percentage of laptop participants completing an associate degree (37.1%, *n* = 52) compared to the control group (62.9%, *n* = 88), however Cramer's V (.118) indicated a weak association between associate degree completion and laptop program participation. Table 15 provides details of the chi-square analysis for associate degree completion between treatment and control groups.

Table 15

Chi-square analysis of associate degree completion

	Group				Delta
	Laptop Program Participant		Control		
Associate degree completion	*N*	%	*N*	%	%
Completed	52	12.9%	88	21.8%	-8.9%
Did not complete	351	87.1%	315	78.2%	8.9%
Total	403	100%	403	100%	

Note: Chi-square = 11.203, df = 1, p = .001

For the variable diploma completion there were no statistically significant differences for those who participated in the laptop loan program compared to those who did not participate (*p* = .832). Table 16 provides details of the chi-square analysis for diploma completion between treatment and control groups.

Table 16

Chi-square analysis of diploma completion

	Group				Delta
	Laptop Program Participant		Control		
Diploma completion	*N*	%	*N*	%	%
Completed	12	3.0%	11	2.7%	0.3%
Did not complete	391	97.0%	392	97.3%	-0.3%
Total	403	100%	403	100%	

Note: Chi-square = .045, df = 1, p = .832

For the variable certificate completion there were no statistically significant differences for those who participated in the laptop loan program compared to those who did not participate (p = .467). Table 17 provides details of the chi-square analyses for certificate completion between treatment and control groups.

Table 17

Chi-square analysis of certificate completion

	Group				Delta
	Laptop Program Participant		Control		
Certificate completion	*N*	%	*N*	%	%
Completed	50	12.4%	57	14.1%	-1.7%
Did not complete	353	87.6%	346	85.9%	1.7%
Total	403	100%	403	100%	

Note: Chi-square = .528, df = 1, p = .467

The results for the variable identifying completion of any award showed statistical significance (p = .003) and a review of results show a lower percentage of laptop participants completing any award (22.3%, n = 90) compared to the control group (31.5%, n = 127), however Cramer's V (.103) indicated a weak association between associate degree completion and laptop program participation. Table 18 provides details of the chi-square analysis for completion of any award between treatment and control groups.

Table 18

Chi-square analysis for completion of any award

	Group				Delta
	Laptop Program Participant		Control		
Completion of any award	*N*	%	*N*	%	%
Completed	90	22.3%	127	31.5%	-9.2%
Did not complete	313	77.7%	276	68.5%	9.2%
Total	403	100%	403	100%	

Note: Chi-square = 8.633, df = 1, p = .003

Summary

Chapter 4 presents the results of the data analysis for the study using propensity score matching to determine outcomes as measured by credits attempted, credits earned, total sections taken, course pass rates, cumulative GPA, and completion of an associate degree, diploma, or certificate for students who participate in the Wolfpack laptop loan program compared to students who did not participate in the Wolfpack laptop loan program.

The logistic regression model demonstrated that gender, age, Pell status, and the race/ethnicity coded as Black were statistically reliable in predicting membership in the dependent variable (participation or non-participation in the laptop loan program). Prior to matching the difference between participation in the treatment, students participating in the Wolfpack laptop loan program, compared to control group were unbalanced with gender underrepresented (15.60% difference), students coded as Black over-represented (22.40% difference), students coded as White underrepresented (18.90% difference), Pell recipients over-represented (27.40% difference), and Non-traditional students over the age of 24 over-represented (19.90% difference). After matching, there were no statistically significant differences in the covariates between the treatment and control groups.

Study results show that students who participated in the Wolfpack laptop loan program attempted and earned more credits while also taking more courses, retained at a higher rate, yet had a lower cumulative GPA than students who did not participate in the laptop loan program. These results showed a statistically significant connection to participation in the laptop loan program. While there was not a statistically significant connection, students who participated in the laptop loan program completed fewer credentials and passed fewer courses than students who did not participate in the laptop loan program.

CHAPTER 5

DISCUSSION

Chapter 5 provides the conclusions of the study, a discussion of findings, and recommendations for practice and future research. Conclusions and discussions are organized by research questions. The chapter concludes with a review of the limitations of the study, impacts on practice, recommendations for future research and a conclusion.

Technology is used extensively in education and continues to expand, with annual spending of over $10 billion for software, hardware, and digital content (Herold, 2016). Higher education is no exception to the continued expansion of technology. Since 1994 the Campus Computing Survey has showed growth in the use of technology with the ability to eliminate barriers to learning form many students (*Technology in Education - Higher Education*, n.d.). Research has shown that integrating technology into the classroom and building technology literacy can have a positive impact on educational outcomes (Anderson & Horn, 2012).

While there appear to be benefits to increasing the use of technology in the educational setting, the reality is there remains a digital divide in the United States (Vogels, 2021). Students entering college may lack access to a dedicated device for use in school or lack the reliable home Internet access necessary to complete their coursework (Winslow, 2019). A growing number of schools and colleges are investing in technology programs that provide laptops or other devices to students even as the pandemic continues to impact supply chain availability (McKenzie, 2021). Online and hybrid courses became the default course delivery method during the pandemic and the popularity of online education remains (Grajek, 2021, p. 10). Educause states (2021):

> "As technology provides more of the foundation on which higher education institutions conduct their core operations, building processes, controls and training that ensure continuity of access and ongoing integrity of those underlying IT products becomes business-critical."

Exploring the impact of providing technology to students is important to help inform how colleges should support and invest in technology resources that support student success.

The purpose of this study was to examine how participation in a laptop loan program impacted student outcomes. The study identifies student outcomes as the impact on grade point average (GPA), retention, credits successfully attempted and completed, and degree, diploma, or certificate completion from a curriculum program. The study examines the characteristics of laptop loan program participants compared to the overall student body.

While there has been a growing body of research on the impact of one-to-one laptop programs in education, most of the research to date has focused on the impact to K-12 education as opposed to community colleges. Prior to the study a comprehensive review of literature germane to the study topic was discussed. The theoretical and conceptual frameworks for the study as well as the quantitative methodology used in the study, propensity score matching, were discussed. This chapter outlines the major findings from the study, discusses limitations to the research, and shares recommendations based on research findings.

Conclusions and Discussion

This study utilized three research questions to guide the collection of data and information that were most important to determining the outcomes of the study. The research questions focused on academic performance characteristics for students who did and did not participate in the Wolfpack laptop loan program. Findings from the research questions provide an understanding of how laptop loan program participation impacts the student success outcomes of grade point average (GPA), retention, credits attempted, credits earned, course sections attempted, and the completion of degrees, diplomas, and certificates.

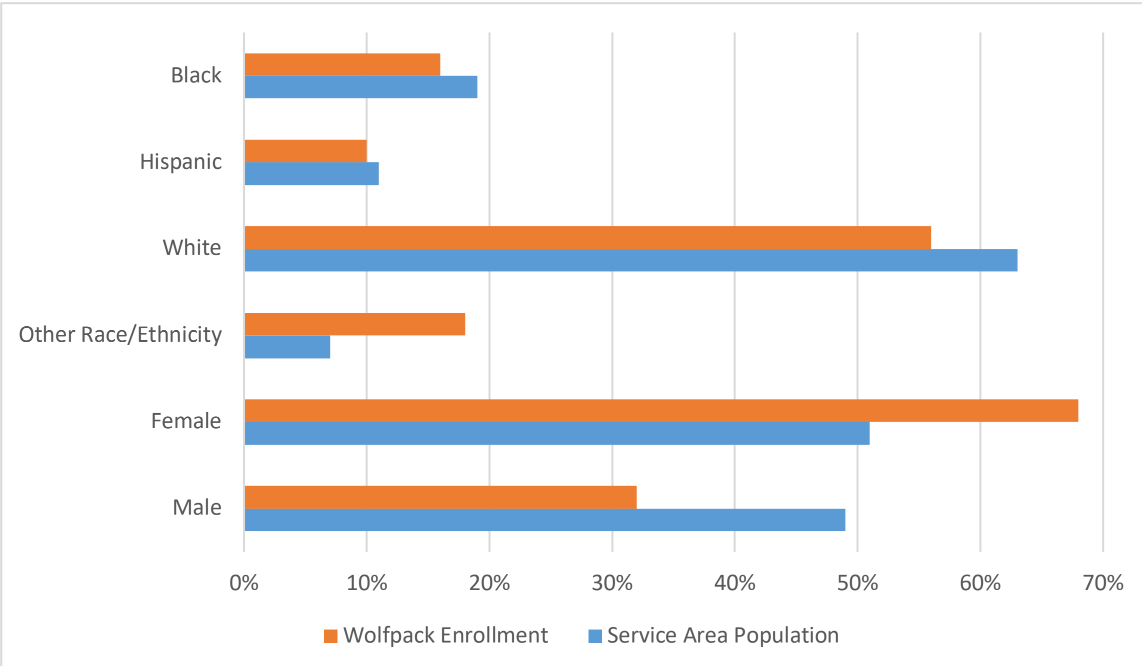
The study utilized 12,332 student records for associate degree seeking students at Wolfpack Community College between the spring of 2020 and fall of 2022 with 405 (3.30%) of students participating in the laptop loan program. The treatment and control groups of the study contained a large number of female students and Black students were the most represented in the study with White and Hispanic students having the second and third greatest representation. The treatment and control groups consisted of many non-traditional students (students over the age of 24) and student who received Pell.

The students who made up the sample and treatment group for this study were a strong representation of the community college and service area for the community college in many areas such as gender and age, while less representative of the community in areas such as race/ethnicity. In 2022 Women represented 50.82% of the service area population. The service area was 63% White, 19% Black, and 10.92% Hispanic (*Demographic Overview*, n.d.). The service area for the college contains 67.79% of individuals who are over the age of 24 and earnings per job are $20,000 below the national average (*Demographic Overview*, n.d.; *Economy Overview*, n.d.).

The college's total curriculum student body in 2022 was 56% White, 16% Black, and 10% Hispanic. The college is 63% Female with 68% of total students pursuing an associate degree. Participants in the laptop loan program were more likely to be female, Black, non-traditional students over the age of 24 and receive Pell. Figure 4 provides a visual representation of the demographic distribution in the service area and college.

Figure 5

Service area and Wolfpack Community College demographic distribution.



Pre-Matching and Matching

The covariates that were used for matching included gender, age at first term, Pell status, enrollment status (full-time or part-time), enrolled in summer, enrolled in a transfer program, and race/ethnicities of Black, Hispanic (any race), and White (non-Hispanic). Prior to matching the largest difference between the control and treatment groups were observed in the variables gender, Pell recipient, Black students, and non-traditional students (students over the age of 24).

To establish the strongest match, multiple matches were completed with different combinations of covariates. Each match was analyzed using propensity scores. The final matching was shown to predict 8.3% of the variance after correctly classifying 96.7% of the cases. The final treatment and control groups contained 403 cases for a total of 806 cases post-matching.

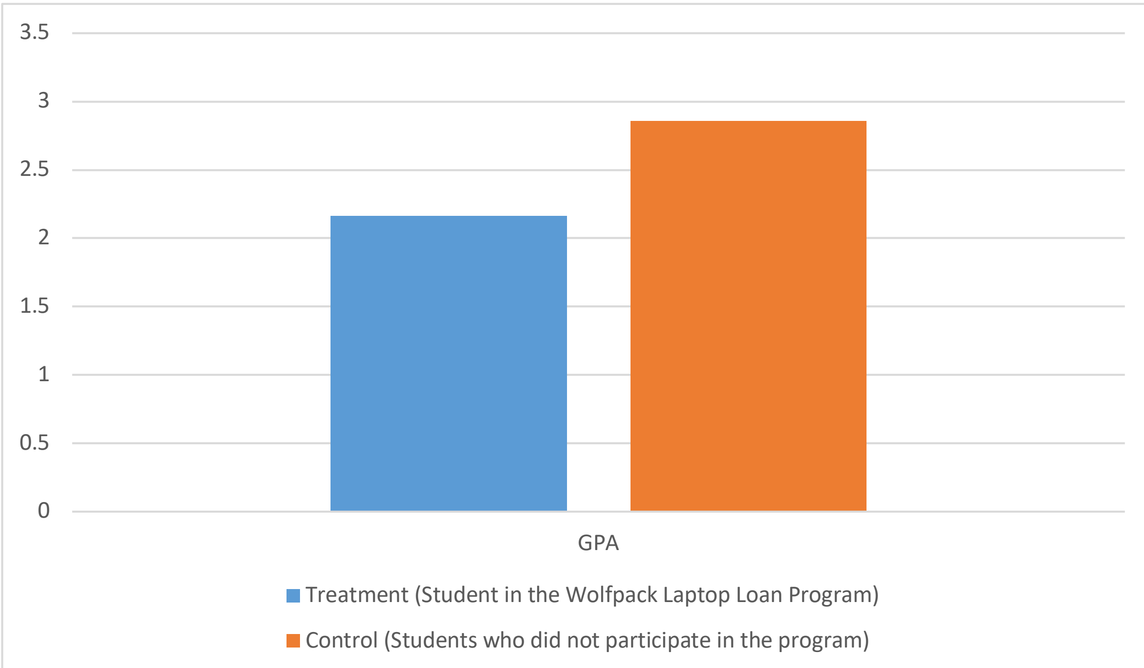
Research Question 1

Research question 1 sought to determine if there was a difference in performance for students who participated in the laptop loan program compared to students who did not participate in the laptop loan program. For the purposes of this study, performance is measured by the cumulative grade point average (GPA) earned by the student. Following the matching process, T-tests were performed on the cumulative GPA for students who participated in the laptop loan program as well as students who did not participate in the laptop loan program.

The results showed that students who participated in the laptop loan program had an average GPA of 2.16 (*SD* = 1.38) between the spring of 2020 and fall of 2021. Comparatively, students who did not participate in the laptop loan program earned and average GPA of 2.86 (*SD* = 1.05). These results indicate a GPA difference of 0.7 points lower for a student who participated in the Wolfpack laptop loan program. Figure 5 provides a visual representation of the GPA performance data.

Figure 6

Average GPA of Post-Match Treatment and Control Groups



Research Question 2

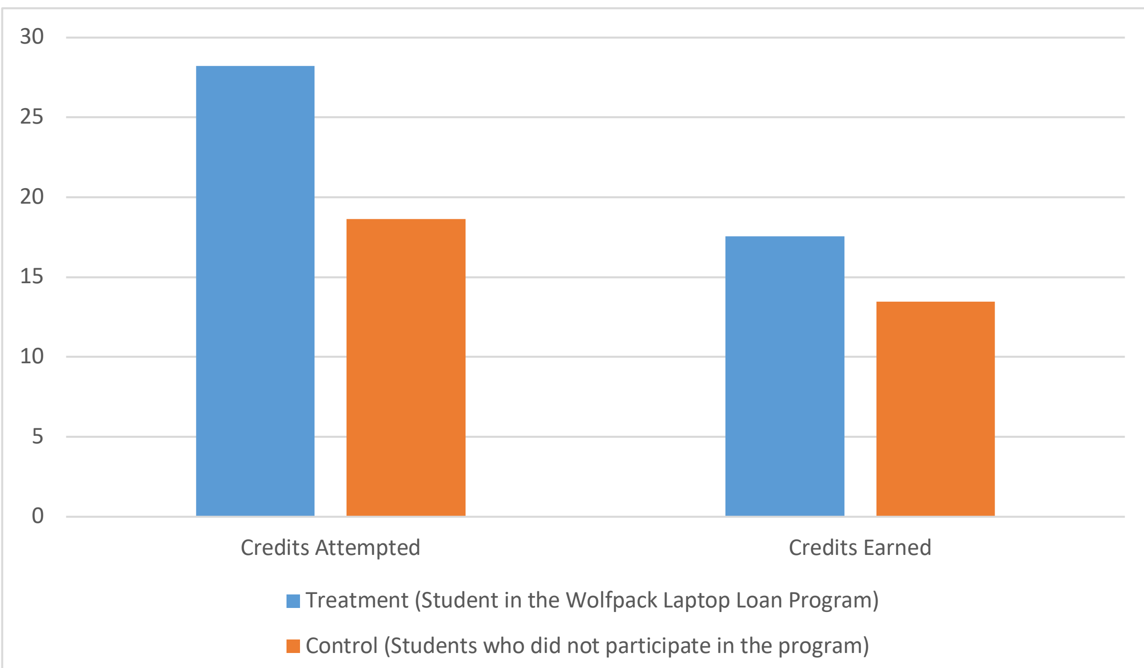
The second research question sought to compare the impact on retention for those students who did and did not participate in the laptop loan program. T-tests were performed on the outcome variables with a grouping variable of laptop loan participation by students. The outcome variables of credits attempted, credits earned, sections taken, and retention rate were examined. Independent sample t-test analysis was completed in SPSS to analyze the program's impact on retention. Findings indicate that students who participated in the laptop loan program (treatment group) had a higher retention rate and were more likely to attempt and earn more credits than student who did not participate in the laptop loan program (control group).

The results showed a statistically significant difference in credits attempted, credits earned, course sections taken, and retention rate. Students who participated in the laptop loan program on average attempted 3.19 more sections than students who did not participate in the program. Similarly, students who participated in the laptop loan program attempted on average 9.59 more credits and successfully earned on average 4.08 more credits than students who did not participate in the laptop loan program.

T-tests were also used to examine the difference in course pass rate for students who did and did not participate in the laptop loan program. The results showed no statistically significant difference between the treatment (students who participated in the laptop loan program) and control (students who chose not to participate in the laptop loan program) groups for the study. Figure 6 provides a visual representation of the credits attempted and credits earned data.

Figure 7

Post-match credits attempted, and credits earned for the treatment and control groups.



Research Question 3

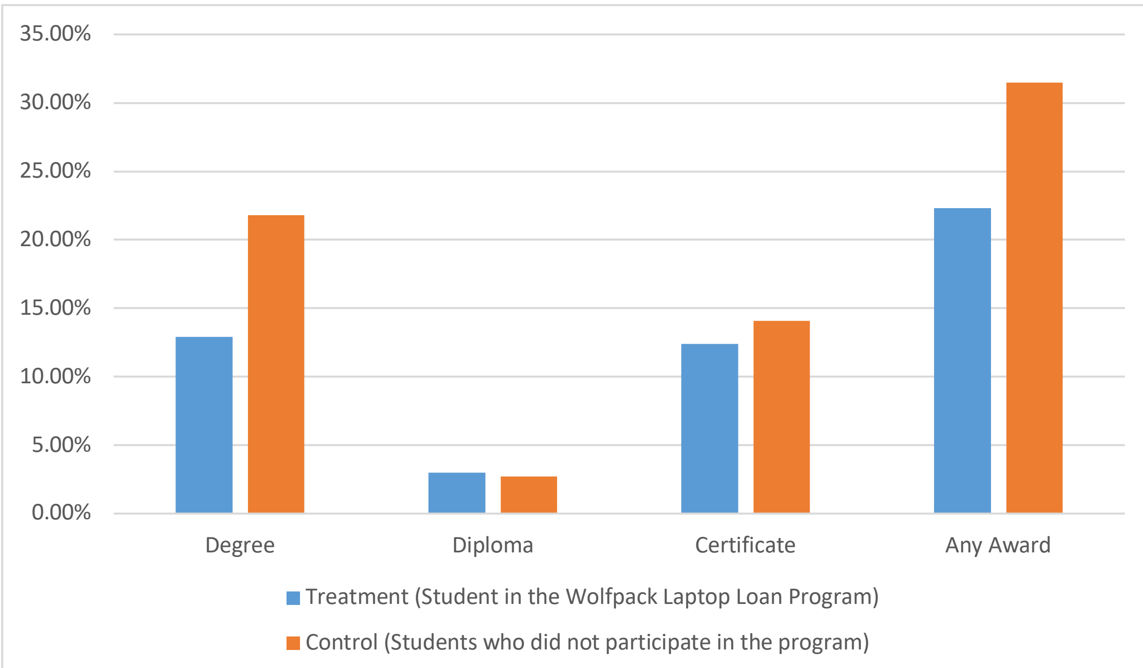
The final research question sought to compare degree, diploma, and certificate completion rates for students who did and did not participate in the laptop loan program. Following the matching process, chi-square analysis was performed on each award type (degree, certificate, diploma) and the collection of any award by a student.

Results show that laptop program participants completed fewer associate degrees (12.9%, $N = 52$) than those who did not participate in the program (21.8%, $N = 88$). Similarly, students who participated in the laptop loan program completed fewer certificates (12.4%, $N = 50$) compared to students who did not appear as part of the program (14.1%, $N = 57$). However, students were slightly more likely to have completed a diploma if they had participated in the laptop loan program (3.0%, $N = 12$) compared to students who did not participate in the program (2.7%, $N = 11$).

One factor which may have impacted the number of degrees, diplomas, and certificates earned by participants of the laptop loan program is the timeframe of the study. Study data was collected in the spring of 2023 with the collection of data starting in the spring of 2020 and ending in the fall of 2022. A large number of participants in the study would have had to complete their degree in two years to earn a credential in the timeframe identified in the study. The majority of individuals in both the control and treatment group take courses part-time, challenging the ability to complete a full degree within 2 years. The college's average time to associates degree completion for a curriculum student is just under 5 years. However, certificates and diplomas can often be completed in a significantly shorter timeframe and results showed greater parity in outcomes between laptop program participants (certificates: 12.4%, $N = 50$; diplomas: 14.1%, $N = 57$) and students who chose not to participate in the loan program (certificates: 87.6%, N = 353; diplomas: 85.9%, N = 356). Figure 7 provides a visual representation of completion data from the study.

Figure 8

Degree, diploma, certificate, and any award results from treatment and control groups.



Recommendations for Practice, Research, and Theory

As the use of technology continues to expand, understanding the impact of technology on educational outcomes is vital to ensuring continued support for technology integration into the college experience and encouraging colleges to increase access to technology for all students. This study highlights the results of loaning a laptop computer to students and the subsequent impact on performance, retention, and completion. The study showed that providing a laptop computer results in students retaining at a higher rate, taking more classes, attempting more credits, and earning more credits. The study also showed that students who participated in the laptop program had a lower grade point average compared to students who did not participate in the program.

College leaders, faculty, and other practitioners need to understand that while increasing access to technology has a positive impact on the number of courses taken and credits earned, leaders must create practices that use the technology to improve performance (GPA) and completion. Continuing research on the impact of providing technology to students and all facets of technology in education is crucial. Expanded quantitative studies on the effectiveness of providing students a computer for coursework is vital to the continued investment and growth of student personal computing efforts.

Recommendations for Practice

Recommendations for practice include the creation of specific criteria to participate in the laptop loan program, connecting the checkout process to an academic advising session, developing multiple semester check-in sessions, connecting faculty technology training to the checkout program, embedding peer support resources for students participating in the program, and providing internet hotspots in addition to laptop computers.

Recommendation 1. The program lacks specific criteria for participation, yet over half of the program participants are low-income and underserved students. The program should be adjusted to prioritize providing technology resources to these groups. Connecting the laptop loan program to support services focused on low-income and underserved students can help to bridge the digital divide and improve outcomes for these students.

The Wolfpack laptop loan program did not specify criteria for participation in the laptop loan program beyond active enrollment in a course at the college. While an open approach to participation provides a broad opportunity to gain access to the device, this approach can also make it challenging to tailor support services to the students who have the greatest need. Participant data showed that 51.3% of total laptop program participants received Pell and that 77% were associate degree-seeking. The majority of laptop program participants (61.74%) were also part of a historically minoritized population, with the largest group of participants identifying as Black. Additionally, 89% of program participants attended the college predominately part-time.

The program should be adjusted to create criteria for participation that focuses on providing the technology resources to underserved and low-income students. Adjusting to criteria that focuses on these student populations will serve the students with the greatest need and provide opportunity to connect the program to other support services provided to underserved and low-income students. Low-income and underserved students face the greatest challenges related to the digital divide. Outcomes from the study show that students who participate in the program attempt more credits and take more classes. These increases result in more funds being available to the college to help fund the loan program. In the case of Wolfpack Community College the increase in credits attempted and sections taken resulted in the program more than paying for the cost of the laptop and opening the door for increased investment in the program. As discussed in the literature review, there remains a significant digital divide despite the rapid expansion of technology adoption over the last several years. While 92% of households own some type of device, just over 50% of households making less than $25,000 per year own a computer (Alsop, n.d.; Martin, 2021). This disparity in access impacts underserved communities most acutely (Martin, 2021).

The same students participating in the laptop loan program may also have needs related to food insecurity, financial support, or other wrap-around services available at the college. The technology group, which manages the laptop loan program, should partner with student services to promote the availability of the program in general student support programs such as TRIO. Participating students are often part of the same groups that frequently face larger scale challenges, outside of their college experience, that often impact enrollment and success (Baugus, 2020). Many colleges have developed programs such as wellness centers, last-dollar financial support, and other support structures to help low-income and underserved students obtain the resources they need. Connecting the laptop loan program to these support programs could help to bolster participation and encourage stronger outcomes.

Recommendation 2. Students who participated in the program retained at a higher rate, attempted, and earned more credits, and completed more course sections than non-participants. Yet participants also had lower GPAs. Participation in the program should be linked to a mandatory advising session during checkout to provide guidance on course selection and program paths.

The study showed that students who participated in the laptop loan program attempted and earned more credits on average (attempted: 28.22, *SD*=21.11; earned: 17.55, *SD*=18.32) than students who did not participate in the program (attempted: 18.63, *SD*=15.83; earned: 13.47, *SD*=14.69). Students who participated in the program also completed more sections (9.06 average, *SD*=6.93) than students who did not participate (5.87 average, *SD*=5.10). While these data would seem to indicate greater success, students who participated did not perform as well in terms of GPA (2.16 average, *SD*=1.38) or completion of any award (22.3%, *N*=90) compared to those who did not participate in the program (GPA: 2.86 average, *SD*=1.05; completion of any award: 31.5%, *N*=127).

Participation in the laptop loan program should be linked to a mandatory advising session with a team member from the student services staff during the checkout process. Although students may perceive the technology as an opportunity to complete more courses, negative performance outcomes can have a detrimental impact on their overall college experience. By connecting the checkout process with a mandatory advising session, the college can ensure that the student has received guidance in selecting courses and a potential program path that provides the greatest opportunity for academic success. Furthermore, advisors can help understand any challenges the student may face and assist in determining the appropriate course load to maximize their chances of success.

Recommendation 3. To ensure students receive sufficient support, the information technology team should bolster support services around the program. This should include setting up multiple check-in sessions during the term, offering additional training on how to use required software, and sending out a participant newsletter with tips for using the technology. The program should also partner with other areas of the college to help identify resources, not directly related to the laptop, for struggling participants.

When students borrow a laptop as part of the program, they must visit the information technology help desk. The student is not required to connect with the information technology help desk again until the end of the semester when the laptop must be turned in or the checkout renewed. The program provides support for the device whenever requested by the student and provides basic instruction on how to use the device, and required software for the student's academic work, when the device is initially checked out from the college. Students can visit the information technology help desk at any time during the semester for support but frequently do not return at any point until time to return the device.

The information technology team for the college should setup multiple “check-in” sessions throughout the term and reach out to students during the term to encourage visiting or calling for support. These sessions could also serve as opportunities to train students on how to use the technology, the software, and the tools used in the classroom. While many students start college having used computers, they often struggle with the specific software and tools required in the classroom (Wood, 2021).

The information technology team should regularly send out a participant newsletter with tips and tricks for maximizing use of the device to encourage engagement and continued connection for students participating in the program. Multiple engagements with students who participate in the program during the term can help to increase each participants feeling of connection to the college and encourage the students to request support if they are having trouble with the device or the use of technology in their courses. The college technology department could also partner with the library and tutoring center to identify resources that could assist students who may being struggling with their course in a way that is not directly related to the laptop.

Recommendation 4. The program should partner with faculty and the instructional development group to provide support and develop instructional material on how to maximize the use of laptops in the classroom from both a pedagogy and technology perspective. The training and support resources should be flexible and multi-modal to accommodate different learning styles.

The Wolfpack laptop loan program did not identify proactive engagement with faculty related to the loan program. While faculty may be aware of the program, no instruction or information has been provided to maximize the use of laptops in the classroom. During the term a student's most consistent engagement with the college is through the faculty members that teach the courses they are taking.

The information technology group should partner with faculty to provide support information and resources that may be used in the classroom to help students with common questions about operating the device and the software required for the course. The information technology group should also partner with the faculty training group to develop instructional material on the use of technology in the classroom and how to maximize the use of student devices, including loaned laptops, in the classroom experience. The training must be specific to the discipline being taught and flexible enough to understand the distinctions between programs (Polly et al., 2021). As with the student support newsletter, training and support resources for faculty should be multi-modal, providing synchronous opportunities for faculty to attend training as well as asynchronous opportunities with tools like video, documentation, and interactive assets. Partnering directly with faculty and the instructional development group will help faculty understand both pedagogical and technological opportunities to use the laptops in the classroom (Coles et al., 2020; Turnbull et al., 2021).

Recommendation 5. Most of the students who participated in the laptop loan program attend college part-time. To support these students, the college should create a peer support program with full-time students who are trained to provide support to laptop loan program participants.

The students who participated in the laptop loan program were primarily associate degree seeking students (77%) attending the college part-time (89%). Reviewing all students who attended the college between the spring of 2020 and fall of 2022 that did not participate in the laptop loan program shows that 65% were degree seeking with 6% both degree seeking and full-time students for at least half of the fall and spring terms.

The college should create a peer support program for participants in the laptop loan program. Peer support participants could be recruited from full-time, degree seeking students who are registered in programs that overlap with the programs of students who are participating in the laptop loan program. These peer support students could be trained to support other students participating in the loan program. The peer support group would be trained by the information technology staff and could be provided work-study hours and funding to support participation as a peer support individual. Students may find they are more comfortable asking for assistance or working with a student colleague. Prior research has shown that technology can help build a sense of belonging, increase collaboration, and improve engagement for students (Gierdowski, 2019; Warschauer et al., 2004; Werang & Leba, 2022). Since the majority of students who participate in the laptop loan program are part-time, creating stronger student to student connections could help build a sense of belonging and connection for the students who participate in the loan program.

Recommendation 6. Lack of, or low-quality, access to the internet has a disproportionate impact on low-income and underserved students, and the college should include an option for an Internet hotspot along with the laptop loan program. Students need to have access to an Internet connection along with an adequate device to complete their coursework. The college could explore partnership opportunities with local network providers to expand connectivity for program participants.

Research has shown that the digital divide is not merely a lack of access to a computer, but frequently lack of consistent access to the Internet (Muller, 2022). Many parts of the United

States continue to have inadequate Internet service and many students cannot afford high speed Internet even when available (Wood, 2021). Inconsistent Internet access has a disproportionate impact on low-income and underserved students.

The college should include an option for an Internet hotspot along with the laptop loan program. The COVID-19 global pandemic highlighted the need for students to have access to an Internet connection along with an adequate device to complete their coursework (Turnbull et al., 2021). Adding a hotspot option to the program would expand the scope of impact provided by the program, potentially open the program to additional students, and help address the larger issues related to the digital divide. While it will likely be difficult for the college to afford providing an Internet hotspot to every participant of the laptop loan program, the college could explore partnership opportunities with local network providers to maximize the number of hotspots available to program participants. Additional criteria could be also developed to narrow the number of internet hotspots required to support students.

Implications and Recommendation for Study Methodology

The researcher acknowledges there are several limitations inherent in conducting non-scientific research on student performance, retention, and completion where participants are not randomly assigned or equivalent in terms of motivation, intentions, background, or skill level (Titus, 2007). Random selection, where a treatment is provided to a group yet purposely withheld from another group, is not feasible and considered unethical in the education setting. Propensity score matching is a method that simulates experimental design and provides a means to create two matching groups comprised of a group that received the treatment and a group that did not receive the treatment. Participants self-select into the treatment group and propensity score matching is used to create a like control group from those who chose not to self-select into the treatment group. Propensity score matching creates a one number composite of all the covariates for the study to match the treatment and control groups. A propensity score represents the "conditional probability of a person being in one condition rather than another given a set of observed covariates used to predict a person's condition" (Rosenbaum & Rubin, 1983).

There are other statistical methods, such as multiple regression, available when performing research that must account for selection bias. Multiple regression has many drawbacks compared to propensity score matching including a requirement for linear, normally distributed relationships and sample size influence with large datasets (B. E. Frye & Bartlett, 2017).

Logistic regression is often preferred to multiple regression as it is not sensitive to violations of linearity or normality and purposeful sample are created for additional analysis (B. E. Frye & Bartlett, 2017). When using propensity score matching researchers should ensure there is adequate sample size for the creation of the treatment and control groups (Rosenbaum & Rubin, 1984). Researchers should always check for missing values, address any outliers that may impact the model, and screen for correlation between covariates.

Following the creation of the treatment and control group, researchers may perform t-tests and chi-square analysis to evaluate student outcomes in performance, retention, and completion.

Recommendations for Research

While research exists on the impact of technology in higher education, there remains opportunity to expand research on the impact of providing technology resources and support to students in higher education. The following provides a summary of areas where research related to providing technology resources to community college students is needed as well as opportunities to expand and support research in the field.

The recommendations for research include broadening the scope of the original research to explore results from other community colleges; a qualitative study with students who participated in the laptop loan program to better understand the impact of the program on the student experience; research into which resources or factors in combination with the laptop loan program have the greatest impact on student outcomes; the impact of the pandemic on resource utilization and academic performance; how technology is used in the classroom and how that impacts student outcomes; comparing students who have home Internet with students who do not have a home internet connection and how the distinction impacts outcomes.

Recommendation 1. Further research should be conducted on laptop loan programs in community colleges of varying locations, types, and sizes to determine if outcomes from Wolfpack community college hold true at other institutions, and to identify differences that may impact outcomes or inform the development of future programs.

A limitation of this study is the fact that participants for the study were derived from a single, sub-urban community college in North Carolina. Further research should be completed in community colleges from a diverse group of community colleges. Researchers should explore differences in outcomes at urban and rural colleges compared to suburban community colleges as well as community colleges from different areas of the country. Beyond geographic and community type differences, research should be completed at community colleges of different sizes and potentially different support capabilities.

Broadening the location, type, and size of the community college would help practitioners determine if the observations from Wolfpack Community College would hold true in other types of community colleges. Exploring a broad range of community colleges could also highlight differences between laptop loan programs which may impact outcomes or inform the development of future programs intended to provide technology to students. Expanded studies could help determine if there is correlation between other demographic or enrollment factors and outcomes, changes to outcomes at scale, or other factors that may result in different outcomes from the study.

Recommendation 2. A follow-up, qualitative study of program participants could help refine the program, provide insight into their experiences, and identify barriers that affected outcomes.

This study is a quantitative study that uses propensity score matching to determine the impact on student outcomes of loaning a laptop to community college students. This study only evaluates quantitative markers and does not speak to qualitative experiences that may impact the results of the study. Additional research should include a qualitative study of program participants to learn more about their experience in the program and how participation in the program impacted their overall educational experience.

Likely most students who participated in the laptop loan program also had access to a laptop or tablet device as part of a K-12 one-to-one device program. Similar programs in K-12 have been proven to improve access and have a positive impact on learning outcomes (Bebell & Kay, 2010; Heubeck, 2022). Community colleges remain a low-cost option for students and presumably providing additional resources to assist students with completing their course work would have a positive impact on outcomes (Spica & Biddix, 2021). Yet, study results show that while students who participated in the program attempted and earned more credits, their GPA and overall completion rates were lower than students who did not participate in the program.

These results exist with a group that is predominately Pell eligible and identify as Black where nationally just over 50% individuals making less than $26,000 per year own a computer, and 64% of individuals who identify as Black own a computer (Martin, 2021).

A qualitative study of program participants could answer questions about the experience of the students participating in the program including how the program impacted a student's feeling of belonging, did the student feel the laptop supported their educational goals, did the students feel that having the laptop opened the opportunity to take more courses, did the student utilize the support resources provided and feel they were helpful, as well as other questions that may provide insight into the overall experience. Qualitative results could also help identify other barriers that may have impacted completion and performance results. Finally, qualitative analysis could help to identify ways to refine the program and provide insight into other areas of the college, such as the classroom experience, where more effective use of technology may improve the outcome results for students.

Recommendation 3. Additional research should be conducted to understand the other factors that may have impacted the outcomes observed in the study, particularly for low-income and part-time students who often face a combination of challenges that make completing their coursework difficult.

Results from the study indicated both positive and negative outcomes for students who participated in the laptop loan program compared to students who did not participate but otherwise shared similar characteristics. Additional research should be performed to understand what other factors or resources may have impacted the outcomes observed in the study.

While students may benefit from being provided a computer, if they are facing other challenges that impede their ability to complete their coursework then outcomes may be negatively impacted. Often it is not a single factor that impacts a student's experience but multiple factors. A student may be facing food insecurity, supporting children or other family members, all while dealing with work obligations and challenges that may make completing a degree or program difficult. The study participants were predominately part-time and lower income. Historically lower income and part-time students take longer to complete or struggle to ever complete compared to full-time students and students with greater financial resources (Levesque, 2018). These students struggle to pay for college, they are frequently working jobs, and they struggle to feel like they belong in college (Schneider, 2022). Research that looks at a combination of resources to support students will help practitioners create stronger program and structures that could lead to improved outcomes.

Recommendation 4. The COVID-19 pandemic greatly disrupted education, accelerated trends toward online education, and had a particularly strong impact on low-income students. Future research should explore the pandemic's impact on education and the use of technology in education.

This research was performed during a global medical crisis that had a significant impact on individuals, colleges, and society. The COVID-19 pandemic was massively disruptive to education, requiring the overwhelming majority of courses to move online or into an alternative format in a very short period of time. In many ways, the pandemic acted as an accelerator for trends that were already happening in education. The popularity of online education has been growing over the past several years and tools such as Zoom have become vital parts of the educational experience. The pandemic required even technology-resistant schools to embrace technology.

This rapid change came in the midst of economic disruption that saw more than 10 million people lose their job and 25% of people have trouble covering basic expenses (Center on Budget and Policy Priorities, 2022; O'Donnell et al., 2020). Researchers know that the pandemic had a particularly strong impact on low-income and underserved individuals.

While students have communicated appreciation for the resources made available during the pandemic, including laptop computers, student outcomes during the pandemic struggled. Enrollment was down, completion was down, and overall education disruption only increased (Finkel, 2021). Future research should explore the impact of the pandemic on education and how technology contributed to education's response to the pandemic.

Recommendation 5. While the laptop loan program showed that participants retained at a higher level while attempting and completing more credits, their GPA was lower, indicating a need for additional research on how faculty use laptops in the classroom as well as the skills and training required for faculty to effectively incorporate technology in the classroom.

Results from the study showed that students who participated in the laptop loan program retained at a higher rate, attempted more credits, and completed more credits but that the student's GPA was lower. Research has shown that access to a laptop in the classroom has multiple benefits, including collaboration, note-taking, media consumption, assignment completion, and increased engagement (Kay & Lauricella, 2011; McKenzie, 2021). There appears to be a disconnect between the benefits of a laptop and the outcomes for students who participated in the Wolfpack laptop loan program. Additional research should explore the classroom experience for participants of the laptop loan program.

The study utilized data provided through the student information system and program participant records to complete the analysis. The study did not review learning management system data or explore the classroom experience and how that impacted outcomes for laptop loan participants. Research could explore how faculty use laptops in the classroom, what skills and training impact the faculty members use of technology in the classroom, and what skills are needed for the student to be successful in the classroom using the laptop. Nearly 20% of students have reported struggling to learn the technology required for use in the classroom (Wood, 2021). Students enrolling directly from high school also frequently enter college without the technology skills necessary to complete their coursework (Elliott et al., 2018). Similarly, faculty often struggle to effectively support and incorporate technology in the classroom. Further research into the use of technology in the classroom could help loan programs develop training resources sensitive to the specific needs of the classroom for faculty and students.

Recommendation 6. The lack of Internet access is an issue for many students and a growing number of community colleges have built Internet hotspot programs to support connectivity for students in need. Further studies should explore the impact on student outcomes of providing broadband connectivity to students as well as the combined impact of providing both broadband access and a laptop computer.

As the digital divide has evolved over the last several years the importance of access to the Internet has continued to grow. With an average cost of nearly $60 per month, the majority of people making less than $30,000 per year do not have broadband in their home (Winslow, 2019). This lack of access exists in a higher education ecosystem that has seen a dramatic increase in the use of technology over the past several years. Even in areas where broadband exists speeds may be low or inconsistent. Microsoft found that there are more than 125 million individuals in the United States with a home download speed of less than 25 Mbps and less than 3 Mpbs upload speed. In households where there are multiple individuals in school, there is frequently a need to share technology and bandwidth resources, often disadvantaging the older student who may be attending college (McKenzie, 2021). As one analyst indicates:

> “Kids can’t do homework. Older people have to drive off our islands to talk to a doctor. Boats delivering live lobsters from the ocean that can’t ‘talk’ in real-time to their customers lose a competitive edge in the supply chain. Before long, young families, older citizens, and jobs leave. New employers don’t come in.” (Winslow, 2019)

Many community colleges have built Internet hotspot programs to support connectivity for students in need. Like the laptop loan program, these programs provide Internet connectivity for students who otherwise may not have access to a broadband connection outside of school. These programs take different forms, and many programs are intended for short-term use. Often these programs are smaller than laptop loan or one-to-one device programs due to the ongoing service cost associated with maintaining the connection. As these programs continue to grow researchers should perform studies exploring the impact on student outcomes of providing broadband to connectivity to students. This study can serve as a guide for the process and development of future research around the impact of connectivity. There is also an opportunity to explore the combined impact on student outcomes of providing both broadband access and a laptop computer.

Recommendations for Theory

Various theories have been used when studying the impact of technology in education. Frequently the Technology Acceptance Model, developed by Davis in the 1980’s, is used to evaluate the impact of technology in various situations (Davis, 1989). This study focused on exploring the impact of providing the computer on student outcomes. As a result, Resource

Theory was a better fit for analyzing the outcomes of the study. Resource theory explores how a student uses a resource to accomplish a desired outcome (E. B. Foa & Foa, 1980).

Although resource theories have identified and helped measure the connection between a resource and desired outcome, there is an opportunity to expand the scope of resource theory to incorporate the value of the resource provided into the theory. The reality is that not all resources hold equal value and likely have varying degrees of impact on the desired outcome. While laptops are shown to have enough power to impact the retention rate, number of course taken, credits attempted, and credits earned, a laptop may not have enough power to impact the student's GPA.

Resource theory of the firm does recognize that the value of a resource may have an impact on the ability to obtain a desire outcome (Dorsch et al., 2017). Resource Theory of the Firm examines value of a resource from the perspective of resource value, inimitability, rarity, and substitutability (Dorsch et al., 2017). This value proposition is focused on the potential to gain an outcome in a competitive environment. While this approach to value makes sense in the competitive business marketplace, it does not translate as well to the education context. For the purposes of education, identifying value as the power of a resource to impact the accomplishment of a desired outcome would assist researchers in further determining the weight of impact a resource had on a desired outcome.

Additionally, further research on providing laptops and other technology to students in the community college could benefit from expanding the scope of resource theory and look at the impact of multiple resources in combination on student outcomes. Investigating the impact of technology on student outcomes from a combined perspective of both Resource Theory and the Technology Acceptance Model could also provide valuable insight into both the use of resources to accomplish goals but also the impact of ease of use in adopting technology in the educational context.

Limitations

There were 6 limitations recognized as part of this study. First, this study was limited to two years' worth of enrollment, participation, and outcome data. The scope of the study did not provide sufficient time to determine if part-time students would complete more degrees, diplomas, or certificates based on participation in the program. The average time to complete a degree at Wolfpack Community College is 5 years for the combined group of part-time and full-time students. Results did indicate that participants completed more courses, yet there has been insufficient time to determine if increases in courses taken and credits earned will result in faster or higher completion.

Second, there was no control over which students chose to participate in the laptop loan program and which students did not choose to participate. This limitation meant that some demographic characteristics were more prevalent in the data than others. The data showed that more women, students who identify as Black and Pell-eligible students were present in the data compared to their peers.

Third, students are not required to have a laptop, or other computing device, to attend the college. Students may choose to use another type of device, or devices available exclusively on campus to complete their courses. As a result, the study cannot account for the fact that a non-participant in the control group may have already owned or had access to a laptop to complete their coursework. The study could not account for the prior ownership of a computer, number of computers available in the household, or impact of other computing factors outside of participation in the laptop loan program.

Fourth, the analysis presented in the study focuses on the impact on student outcomes of participating in the laptop loan program and does not account for additional factors that may impact student outcomes. There are other factors students must account for when attending college that could have impacted the outcomes of both students who participated in the laptop loan program as well as those who did not participate in the program. Factors include areas outside of what is collected by the college's student information system or other student support systems. While these factors may impact student outcomes, they are outside of the scope of this study. Additionally, some factors outside of the scope of the study, in combination with participation in the laptop loan program may impact student outcomes or further explain the results presented as part of this study.

Fifth, this study does not directly evaluate the impact of the COVID-19 pandemic on either laptop program participation or student outcomes. The pandemic had a significant impact on education and the student experience. Many courses that previously had been offered in-person were required to move online to support public health and safety. Students experienced disruption both in the college and outside of the college that could impact outcomes. Factors related specifically to the pandemic that could impact student outcomes are not captured or analyzed as part of this study.

The final limitation is that propensity score matching eliminated a significant number of students from the final analysis. Propensity score matching simulates an randomized experimental design by build a matching treatment and control group from a larger dataset (Titus, 2007). The total number of records used in the final analysis are reduced as part of the matching process. Although the total number of records analyzed is reduced through the matching process, the validity of statistical results is increased, and challenges associated with selection bias are accounted for.

Conclusion

The use of technology in every American's daily life continues to grow. Technology is woven into the fabric of industry, government, education, and general daily life. In order to create a competitive workforce for the future, community colleges must embrace the use of technology in the education process. While the need for technology in education continues to expand, there also remains a large digital divide for many students. Many students frequently do not have access to the technology they need to complete their education and be competitive in the workforce. Students need access to a laptop and the software required to complete their educational goals. Without this access and corresponding support, students will be less likely to succeed, resulting in a further expansion of the digital divide, lower student success outcomes, and could contribute to further income inequality.

This study examines the impact of providing laptops to students and furthers research on the role technology plays in the community college experience. The study showed that providing laptops and support for students in need results in higher retention, more courses being taken, more credits attempted, and more credits earned. This credit momentum and stronger retention has the potential to reduce time to completion and improve outcomes for students over time. The credit momentum and stronger retention also results in greater income to the community college, helping to justify the expense of providing laptops to students. Providing these important resources helps to better prepare a student for the technology-enabled workforce of the future.

During the global pandemic, technology in education experienced an acceleration beyond the rapid adoption that was already taking place. Classes moved online, and every student needed a device to complete their coursework, while traditional methods of supporting students were upended. The observed results of the study occurred during the heart of the global pandemic. Coming out of the pandemic, online and technology-enabled learning continues to be popular with students, and the need to ensure every student has the technology they need to succeed shows no signs of slowing down.

As Dallas Herring, a key figure in the development of North Carolina community colleges, stated, it is the community college's job to "take the people where they are and carry them as far as they can go" (McClellan, 2022).

While additional research and time will provide even more clarity on the impact of the Wolfpack program, the study shows great promise for future programs and can help inform the development of similar programs at other community colleges. Providing resources to help students succeed and be competitive in the workforce only serves to benefit the community college and community it serves.

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